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Technology Finance, Enterprise Digital Transformation, and Internal Control Quality

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Abstract

This article first comprehensively measures the digitalization level of physical enterprises of Shanghai and Shenzhen listed companies from 2007 to 2022. Secondly, with the help of the "Promoting the Integration of Technology and Finance Pilot" policy, a difference in differences model is used to identify the impact of technology and finance on the quality of internal control of enterprises, and the role of enterprise digital transformation in it is analyzed. Research has found that: firstly, the implementation of technology finance policies can effectively improve the quality level of internal control in enterprises, and this conclusion still holds significant after a series of robustness tests; Secondly, the level of digitalization in enterprises plays a moderating role between technology finance and internal control quality; Thirdly, heterogeneity analysis found that the promotion effect of technology finance pilot policies on the digital transformation and internal control quality of physical enterprises is more significant in the eastern region and high-tech industries. The research results of this article not only reveal the impact pathways and economic outcomes of technology finance policies on promoting internal control quality in enterprises, but also provide important experience and inspiration for the formulation of relevant policies for future enterprise development.

Keywords

Technology finance; Digital transformation; Internal control quality; Difference-in-Difference.

1. Introduction

The real economy is an important pillar of national economic development and plays a crucial role in promoting high-quality social and economic growth. Internal control of enterprises is of great significance to the overall economic system and social stability at the macro level. Good internal control helps to improve market transparency and standardization, reduce market uncertainty and risks, promote healthy market development, and ultimately promote economic stability and sustainable growth. In 2011, relevant departments gradually launched the "Pilot Program for Promoting the Integration of Technology and Finance" to promote innovative development of finance and guide financial resources to become an important driving force for promoting technological innovation. So, under the implementation of technology finance policies, can technology finance become a new driving force for improving the quality of internal control in enterprises, and what are the ways to promote the quality of internal control in enterprises. Comprehensively clarifying these issues can not only provide useful guidance for enterprises' innovative development and optimized management service construction in theory, but also help enterprises deeply understand the internal mechanism of technology

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finance policies, implement policy effects, and thereby improve the quality and level of enterprise development, promoting high-quality economic development in China.

The increasingly complex domestic and international economic environment has raised the country's requirements for the economic and management level of enterprises, and the role of internal control systems in enterprise management processes is becoming more and more evident. The success of a company is not only about catering to the market, but also about having an efficient operating system. However, nowadays most companies are eager to develop their economy and are committed to short-term planning such as how to occupy the market and sell products. They lack sufficient attention to improving the quality of internal control in order to seek longer-term development, which leads to many problems encountered by the company in the later stage of development and is also not conducive to the stable operation of the market. Therefore, we need to increase the importance that enterprises attach to the quality of internal control and strengthen the construction of the internal control system in Chinese enterprises.

General Secretary Xi Jinping pointed out that "digital technology is fully integrated into all fields and the whole process of human economy, politics, culture, society, and ecological civilization construction with new concepts, new formats, and new models, bringing broad and profound impacts on human production and life", and digital transformation is becoming an inevitable trend of enterprise strategic choice in the digital economy era [1]. How to build a bridge between digitalization and internal control quality requires the implementation of certain policies. In 1993, the Shenzhen Science and Technology Bureau first abbreviated "technology and finance" as "technology finance", which entered the public eye and received widespread attention from all sectors of society. After more than 30 years of development, China's technology finance has gradually formed a multi-channel, all-round, and multi perspective technology finance system with technology branches, technology insurance, venture capital, and multi-level capital markets. The so-called technology finance policies refer to a series of policy measures aimed at promoting the deep integration of technology and finance, supporting technological innovation and industrial development, which are usually formulated and implemented by the government[2]. At present, the implementation of technology finance policies can effectively promote the digital transformation of enterprises, reduce obstacles in the transformation process, and influence the quality of internal control through digitalization, thereby achieving a virtuous cycle effect and enhancing the core competitiveness of enterprises. This article is based on this research on how digital transformation can realize the effectiveness of technology finance policies, promote high-quality development of enterprises, and provide theoretical basis for enterprises to cope with the digital wave.

This article uses the exogenous shock events of the technology finance pilot policy and employs the difference in differences method to empirically test the impact of technology finance on the internal control quality of real enterprises. Research has found that pilot policies for technology finance have significantly improved the internal control quality of physical enterprises. Further testing has shown that pilot policies can strengthen the quality of enterprise management by promoting digital transformation. Heterogeneity tests show that the promotion effect of technology finance pilot policies on the digital transformation and internal control quality of physical enterprises is more significant in the eastern region and high-tech industries.

The marginal contribution of this article is reflected in the following two aspects: firstly, existing literature such as Xue Ying et al. (2020) [3], Hu Huanhuan et al. (2021) [4], Gu Jianghan et al. (2022) [5] mostly focus on the impact of technology finance on economic development, industrial structure, green innovation development, etc., but there is no literature exploring the impact of technology finance pilot policies on internal quality control of enterprises. This article examines the implementation effect of technology finance policies from the perspective of enterprise management, providing empirical evidence for the first time and supplementing

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relevant literature on the consequences of technology finance pilot policies. Secondly, Qi Huaijin et al. (2020) [6] and Li Hui (2020) [7] pointed out that the development of the digital economy plays a significant role in the high-quality development of enterprises. However, these studies face questions about endogeneity, and how to accurately identify the causal relationship between the two and explore their mechanisms of action still needs further clarification. Based on this, this article provides causal evidence for the impact of technology finance development on the high-quality development of enterprises using exogenous shock events of technology finance pilot policies, and further explores possible mechanisms of action, supplementing relevant research on the high-quality development of enterprises.

2. Theoretical Analysis and Research Hypotheses

2.1. Technology Finance and Internal Control Quality

Many companies in the market, in pursuit of profits, often excessively compress costs and neglect the construction of internal control management mechanisms. This leads to a lack of motivation for enterprises in the later stages of development, resulting in many management problems and inability to resist business risks, forcing them to exit the market. In response to the new situation and challenges of internal control in the development of enterprises, the implementation of technology finance policies can effectively play the guiding role of the government. By reducing transaction costs, improving the ability of enterprises to cope with risks, and improving the information communication mechanism of enterprises, internal management of enterprises can be optimized. Through information digitization platforms, the circulation and sharing of enterprise information can be promoted, and financial risks can be reduced. In addition, technology finance policies can continuously improve the follow-up guarantee for enterprise development, encourage innovative businesses in various regions, establish risk diversification mechanisms, implement financial insurance subsidy policies, and improve enterprise management mechanisms[8]. Through a series of measures, technology finance policies can effectively improve the external development environment of enterprises, stimulate their management vitality, increase the importance of internal control, enhance their ability to cope with market risks, and promote their long-term development[9]. Based on the above analysis, hypothesis 1 is proposed.

H1: The implementation of technology finance policies has a positive impact on the quality of internal control in enterprises.

2.2. Enterprise digital transformation and internal control quality

With the continuous advancement of digital transformation, advanced scientific and technological advancements such as big data and artificial intelligence have profoundly influenced the internal control system of enterprises, becoming important tools for enterprise transformation and fully improving their ability to process information[10]. Based on relevant literature, we found that the impact of enterprise digital transformation on internal control quality mainly focuses on two aspects: control environment and risk identification. From the perspective of control environment, the digital transformation of internal control system is a systematic work, involving strategic adjustment, technological innovation, mode transformation, management change, capacity building and other aspects. Digital technology can deeply integrate with business processes, evolve the internal control system into a three-dimensional network structure, make it more flexible, and optimize internal governance efficiency [11]. At the same time, it can monitor changes in the internal and external environment of the enterprise in real time, use technologies such as big data and digital commonalities, clarify deficiencies, weaknesses, and deficiencies in the design and implementation of the internal control system, and improve the competitiveness of the

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enterprise; From the perspective of risk identification, firstly, the high usability and penetration of digital technology can improve the interaction system and information disclosure system between enterprises and stakeholders, greatly reducing information asymmetry and interaction costs between enterprises and stakeholders[12]. At the same time, it also reduces opportunistic tendencies caused by information opacity, and has advantages in important aspects such as information communication and audit supervision, which can enhance the effectiveness of internal control and reduce management risks[13]. Secondly, digital transformation can help improve the accuracy of risk assessment, risk response, and monitoring, that is, digital transformation can fully utilize data as a production factor, improve the efficiency of information utilization, help enterprise management timely and accurately discover problems in the business process, respond to changes in the industry and market, and play a role in risk diversification[14]. Based on the above analysis, hypothesis 2 is proposed.

H2: Digital transformation of enterprises can promote the improvement of internal control quality.

2.3. Technology finance, enterprise digital transformation, and internal control quality

The digital transformation of enterprises can significantly regulate the promoting effect of technology finance policies on internal control quality. The main purpose of implementing technology finance policies is to solve the problem of insufficient innovation motivation for enterprises. In the current era of rapid development of the digital economy, technological innovation relies on big data to grasp market dynamics and cutting-edge information. The implementation of technology finance policies can not only establish a digital platform for technology finance information through new information technology, enabling enterprises to understand technical knowledge in different fields and effectively utilize resources through the platform, but also drive technological development with innovative financial resources, and play a leading role in the high-quality development of enterprises through the innovation driven development strategy[15]. The development of enterprises cannot be separated from effective internal management. Effective internal control can improve operational efficiency, protect asset security, and provide guarantees for enterprise risk management. The digital transformation of enterprises can effectively regulate the relationship between the two. On the one hand, the implementation of technology finance can alleviate the financing constraints of physical enterprises, stimulate the vitality of digital transformation of enterprises [16], and then rely on scientific and effective digital information technology to coordinate various aspects of internal management and operation of enterprises, establish a comprehensive risk management framework, and strengthen the internal control awareness and responsibility of senior leaders. On the other hand, in the early stages of establishment, enterprises need some time to form an internal control system that suits their own situation. If they cannot quickly and accurately form and improve their internal management system, they may be overwhelmed by market risks and unable to develop and grow. Even if the implementation of technology finance policies can provide certain guarantees, enterprises still need to internalize the policies as a support plate as their own development driving force. The information exchange brought about by digital transformation breaks the traditional enterprise development model. Enterprises can use the information resources provided by big data platforms to reduce information collection costs, find like-minded partners, acquire knowledge elements, learn advanced management methods, enhance management capabilities, reduce trial and error costs, communicate and exchange with other enterprises, and achieve win-win cooperation. Based on the above analysis, hypothesis 3 is proposed.

H3: Enterprise digital transformation can regulate the relationship between technology finance policies and internal control quality of enterprises.

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3. Research Design

3.1. Data sources

In order to better match the implementation effect of financial technology policies, cater to the development trend of the digital economy, and avoid text mining errors caused by core digital industries such as Internet enterprises, software research and development enterprises, this paper selects the data of A-share listed companies in Shanghai and Shenzhen from 2007 to 2022, and filters and processes the samples according to the following criteria: (1) ST, * ST, PT companies are excluded, mainly considering the interference of abnormal data; (2) Exclude companies in the real estate and financial industries; (3) Exclude company sample data with missing data. Finally, 12961 samples were obtained for empirical analysis. To reduce the impact of extreme values on empirical results, this study conducted a 1% tail reduction on all continuous variables in the sample. This article studies the use of Python software to mine the required annual report data of listed companies for Chinese text analysis. The corporate governance and financial data are sourced from the China Economic and Financial Database (CCER) and the Guotai An Database (CSMAR).

3.2. Variable Declaration

3.2.1. Pilot policies for the integration of technology and finance

Technology finance is a systematic arrangement of financial tools, policies, and related services that promote technological research and development, achievement transformation, and the development of high-tech industries. It is a complete system composed of the main body and corresponding behavioral activities that provide financial resources.In order to promote the integration of science and technology and finance, the Ministry of Science and Technology, the People's Bank of China and other relevant departments carried out the first pilot work of science and technology and finance integration in 16 regions in 2011. Subsequently, multiple supporting measures have been introduced to promote the deep integration of technology and finance. The purpose of the pilot is to support technological innovation and the development of technology enterprises, promote high-level technological self-reliance and self-improvement, and achieve high-quality development. The Ministry of Science and Technology, the People's Bank of China and other relevant departments started the second batch of pilot work in nine cities, including Zhengzhou and Xiamen, in 2016. With the acceleration of science and technology finance policies, whether the implementation of policies can promote the digital transformation and internal control quality of enterprises, and achieve high-quality development of enterprises[18]is the main content of this paper.Therefore, this article takes the pilot policy of integrating technology and finance as a quasi natural experiment, and uses the double difference and triple difference methods to evaluate the effectiveness of policy implementation. According to the list of pilot cities and regions for science and technology finance policies released by the country, determine the sample of pilot cities and non pilot cities, and set up virtual variables of treatment for the experimental group and control group. If the enterprise belongs to the science and technology finance policy pilot city, the treatment value is 1, and the treatment value for other non pilot city enterprises is 0. Next, set the policy time dummy variable 'post'. If it belongs to the policy implementation time range (2011 and later, and the second batch of pilot cities opened in 2016), the value of 'post' will be 1, and for other times it will be 0.

3.2.2. Enterprise digital transformation

The enterprise digital transformation data used in this article draws on the indicators constructed by Wu Fei et al. (2021) [19]. Existing literature mainly focuses on theoretical research on digital transformation, such as Chen Chunhua et al. (2019) [20], Chen Jian et al. (2020) [21], Xiao Jinghua (2020) [22], etc. There is little quantitative research on digital

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transformation. Regarding how to measure the intensity of digital transformation, Wu Fei et al. found from the perspective of national strategy that characteristic information of digital transformation is more easily reflected in the annual reports of enterprises with summarizing and guiding properties. Therefore, the corresponding keyword frequency measurement in the annual reports published by listed companies can be used as a proxy indicator of the degree of enterprise digital transformation. The specific technical implementation is to use Python crawler function to collect and organize the annual reports of all A-share listed companies on the Shanghai Stock Exchange and Shenzhen Stock Exchange, and extract all text content through the Java PDFbox library. After Python software word segmentation and manual recognition, a digital transformation feature keyword map is sorted and summarized to perform text analysis on the annual reports of enterprises, and the frequency of each feature keyword is calculated and summed up. The final technical data obtained has serious right bias problems. Therefore, the sum of the word frequency data was subjected to natural logarithmic processing, resulting in another explanatory variable for this article, enterprise digital transformation (Digital). The larger the value of this indicator, the higher the degree of digital transformation of the enterprise.

3.2.3. Internal control quality of enterprises

This article draws on the practices of Liu Hao et al. (2015) [23] and Liu Yunguo et al. (2016) [24], using the internal control index released by Shenzhen Dibo Big Data Research Center as a proxy variable for internal control quality. The index includes five information indicators closely related to internal control quality, namely internal environment, risk assessment, control activities, information and communication, and internal supervision. At the same time, internal control deficiencies are used as a correction variable to modify the basic internal control index, ultimately forming an internal control index that comprehensively reflects the internal control level and risk management ability of listed companies, and comprehensively depicts the internal control level and risk management ability of enterprises.

3.2.4. Control variable

This article refers to the relevant research of Liu Qiliang (2012) [25], Zhang Chuancai, and Chen Hanwen (2017) [26], and comprehensively considers the main factors that affect the quality of internal control in enterprises. The following indicators are mainly used as control variables: enterprise size (Size), return on equity (ROE), asset liability ratio (LEV), board independence (Indep), executive shareholding ratio (Mshare), cash flow ratio (Cashflow), dual role, whether the auditor comes from the Big Four accounting firms (Big4), audit opinion type (Opinion), and equity balance (Balance 3).

The main variable definitions involved in this article are shown in Table 1.

3.3. Descriptives

The descriptive statistical results of the main variables are shown in Table 2 (logarithmic variablesare taken as natural logarithms). From the table, it can be seen that the average internal control quality (IC) is 6.7340 (maximum value 9.1580), indicating that the overall level of internal control quality of Chinese listed companies is relatively high. The average digital transformation of enterprises is 3.7160, with a maximum value of 7.0120 and a minimum value of 1.0990, indicating that there are certain differences in the degree of digital transformation among different enterprises.

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Table 1. Variable Definition

Variable		Variable Symbol	Variable Declaration
Explained Variable	Internal Control Quality	IC	DiBo Internal Control Index/100
explanatory variable	Technology and finance policies	treat×post	The treatment for pilot cities is 1, and for non pilot cities it is 0; Posts from 2011 onwards are 1. Posts before 2011 are 0
Adjusting variables	Enterprise digital transformation	Digital	Logarithmic processing of related word frequency summation in corporate annual reports
control variable	Enterprise size	Size	Natural logarithm of annual total assets
	Roe	ROE	Net profit/average balance of shareholders' equity
	Asset liability ratio	LEV	Year end total liabilities/Year end total assets
	board Independence	Indep	Independent directors divided by the number of directors
	Executive shareholding ratio	Mshare	Number of shares held by directors, supervisors and senior executives/total share capital
	Cash flow ratio	Cashflow	Net cash flows from operating activities/total assets
	duality	Dual	If the chairman and general manager are the same person, it is 1; otherwise, it is 0
	Are auditors from the Big Four accounting firms	Big4	The company has been audited by the Big Four (PwC, Deloitte, KPMG, Ernst&Young) and is rated as 1, otherwise it is rated as 0
	Type of audit opinion	Opinion	If the company's financial report for that year is issued with a standard audit opinion, the value is 1; otherwise, it is 0
	power balance with shareholder structure	Balance3	The sum of the shareholding ratios of the second to tenth major shareholders/the shareholding ratio of the first major shareholder

Table 2. Descriptive statistics of main variables

variable	Observation numbers	mean value	median	standard deviation	Maximum value	minimum value
IC	12961	6.7340	6.7970	0.8780	9.1580	2.8570
treat×post	12961	0.4390	0.0000	0.4960	1.0000	0.0000
Digital	12961	3.7160	3.6640	1.3390	7.0120	1.0990
Size	12961	22.5500	22.4400	1.2990	26.1100	20.0600
LEV	12961	0.4680	0.4780	0.1830	0.8420	0.0750
ROE	12961	0.0830	0.0760	0.0950	0.3730	-0.2600
Cashflow	12961	0.0570	0.0540	0.0660	0.2490	-0.1300
INV	12961	0.1370	0.1180	0.1070	0.5240	0.0000
Indep	12961	36.9200	33.3300	5.2570	57.1400	30.0000
Dual	12961	0.1590	0.0000	0.3660	1.0000	0.0000
Balance3	12961	0.7540	0.5470	0.6910	3.3790	0.0320
Mshare	12961	3.3190	0.0080	9.3870	50.2600	0.0000
Big4	12961	0.0790	0.0000	0.2700	1.0000	0.0000

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3.4. Modeling

3.4.1. Technology Finance and Internal Control Quality

This article uses model (1) to explore the impact of technology finance policies on the quality of internal control in enterprises:

$$IC_{i,t}=\beta_0+\beta_1(treat\times post)_{i,t}+ Controls + u_i+ v_t + \varepsilon_{i,t} \quad (1)$$

The interaction term 'treat x post' is the explanatory variable in this article, and its estimated coefficient can reflect the net effect of the implementation of technology finance pilot policies. In Model (1), this article focuses on examining the coefficient β_1 of technology finance policy. Controls represents a series of control variables, ui is the industry fixed effect, vt is the time fixed effect, and $\varepsilon_{i,t}$ are the random error terms. The expected coefficient β_1 is significantly positive.

3.4.2. Enterprise digital transformation and internal control quality

This article uses model (2) to explore the impact of digital transformation on the quality of internal control in enterprises:

$$IC_{i,t}=\beta_1 Digital_{i,t}+Controls+u_i+v_t+\varepsilon_{i,t} \quad (2)$$

In model (2), the focus is on examining the digital transformation coefficient β_1 of enterprises. According to hypothesis H2, digital transformation of enterprises can improve the quality of internal control. Therefore, it is expected that the coefficient β_1 will be significantly positive.

3.4.3. Technology finance, enterprise digital transformation, and internal control quality

In the research design of this article, we will use non pilot enterprises that have not implemented financial technology policies as the control group. In order to further explore the impact of digital transformation on the internal control quality of enterprises and its moderating effect on the relationship between technology finance policies and internal control quality, we will use model (3) for regression analysis:

$$IC_{i,t}= \alpha + \beta_1 Digital_{i,t}\times(treat\times post)_{i,t}+ \beta_2 Digital_{i,t} + \beta_3(treat\times post)_{i,t}+ Controls +u_i+ v_t + \varepsilon_{i,t} \quad (3)$$

In Model (3), this study focuses on the coefficient β_1 of the interaction term between digital transformation and fintech policies [$Digital_{i,t}$ * (treat x post) $_{i,t}$]. According to hypothesis H3, it is expected that digital transformation of enterprises can significantly regulate the promoting effect of technology finance policies on internal control quality, therefore, the coefficient β_1 is significantly positive.

4. Empirical Result Analysis

4.1. Technology Finance and Internal Control Quality

This article regresses model (1), and the results are shown in Table 3. The first column onlycontrols for fixed effects, while the second column includes control variables at the company level. The results show that, in the absence of controlled variables, the coefficient of technology finance policy is significantly positive at the 5% level; After adding control variables, the coefficient of technology finance policies remains significant, indicating that the

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implementation of technology finance policies can significantly improve the quality level of internal control in enterprises, which is consistent with hypothesis 1.

Table 3. Regression Results of Technology Finance and Internal Control Quality

variable	Model (1)	
	IC	IC
treat×post	0.0786**	0.0643*
	(0.0345)	(0.0256)
Size		0.2047***
		(0.0161)
LEV		-0.2594***
		(0.0521)
ROE		3.1640***
		(0.1033)
Cashflow		-0.0376
		(0.0978)
Indep		0.0005
		(0.0018)
Dual		-0.0140
		(0.0232)
Balance3		-0.0314**
		(0.0149)
Mshare		-0.0015
		(0.0011)
Big4		0.1329***
		(0.0365)
Opinion		1.5116***
		(0.1254)
Constant term	6.9943***	1.0831***
	(0.1103)	(0.3553)
N	12961	12961
R2	0.0881	0.3560
industry effect	control	control
Year effect	control	control
Province effect	control	control
p	0.000	0.000

Note: The standard errors for province clustering are in parentheses* The** And * * * indicate that the coefficients are significant at the 10%, 5%, and 1% levels, respectively; All regressions are fixed effects models, controlling for year fixed effects, province fixed effects, and industry fixed effects. Same below.

4.2. Enterprise digital transformation and internal control quality

This article regresses model (2), and the results are shown in Table 4. The first and third columns only controlled for fixed effects, while the second and fourth columns included control variables at the company level. The results show that there is a significant positive relationship between enterprise digital transformation and internal control quality without considering technology finance policies. Without controlling variables, it is significantly positive at the 1% level, and after controlling variables, it is significantly positive at the 5% level. Under the

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influence of technology and finance policies, digital transformation of enterprises still has a significant positive effect on improving the quality of internal control. The results indicate that digital transformation of enterprises can effectively improve the quality of internal management, reduce the probability of decision-making errors caused by information distortion, significantly reduce agency costs and communication costs between enterprises, improve information transparency and management efficiency of enterprises, and thus enhance the quality level of internal control of enterprises. Meets the expectations of hypothesis 2 in this article.

Table 4. Regression Results of Enterprise Digital Transformation and Internal Control Quality

variable	Model (2)			
	IC	IC	IC	IC
treat×post			0.0670*	0.0595*
			(0.0304)	(0.0325)
Digital	0.0844***	0.0251**	0.0829***	0.0236**
	(0.0120)	(0.0109)	(0.0117)	(0.0105)
Size		0.2001***		0.2002***
		(0.0160)		(0.0160)
LEV		-0.2581***		-0.2603***
		(0.0533)		(0.0533)
ROE		3.1528***		3.1502***
		(0.1019)		(0.1033)
Cashflow		-0.0418		-0.0279
		(0.0966)		(0.0990)
Indep		0.0004		0.0004
		(0.0018)		(0.0018)
Dual		-0.0161		-0.0166
		(0.0228)		(0.0228)
Balance3		-0.0326**		-0.0315**
		(0.0150)		(0.0148)
Mshare		-0.0017		-0.0017
		(0.0010)		(0.0010)
Big4		0.1391***		0.1381***
		(0.0359)		(0.0351)
Opinion		1.5137***		1.5110***
		(0.1253)		(0.1255)
Constant term	6.7816***	1.1193***	6.7846***	1.1215***
	(0.1082)	(0.3583)	(0.1098)	(0.3562)
N	12961	12961	12961	12961
R2	0.0966	0.3561	0.0972	0.3566
p	0.000	0.000	0.000	0.000

4.3. Technology finance, enterprise digital transformation, and internal control quality

This article regresses model (3), and the results are shown in Table 5. The first column only controls for fixed effects, while the second column includes control variables at the company level. The results show that technology finance policies are significantly positive at the 5% level, and enterprise digital transformation is significantly positive at the 1% level. The interaction term between technology finance policies and enterprise digital transformation is significantly positive at the 5% and 10% levels, respectively. This result indicates that, based on assumptions 1 and 2, digital transformation of enterprises can significantly regulate the promoting effect of

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technology and finance policies on internal control quality. When the degree of digital transformation of enterprises is high, the level of internal control quality will also be correspondingly improved, ensuring the effectiveness of internal control to a certain extent and promoting the improvement of internal control quality. The above analysis results support hypothesis 3 of this study.

Table 5. Regression Results of Technology Finance, Enterprise Digital Transformation, and Internal Control Quality

variable	Model (3)	
	IC	IC
treat×post	0.2431**	0.1433*
	(0.1134)	(0.0819)
Digital	0.1057***	0.0341**
	(0.0171)	(0.0139)
Digital*(treat×post)	0.0241***	0.0134*
	(0.0068)	(0.0073)
Size		0.2003***
		(0.0161)
LEV		-0.2606***
		(0.0540)
ROE		3.1435***
		(0.0987)
Cashflow		-0.0281
		(0.0994)
Indep		0.0004
		(0.0018)
Dual		-0.0163
		(0.0228)
Balance3		-0.0316**
		(0.0148)
Mshare		-0.0017
		(0.0010)
Big4		0.1387***
		(0.0355)
Opinion		1.5112***
		(0.1262)
Constant term	6.7212***	1.0894***
	(0.1090)	(0.3668)
N	12961	12961
R2	0.0982	0.3569
p	0.000	0.000

5. Robustness Test

5.1. Parallel trend testing and dynamic analysis

The parallel trend hypothesis is a core and important prerequisite for evaluating the effectiveness of policy implementation using the difference in differences (DID) model. This paper studies the model through parallel trend testing and dynamic analysis, and the test

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results are shown in Figure 1. The results showed that the confidence interval of the estimated coefficients for the years before the implementation of technology finance (2007-2010) included zero and was below the baseline, indicating that there was no significant difference in the internal control quality level between the experimental group and the control group before the pilot policy was implemented, meeting the parallel trend hypothesis; After the implementation of technology finance policies (2011-2022), the estimated coefficient of the model is positive and does not include zero in the confidence interval, which passes the test. This indicates that the implementation of technology finance policies has a sustained positive impact on the quality of internal control in enterprises. In addition, from a dynamic perspective, we can see that in the years after the implementation of the policy, as the policy continues to advance, the internal control quality coefficient of physical enterprises gradually increases, indicating that the implementation of the policy has a continuously strengthening dynamic evolution in improving the level of internal control quality of enterprises.

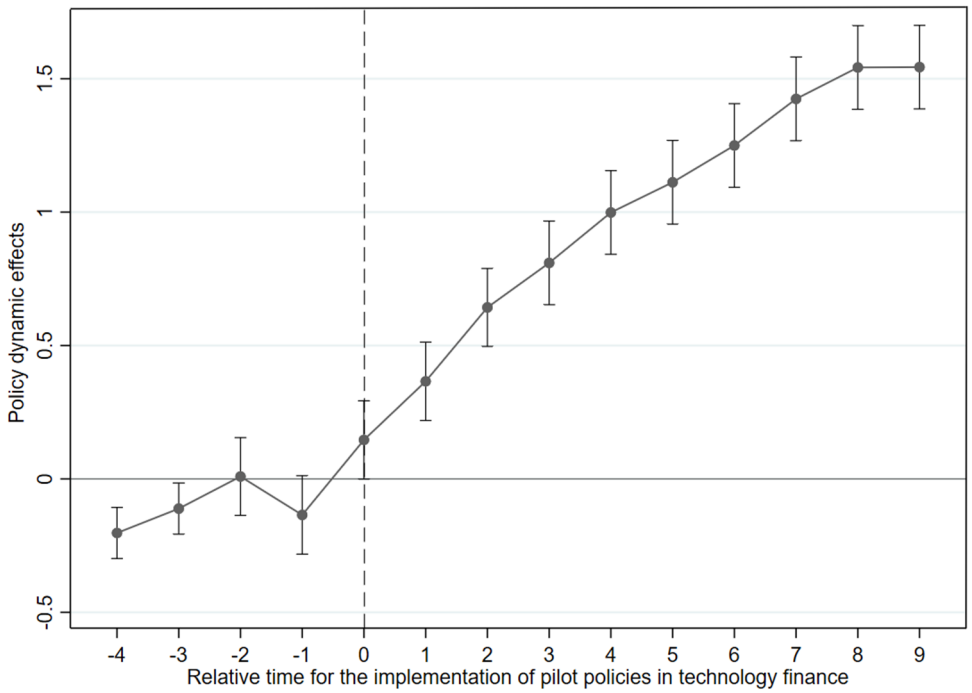

Figure 1. Parallel Trend Test

5.2. Endogeneity test

The implementation of policie**s is** influenced by certain time factors, so the effectiveness of implementation needs to be proven over time. In addition, the selection of pilot cities may have non randomness, taking into account the economic development level, resource endowment, and regional advantages of different cities, which play a key role in the effectiveness of policy implementation. The differences in these factors over time may have different impacts on the quality level of internal control of enterprises, leading to the hypothesis being invalid. Therefore, this article adopts different methods to overcome the endogeneity problem caused by the sample screening process.

5.2.1. Adopting propensity score matching method

This article uses propensity score matching method to overcome the endogeneity problem of the sample. After 1:1 nearest neighbor matching, it was found that there was no significant difference between the experimental group and the control group at the 10% level. Using the matched samples for further validation, the results remain robust.

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5.2.2. Using instrumental variable method

Based on the previous discussion of causal relationships among variables, we can conclude that there is a high possibility of reverse causal relationships between variables. Simply put, the implementation of technology finance policies will optimize the internal management of enterprises to a certain extent, and the continuous improvement of the quality level of internal control of enterprises will also reverse the effectiveness of the implementation of technology finance policies. Therefore, we choose instrumental variables from two aspects to alleviate the problem of sample endogeneity. Drawing on relevant literature, the first instrumental variable we selected is the number of listed companies in the province where the company is located (PLCN). On the one hand, the more listed companies in the province, the higher the level of financial technology development in that region, indicating a certain correlation between the two; On the other hand, the strategic choice of internal control quality for general listed companies is not obvious and has exclusivity. For the second instrumental variable, we select the mean financial development level (Fin) of the two other prefecture level cities closest to the GDP of the enterprise's location (measured by the ratio of institutional deposit and loan balances to GDP). On the one hand, the GDP of similar regions is similar, and their financial technology structures also have a certain degree of similarity and high correlation, which meets the requirements of the experiment; On the other hand, the level of financial technology development in similar regions is difficult to be directly affected by macro GDP and has a certain degree of exogeneity. The instrumental variable regression results also support the main conclusion of this article.

5.2.3. Other robustness tests

Firstly, only retain the sample data from 2011 to 2022 for re regression to eliminate the impact of the 2008 financial crisis. Secondly, remove the sampledata from four municipalities directly under the central government and regress. Observing the regression results, the above regression results are still robust.

Table 6. Regression results of robustness test

variable	(4)	(5)	(6)	(7)	(8)
	PSM	first stage	Second stage	IC	IC
		treat×post	IC		
treat×post	0.0971***		0.1316***	0.1347**	0.1161**
	(0.0352)		(0.0371)	(0.0612)	(0.0526)
Digital	0.0384***			0.0383***	0.0265***
	(0.0116)			(0.0125)	(0.0099)
Digital*(treat×post)				0.0210***	0.0179***
				(0.0048)	(0.0041)
PLCN		0.0394***			
		(0.0012)			
Fin		0.0670***			
		(0.0023)			
Constant term	6.9085***	-0.3082***	0.8890***	0.4761*	1.4334***
	(0.0502)	(0.0867)	(0.1609)	(0.2881)	(0.2830)
N	12961	12961	12961	9864	10634
R2	0.0056	0.4239	0.3638	0.2337	0.3528
control variable	control	control	control	control	control

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6. Heterogeneity Analysis

The heterogeneous impact of technology finance as an important policy innovation has also attracted much attention. This article explores the heterogeneous impact of technology finance policies on the digital transformation and internal control quality level of enterprises from two perspectives: geographical location differences and industry differences.

Table 7. Regression Results of Technology Finance Policies and Internal Control Quality

variable	(9) Eastern region	(10) Western Region	(11) Central region	(12) High tech industry	(13) Non high-tech industries
treat×post	0.1172***	0.0081	-0.0774	0.0597**	0.0033
	(0.0228)	(0.0825)	(0.0640)	(0.0247)	(0.0418)
Size	0.2209***	0.1475***	0.2064***	0.1858***	0.2159***
	(0.0218)	(0.0346)	(0.0238)	(0.0128)	(0.0229)
LEV	-0.2449***	-0.4051**	-0.1906	-0.1878***	-0.3084***
	(0.0561)	(0.1598)	(0.1358)	(0.0536)	(0.1097)
ROE	3.2721***	2.9938***	2.8624***	3.3559***	3.0173***
	(0.1224)	(0.2781)	(0.2588)	(0.1363)	(0.1465)
Cashflow	0.0508	-0.2867*	0.0157	-0.0542	0.2053
	(0.1143)	(0.1301)	(0.3104)	(0.1446)	(0.1957)
Indep	0.0012	-0.0061	0.0039	0.0011	0.0014
	(0.0023)	(0.0034)	(0.0035)	(0.0018)	(0.0030)
Dual	0.0034	-0.0608	-0.0025	-0.0423*	0.0178
	(0.0023)	(0.0739)	(0.0555)	(0.0235)	(0.0385)
Balance3	-0.0505**	0.0179	0.0113	-0.0274**	-0.0236
	(0.0222)	(0.0199)	(0.0391)	(0.0123)	(0.0178)
Mshare	-0.0010	-0.0076**	0.0034	-0.0018*	-0.0020
	(0.0015)	(0.0022)	(0.0021)	(0.0010)	(0.0021)
Big4	0.1134**	0.1111	0.1763**	0.1141***	0.1997**
	(0.0365)	(0.1179)	(0.0784)	(0.0389)	(0.0792)
Opinion	1.4817***	1.9195***	1.3378***	1.5450***	1.4593***
	(0.1336)	(0.4294)	(0.2045)	(0.1554)	(0.1842)
Constant term	0.8520	2.1392**	0.8131	1.3685***	1.0585**
	(0.5003)	(0.6505)	(0.6851)	(0.2984)	(0.5049)
N	8289	2626	2046	6810	6151
R2	0.3805	0.3295	0.3620	0.3983	0.3199

6.1. The impact of geographical location

This article divides the sample cities into three regional modules: the eastern region, the western region, and the central region to explain regional heterogeneity. The results are shown in models (9) - (11) in Table 7. After comparing the regression results, it was found that the eastern region had the most significant effect. This may be because the development of technology finance in the eastern region mainly relies on market forces, forming a relatively complete technology finance system that is more effective in promoting enterprise development. In the central and western regions, the government's intervention in the development of technology finance is relatively high, and the market's role is relatively weak, resulting in insignificant effects and impacts on the implementation of technology finance policies. According to the table, the regression coefficient of the double difference variable 'treat x post' in the eastern region is significantly positive, indicating that the implementation of

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technology finance policies can stimulate the development vitality of enterprises in the eastern region. However, the coefficient is not significant in the western and central regions, indicating significant regional differences in the implementation effect of technology finance policies.

Table 8. Regression Results of Technology Finance, Enterprise Digital Transformation, and Internal Control Quality

variable	(14)	(15)	(16)	(17)	(18)
	Eastern region	Western Region	Central region	High tech industry	Non high-tech industries
treat×post	0.2261**	0.1588	-0.1226	0.1078*	0.1651
	(0.0967)	(0.2375)	(0.2061)	(0.0614)	(0.0988)
Digital	0.0446**	0.0219	0.0393	0.0262**	0.0401**
	(0.0183)	(0.0199)	(0.0289)	(0.0111)	(0.0186)
Digital*(treat×post)	0.0226***	-0.0452	0.0192	0.0123***	-0.0433*
	(0.0048)	(0.0505)	(0.0445)	(0.0047)	(0.0243)
Size	0.2148***	0.1197**	0.1724***	0.1824***	0.2132***
	(0.0220)	(0.0421)	(0.0279)	(0.0128)	(0.0234)
LEV	-0.2402***	-0.2534	-0.0849	-0.1831***	-0.3086***
	(0.0587)	(0.1700)	(0.1716)	(0.0537)	(0.1096)
ROE	3.2427***	3.1857***	2.9202***	3.3369***	2.9946***
	(0.1098)	(0.2899)	(0.2638)	(0.1356)	(0.1462)
Cashflow	0.0687	0.0132	0.2012	-0.0376	0.1968
	(0.1169)	(0.2156)	(0.3441)	(0.1450)	(0.1978)
Indep	0.0011	0.0005	0.0022	0.0011	0.0015
	(0.0024)	(0.0022)	(0.0039)	(0.0018)	(0.0030)
Dual	0.0007	-0.0735	0.0153	0.0434*	0.0162
	(0.0208)	(0.0723)	(0.0591)	(0.0233)	(0.0391)
Balance3	-0.0509**	0.0148	0.0076	-0.0273**	-0.0235
	(0.0223)	(0.0252)	(0.0412)	(0.0123)	(0.0179)
Mshare	-0.0013	-0.0061**	-0.0017	-0.0020**	-0.0021
	(0.0014)	(0.0020)	(0.0028)	(0.0010)	(0.0021)
Big4	0.1178***	0.0866	0.2327*	0.1186***	0.2013**
	(0.0351)	(0.1135)	(0.1103)	(0.0388)	(0.0795)
Opinion	1.4885***	1.8542***	1.3407***	1.5189***	1.4706***
	(0.1323)	(0.3694)	(0.2376)	(0.1562)	(0.1845)
Constant term	0.8766	2.3900**	1.6937*	1.3822***	1.0042*
	(0.5273)	(0.7199)	(0.8458)	(0.3010)	(0.5285)
N	8289	2626	2046	6810	6151
R2	0.3819	0.3255	0.3350	0.3989	0.3209

6.2. The impact of industry differences

This article refers to the approach of Peng Hongxing et al. (2017) [27], draws on the "Classification Catalogue of Strategic Emerging Industries", "Classification of Strategic Emerging Industries (2012) (Trial)", and relevant documents of the Organization for Economic Cooperation and Development (OECD), and compares with the "Guidelines for Industry Classification of Listed Companies (Revised in 2012)" to determine the industry codes of high-

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tech listed companies. Therefore, the sample listed companies are divided into two types: high-tech industries and non high-tech industries. With the integration of finance and technology and the continuous promotion of digital transformation of enterprises, the impact of digitalization on the internal control quality of high-tech industries is becoming more apparent. Because the financial system established by technology finance policies can effectively support enterprise innovation activities, compared to other industries, the industrial chain updates quickly and research and development investment is large. Therefore, strong policy support can reduce obstacles in development, and promote the digital development of enterprises and the orderly promotion of innovation activities. As shown in the table, the impact of technology finance policies in the high-tech industry is significantly positive at the 10% and 5% levels, respectively, supporting the above viewpoint.

7. Conclusion and Suggestions

With more and more enterprises joining the wave of digital development, the deep integration of digital economy and real economy has become an important development trend in the future. The effective combination of technology and finance is needed to support digital transformation and internal control quality of enterprises. This article is based on panel data of Shanghai and Shenzhen listed companies from 2007 to 2022 as the research sample. Using text analysis of corporate annual reports, the digital transformation level of physical enterprises is identified. Based on the implementation of the "Promoting the Integration of Technology and Finance Pilot" policy, the impact of the technology finance pilot policy on the quality of internal control of enterprises is evaluated using the difference in differences method. The results showed that technology finance policies can significantly promote the quality of internal control of enterprises by enhancing their level of digital transformation, and this conclusion still holds true after a series of robustness tests. Heterogeneity analysis shows that the promotion effect of pilot policies on internal control quality of enterprises is more significant in the eastern region and high-tech industries.

The research findings in this article have significant practical and policy implications. On the one hand, our research indicates that the development of technology finance is an important factor in improving the quality of enterprise management. With the development of China's digital economy and the further improvement of enterprise digitalization, there is still room for further improvement in the quality of enterprise management[28]; On the other hand, the improvement of enterprise digitalization level can further strengthen the impact of technology finance on the quality of internal control of enterprises. This means that reducing the cost of enterprise digital transformation through policy intervention can effectively improve the quality of enterprise management and promote high-quality development of enterprises. Possible policy options include: firstly, further deepening the reform of the financial system, improving the external operating environment of enterprises, reducing the cost burden of external transactions, and effectively stimulating the potential for digital transformation of enterprises. Secondly, given the regional differences in policy effectiveness, the government can consider formulating regional differentiated policies and developing more effective measures for the central and western regions to promote the development of science and technology finance and improve the quality of internal control of enterprises in these areas[29]. Thirdly, for different industries, the government can provide phased policy support and resource allocation to enhance the digitalization level of high-tech industries, drive the overall improvement of related industrial chains, and promote the high-quality development of various industries.

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