

Enterprise Digital Transformation and Financial Risk

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Abstract. Digital transformation is an inevitable choice for contemporary enterprises to accelerate sustainable development. This paper empirically analyzes the impact of digital transformation on the financial risk of enterprises, using the data of Chinese A-share non-financial listed companies from 2009-2021 as a sample. The results of the study show that the implementation of digital transformation has a significant effect on reducing corporate financial risk; it also examines that there is a substitution relationship between the quality of internal control and the marketization process on the suppression of corporate financial risk; further research analysis, the suppression effect of digital transformation on corporate financial risk is more significant in non-state-owned enterprises and competitive industry, the impact of digital transformation on mitigating financial risk is more significant in high-tech enterprises and higher research investment. Finally, the article proposes countermeasures and policy implications in three aspects: promoting the development and investment of digital transformation, improving the monitoring mechanism of digital economy development, and optimizing the supervision of enterprise digital transformation to increase social responsibility.

Keywords: digital transformation, financial risk, internal control quality, marketization process, Heterogeneity analysis.

1. Introduction

In recent years, with the iteration of new digital technologies such as artificial intelligence, blockchain, cloud computing, and big data, digital transformation has become one of the strategic imperatives for enterprises to cope with increasingly fierce competition, which indicates the trend of integration and penetration with traditional enterprise services and the use of digital technology to realize enterprise transformation. The top-level design, the "14th Five-Year Plan" outline clearly: put forward to meet the digital era, activate the potential of data elements, promote the construction of a strong network country, to create a new advantage of the digital economy goals outline. According to the discussion of China's national conditions, the digital economy is not only a new variable for economic transformation and growth but also a new blue ocean for economic quality and efficiency. Therefore, accelerate insight into the digital transformation model to achieve high-quality sustainable development, is becoming a consensus from the state to various departments around the world, and then to enterprises in various industries.

Financial risks of enterprises are important hindering factors that affect the normal operation of enterprises. As a kind of signal, financial risk can reflect the enterprise's operation in a thorough manner, which is conducive to good management decisions by stakeholders, such as senior management, to achieve the expected goals of the enterprise (Li, Jiequn, 2010). In order to reduce the financial risk caused by unfavorable factors, digital transformation is an inevitable choice for modern enterprises, which can help improve the revenue and profitability of enterprises and bring significant financial value. While digital transformation can help increase company value, however, companies must effectively prevent and control financial risks if they are to achieve sustainable long-term growth. Therefore, at the time of accelerating the development of the digital economy in China, it is necessary to explore the mechanism of the impact of digital transformation on corporate financial risk and to propose relevant policy recommendations on the future development of corporate digital transformation.

2. Literature Review

2.1 Digital Transformation

Digital transformation is a product of technological innovation, and at the level of its economic consequences for enterprises, the digital operation can not only help manufacturing enterprises to achieve cost reduction and efficiency, improve operational efficiency and added value of economic activities, but also improve productivity and management efficiency, and promote high-quality development of enterprises (Zhao Yan, 2022). Digital infrastructure construction has a positive effect on the total factor productivity of enterprises, and promoting R&D innovation, reducing transaction costs, and improving management efficiency are the paths through which new digital infrastructure affects the total factor productivity of enterprises (Wen, Huwei, 2022). In the process of digital transformation, the citation of digital technology plays an active role in optimizing resource allocation efficiency, building new competitive advantages for enterprises, and reducing production costs, especially labor costs (Zhou, Hsiao, 2022). The promotion effect of digital transformation on enterprise innovation is mainly realized through improving management efficiency, information transparency, risk-taking level, and optimizing human capital structure (Yang Jie, Ma Congwen, Liu Yuncai, 2022). Meanwhile, digital transformation enhances innovation efficiency through, upgrading the integration of production factors(Xu mengzhou, Lv Tie 2022), and enhancing industrial chain synergy (Wu, H.L., 2021), which helps promote sustainable development of enterprises, where the quality of internal control and innovation play a mediating role in the relationship between the two (Li Yuan, Xue Yulian, 2022). In summary, the development of digitalization can contribute to the sustainable development of enterprises, which also provides ideas for the view of digital transformation to reduce financial risks.

2.2 Financial risk

Corporate financial risk is the concentration of micro-enterprise business risk, which is expressed in two aspects of financial results and financial position, including four categories of financing risk, investment risk, capital repayment risk, and earnings distribution risk (Xiang, D.W., 1994). Studies on the factors influencing financial risk have focused on the macro and micro levels. At the macro level, the government's monetary policy tightening can increase the financial risk mechanism of enterprises (Jiang, 2023), and the significant reduction effect of government audits on the financial risk of state-owned enterprises (Chen, Ying-Chen, 2022); at the social level, the active fulfillment of social responsibility by enterprises can help reduce financial risk, and media attention can further strengthen the weakening effect of social responsibility on financial risk (Wu Yangwen, Tang Shenfeng, Wei Shiwei, 2021). From the perspective of business activities, factors such as market recession, development strategy mistakes, and fierce competition in the industry can lead to higher financial risks for enterprises (Zhang Li, Liu Haiyan, 2012) . The micro-level factors include The micro-level factors include internal control, corporate governance, capital structure, internal . Asiligwa and Rennox (2017) studied the impact of internal control on the financial performance of commercial banks in Kenya, from the perspective of the internal governance effect of the board of directors, a well-developed internal governance mechanism of the board of directors can effectively prevent and control financial risks (Zhang, Dunli, 2013); the degree of surplus manipulation and accounting tax differences of the firm both contribute significantly to the financial risk of the firm (Xu, Y. L., 2022). Existing literature has studied the influencing factors of corporate financial risk from macro and micro aspects, but little research has been conducted on the impact of corporate digital transformation on financial risk.

2.3 Literature Summary

At the current research level, there are many research results on digital transformation to drive enterprise development, including digital transformation can reduce the level of information asymmetry of enterprises (Wu, et al., 2022) Digital transformation can drive business model

innovation (Zhang, Z.Y., 1994). It also promotes green technology innovation in resource-based enterprises. It can also improve total factor productivity of enterprises (Zhao Chenyu, Wang Wenchun, Li Xuesong, 2021) and enhance corporate social responsibility (Zhao Chenyu, 2021). Digital technologies such as big data, cloud computing, artificial intelligence, and the Internet of Things are gradually embedded in the business and production operations of enterprises, and the application of digital technologies can identify and control the financial risks of enterprises in a timely and effective manner, and help enterprises achieve efficient business processes, perfect customer experience, and broad value creation. From the background of digital transformation, it is proposed that the complex digital environment has overturned the traditional financial risk identification path and discussed how to effectively identify and control corporate financial risks (Hang, Huiqin, 2022); some scholars have empirically tested the impact of corporate digital transformation on corporate debt financing costs and its mechanism of action using a fixed-effect model (Liu, Monza, 2022). However, the effect on the overall financial risk is not discussed in depth, so focusing on the role of enterprise digital transformation in financial risk reduction is an important research direction.

This paper draws on existing research to analyze the effect of digital transformation on corporate financial risk. The possible marginal contributions of this paper are: first, to focus on examining the relationship between digital transformation and corporate financial risk; second, to explore the moderating role of the level of marketization process and internal control quality between digital transformation and corporate financial risk; third, to examine the effect of digital transformation on corporate financial risk from four aspects: property rights attributes, industry concentration, R&D expenditure degree and corporate attributes.

3. Theoretical analysis study and hypothesis

In this paper, the inhibiting effect of digital transformation on corporate financial risk is divided into three points as follows.

First, digital transformation is conducive to improving business operations [16]. The digital transformation of enterprises takes digital information as the carrier to transform and upgrade the products, sales, business model, and organizational culture of enterprises in all aspects, and improves the efficiency of enterprise resource allocation through the extensive collection and rapid processing of information (Duy, et al., 2022). The improvement of enterprise refinement management and intensive production level can help to reduce business risks, improve management efficiency, and thus reduce the risk of financial default.

Second, digital transformation reduces financial risk by promoting product innovation (Mukesh, 2022) and enhancing product capabilities to further improve operating profitability. Digital transformation of client-side platforms can significantly improve the sensitivity of enterprises to market demand, helping them to quickly grasp business opportunities, precisely define and match market demand (Zhang, et al., 2022) promote product innovation and enhance product capability. The integration and innovation of next-generation information technology and industrial technology help develop operational intellectual property (Teker & Orendil, 2022), which in turn gives rise to innovative intelligent products and high-experience products or services with functions such as sensing, interaction, decision-making, and optimization, enhancing user experience and increasing the value of unit products and services, so that enterprises can help solve users' pain points. Therefore, product innovation can help companies solve users' pain points, meet new demands, and achieve sustainable profit growth for the company, thus reducing financial risks.

Third, digital transformation further curbs financial risks by adjusting the financing structure and reducing financing costs. Enterprises use big data for capital flow analysis, according to which they can guide their capital interaction activities with upstream and downstream enterprises as well as their lending activities with financial institutions, which can effectively improve the efficiency of enterprise capital allocation (Wang Yuanchuo, 2021), smooth the enterprise's capital supply and

demand curve, and reduce the cost of financing. At the same time, enterprises rely on intelligent and efficient information collection technology, which can not only improve internal financial efficiency but also improve the efficiency of docking and cooperation with financial institutions and upstream and downstream enterprises, thus accelerating the working capital turnover rate and improving the financial stability of enterprises (Panshin, 2021). In summary, the following hypotheses are proposed in this paper.

H1: Digital transformation of enterprises can reduce the financial risk of enterprises.

Internal controls are accounting and auditing processes used by a company's finance department to ensure the integrity of financial reporting and regulatory compliance. They help companies comply with laws and regulations, prevent fraud, thereby effectively mitigating adverse shocks, and improving the robustness of the company's financial position. As a result, companies with good-quality internal controls have relatively low financial risk. The digital transformation of companies helps to enhance the information advantage of companies, promote due diligence, enhance their risk warning capability, improve their innovation performance, and reduce financial risk (Yang, 2022). For companies with a high level of internal control, a sound internal control system can suppress financial risks. In contrast, companies with inadequate internal control are more likely to face financial crisis, which leads to digital transformation and effective information for risk avoidance, thus ensuring the achievement of business efficiency goals and corporate return on capital goals. Thus, the quality of internal control plays a substitute moderating effect and further weakens the role of digital transformation in mitigating corporate financial risks. In summary, this paper proposes the following hypotheses.

H2: There is a substitution effect of internal control on digital transformation in reducing the financial risk of enterprises.

Marketization refers to the process of transforming an entire economy from a planned economic system to a larger market-based organization, with the central motivation that increased competition within a sector will stimulate efficiency gains. As a region becomes more market-oriented, the corresponding degree of economic liberalization will be higher (Li, Wengui, and Yu, Minggui, 2012). Therefore, in regions with a high degree of marketization, first, it reduces information asymmetry, promotes the flow and concentration of innovation resources, reduces the probability of mismatching innovation resources, helps subjects to innovate, and continuously improves innovation efficiency; second, the market environment is relatively fair and transparent, which makes financing more convenient and development more rapid, and the market circulation of data factors in regions with a high degree of marketization is faster, which can realize highly efficient information transmission, significantly reducing the cost of information acquisition. Currently, the need for enterprises to improve their innovation output and accelerate the integration of external resources through digital transformation decreases, and the inhibiting effect of digitalization on enterprise financial risk becomes weaker. In summary, this paper proposes the following hypotheses.

H3: There is a substitution effect of the regional marketization process on digital transformation in terms of reducing corporate financial risk.

4. Study Design

4.1 Sample selection.

The article takes 2009-2021 Chinese A-share listed companies as the research object, and the data required for the empirical analysis are obtained from the Guotaian database, Flush database, and annual reports of sample companies. In order to ensure the scientific and accuracy of the research findings, the data are processed as follows: the financial, ST and *ST listed companies and the samples with missing data and insolvency are excluded. In order to ensure the robustness of the research findings, all continuous variables are subjected to tailoring at the 1% and 99% quartiles to eliminate the interference of extreme values.

4.2 Variable definition

First, the explanatory variable: is a corporate financial risk (Z-Score). The article draws on the Z-score of risk method proposed by Altman (1968) to measure the risk. The Z-Score is calculated as follows: $Z\text{-Score} = (1.2 \times \text{working capital} + 1.4 \times \text{retained earnings} + 3.3 \times \text{EBIT} + 0.6 \times \text{total stock market value} + 0.999 \times \text{sales revenue}) / \text{total assets}$, the smaller the Z index, the higher the financial risk of the enterprise. Taking the opposite of this index, if there is a negative coefficient between digital transformation and corporate financial risk, it indicates that digital transformation reduces corporate financial risk, and vice versa.

Second, the core explanatory variable: the degree of digital transformation (Digital). The degree of digital transformation of companies in the Guotaian database was used for estimation. According to Wu Fei et al. and Yi Luxia et al.'s study, we used Python software to crawl the keywords of "digital transformation" in the annual reports of listed companies, matched and counted them, and finally obtained the digital transformation intensity (DCG) index, and plagiarized it.

Third, the moderating variable: internal control quality (ICQ). The internal control quality is characterized by the internal control evaluation level of listed enterprises published by Shenzhen Dibao, and ICQ is considered as high internal control quality and takes the value of 1 when it gets an A or B grade, while it is considered as low internal control quality and takes the value of 0 when it gets C or D grade. Marketization process (MI). Referring to the study of Wang Xiaolu et al. (2021), this paper uses the marketization index in the report of China's marketization index by the province as the moderating variable. The index consists of five indices in total: the relationship between government and the market, the development of a non-state economy, the development of the product market, the development of the factor market, the development of market intermediary organizations and the legal environment, reflecting the marketization progress of each province, municipality and autonomous region in China (excluding Hong Kong, Macao and Taiwan).

Table 1 Variable Definitions

Variable Type	Variable Name	Variable Symbols	Definition
Explained variables	Corporate Financial Risk	Z-score	The Z-value-at-risk method proposed by Altman (1968) was used to measure
Explanatory variables	Digital Transformation	Digital	Indexing using keyword frequency
Adjustment variables	Quality of internal control	ICQ	Natural logarithm measure of internal control index
	Marketization process	MI	Total marketization index to measure the marketization process
Control variables	Enterprise size	Asset	Logarithmic total assets
	Profitability	ROA	Net profit growth rate
	Macroeconomic Environment	GDP	Select the GDP growth rate of the province where the enterprise is located (including provinces, autonomous regions and municipalities directly under the central government, the same as below)
	Leverage	Gearing	Gearing ratio
	Growth Opportunities	Tobin Q	The market value of the company/replacement cost of assets
	Shareholding Concentration	BLOCK	The shareholding ratio of the top ten shareholders
	Growth capacity	P/B ratio	Market price per share / Net assets per share
	Director Size	Board size	Take the natural logarithm

Fourth, control variables: firm size (Asset), gearing (Gearing), firm profitability (ROA), macroeconomic environment (GDP), growth opportunity (Tobin Q), equity concentration (Block), growth capacity (P/B ratio), and board size (Block size) are selected as control variables; while controlling for year and industry effects. The specific variables are defined in Table 1.

4.3 Model setting

To test the hypothesis of the article, a regression model of digital transformation and corporate financial risk was developed and with the quality of internal controls and the marketization process as moderating variables.

$$Zscore_{i,t} = \partial_0 + \partial_1 Digital + \partial_2 control_{i,t} + \partial_3 Year_{i,t} + \partial_4 industry_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$Zscore_{i,t} = \partial_0 + \partial_1 Digital + \partial_2 Digital * ICQ + \partial_3 ICQ + \partial_4 control_{i,t} + \partial_3 Year_{i,t} + \partial_4 industry_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$Zscore_{i,t} = \partial_0 + \partial_1 Digital + \partial_2 Digital * MI + \partial_3 MI + \partial_4 control_{i,t} + \partial_3 Year_{i,t} + \partial_4 industry_{i,t} + \varepsilon_{i,t} \quad (3)$$

where Z-score denotes corporate financial risk, Digital denotes digital transformation index, control denotes control variables other than year and industry, ICQ denotes internal control quality, MI denotes marketization process, Digital*ICQ and Digital*MI are interaction terms, year and industry denote year and industry, respectively. Fixed effects, and ε is a random disturbance term.

5. Analysis of empirical results

5.1 Descriptive statistics

Table 2 shows the results of descriptive statistics of variables. The results show that the maximum value of the opposite of the corporate financial risk (Z-score) is 0.499 and the minimum

value is -37.27, which indicates that different companies face different degrees of financial risk. The standard deviation of the degree of digital transformation (Digital) is 1.014, with a maximum value of 4.159 and a minimum value of 0, indicating that there is a difference in the degree of digital transformation among different companies. The median value is 0.693 and the mean value is 0.872, which indicates that most companies are still in the early stage of digital transformation. In terms of control variables, there are different degrees of differences among the sample companies in the selection of company size (Asset), gearing (Gearing), corporate profitability (ROA), macroeconomic environment (GDP), growth opportunity (Tobin Q), equity concentration (Block), growth capacity (P/B ratio), and board size (Block size). There are different degrees of differences in

Table 2 Descriptive statistics

Variables	Number of samples	Average value	Standard deviation	Minimum value	Median	Maximum value
Digital	37,835	0.872	1.014	0	0.693	4.159
Z-score	37,835	-4.715	5.832	-37.27	-2.963	0.499
Gearing	37,835	0.425	0.223	0	0.414	0.979
GDP	37,835	93.56	36.61	0	107.5	115
Block	37,835	0.493	0.250	0	0.545	0.918
ROA	37,835	0.0372	0.0709	-0.333	0.0385	0.213
PB	37,835	3.660	3.640	0	2.683	24.39
Tobin Q	37,835	1.988	1.482	0	1.581	9.614
Asset	37,835	22.11	1.388	19.25	21.92	26.41
Board size	37,835	2.094	0.335	0	2.197	2.708

5.2 Correlation analysis

The results of the correlation analysis, Table 3, show that the correlation coefficient between the digitalization process Digital and financial risk Z-score is negative and passes the significance test, indicating a significant negative correlation, which is consistent with the content of H1. As for the control variables, firm size (Asset), firm profitability (ROA), macroeconomic environment (GDP), growth opportunity (Tobin Q), equity concentration (BLOCK), and growth capacity (P/B ratio) are significantly and negatively correlated with financial risk Z-score, while gearing is significantly and positively correlated with financial risk Z-score. The score is significantly positively correlated with financial risk Z-score.

Table 3 Correlation analysis

	Z-score	Digital	Asset	Gearing	ROA	Tobin Q	PB	GDP	Block	Board size
Z-score	1									
Digital	-0.061***	1								
Asset	-0.328***	0.058***	1							
Gearing	0.534***	-0.046***	0.425***	1						
ROA	-0.254***	0.013***	-0.013**	-0.378***	1					
Tobin Q	-0.646***	0.050***	-0.338***	-0.133***	0.048***	1				
PB	-0.408***	0.033***	-0.326***	0.010*	0.033***	0.751***	1			
GDP	-0.011**	-0.083***	-0.074***	0.094***	-0.00400	0.020***	0.019***	1		
Block	-0.013**	-0.014***	0.035***	0.055***	0.052***	-0.009*	0.00300	0.200***	1	
Board size	-0.009*	0.045***	0.148***	0.258***	-0.00100	0.065***	0.041***	0.274***	0.220***	1

Standard errors in parentheses

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

5.3 Underlying empirical regression results

Table 4 reports the regression results of the impact of digital transformation on the financial risk of enterprises. The results show that the coefficient of Digital is -0.202 and significant at the 1% level, indicating that digital transformation can significantly reduce corporate financial risk and

hypothesis H1 is verified. The regressions were conducted in steps, and the coefficients were negative and significantly correlated, making the findings more robust.

Table 4 Results of the empirical analysis

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Digital	-0.704*** (0.0408)	-0.363*** (0.0342)	-0.244*** (0.0342)	-0.240*** (0.0342)	-0.237*** (0.0342)	-0.202*** (0.0342)
ROA		10.46*** (0.408)	10.43*** (0.378)	10.17*** (0.380)	10.10*** (0.380)	9.359*** (0.384)
Gearing		-20.89*** (0.205)	-20.17*** (0.196)	-20.42*** (0.199)	-20.40*** (0.199)	-19.97*** (0.202)
Asset			-0.384*** (0.0367)	-0.345*** (0.0371)	-0.306*** (0.0385)	-0.328*** (0.0385)
Tobin Q			1.324*** (0.0191)	1.199*** (0.0257)	1.211*** (0.0260)	1.272*** (0.0263)
PB				0.0742*** (0.0102)	0.0724*** (0.0102)	0.0575*** (0.0103)
GDP					0.00245** * (0.000664)	0.00132** (0.000669)
Board size						-0.117 (0.195)
Block						3.420*** (0.262)
Constant	7.313*** (0.0445)	15.62*** (0.101)	21.01*** (0.794)	20.25*** (0.800)	19.14*** (0.855)	18.01*** (0.947)
Observations	37,835	37,835	37,835	37,835	37,835	37,835
R-squared	0.308	0.308	0.403	0.404	0.404	0.408
Year & Industry	yes	yes	yes	yes	yes	yes

Standard errors in parentheses

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

5.4 Moderating effect test

With the continuous development of digital transformation, the following moderating effect model is constructed to explore the moderating effect of the level of internal control and marketability of the company between the development of digital transformation and corporate financial risk: where ICQ and MI are the interaction terms of digital transformation and the level of corporate governance. The regression results are shown in the table. The coefficient of the interaction term between digital transformation and internal company control is 0.0187 and the coefficient on financial risk is -0.0364, and it is positively correlated at 1% significance level, indicating that both internal company control and digital transformation have the effect of reducing corporate financial risk, i.e., the level of internal company control weakens the negative relationship between digital transformation and corporate financial risk. The coefficient of the interaction term between digital transformation and marketization process is 0.0214 and the coefficient on financial risk is -0.103 and is negatively correlated at 1% level of significance, which indicates that overall, there is a significant alternative relationship between both the level of internal control of the company and marketization process in terms of the inhibitory effect of digital transformation on financial risk.

Table 5 Regression results of moderation effects

VARIABLES	(1)	(2)
Digital	-0.395*** (0.0612)	-0.327*** (0.0607)
Digital*ICQ	0.0347*** (0.00911)	-
ICQ	-0.0364*** (0.0133)	-
Digital*MI	-	0.0214*** (0.00774)
MI	-	-0.103*** (0.0294)
GDP	0.00132** (0.000669)	0.00103 (0.000685)
Block	3.414*** (0.262)	3.516*** (0.263)
ROA	9.341*** (0.384)	9.414*** (0.384)
PB	0.0576*** (0.0103)	0.0574*** (0.0103)
Tobin Q	1.272*** (0.0263)	1.276*** (0.0264)
Asset	-0.328*** (0.0385)	-0.285*** (0.0409)
Board size	-0.124 (0.195)	-0.146 (0.196)
Gearing	-19.97*** (0.201)	-19.81*** (0.198)
Constant	18.24*** (0.952)	17.91*** (0.949)
Observations	37,835	37,835
R-squared	0.408	0.408
Year & Industry	yes	yes

5.5 Robustness test

Replacing the explanatory variables, the modified inverse of Z-score Drawing from Altman (2013), the adjusted Ad Z-score is chosen as the new explanatory variable in this paper, and the modified Z-score = $(0.717 \times \text{working capital} + 0.847 \times \text{retained earnings} + 3.107 \times \text{EBITDA} + 0.42 \times \text{total stock market value} + 0.998 \times \text{sales revenue}) / \text{total assets}$. This index is different from the Z-score in terms of calculation, but it is the same in the direction of measuring financial risk, the smaller the Z-score value, the greater the financial risk faced by the company. The endogeneity test after replacing the explanatory variables, that is, the development of digital transformation can suppress the financial risk of enterprises, is consistent with the results of the benchmark regression, indicating that the previous findings are robust and reliable.

5.6 Endogeneity test

The fixed-effects model constructed in this paper mitigates the endogeneity problem due to the presence of some omitted variables, but given that financial risk may have an inverse causal relationship with digital transformation, this paper adopts instrumental variables approach for validation. There are two main approaches for instrumental variables to satisfy the correlation and

exclusivity conditions: either using the mean of customer relationship characteristics of other firms in the same industry and year as instrumental variables (Campello & Gao, 2017) or using core explanatory variables with one or two lags as instrumental variables (Dhaliwal etl., 2016). In this paper, the first-order lag term of digital transformation is used as an instrumental variable to eliminate endogeneity issues due to reverse causality as much as possible. The second stage results found that digital transformation still significantly suppresses digital risk, demonstrating the stability of the article's results.

Table 6 Robustness test and endogeneity test

VARIABLES	Robustness tests	Phase I	Phase II
Digital	-0.0151***	-0.0161***	-
	(0.00308)	(0.00309)	-
L. Digital	-	-	0.428***
	-	-	(0.00536)
Block	0.189***	0.189***	-0.240***
	(0.0243)	(0.0243)	(0.0426)
ROA	-0.158***	-0.158***	-0.196***
	(0.0355)	(0.0355)	(0.0594)
PB	-0.00214**	-0.00214**	0.00476***
	(0.000936)	(0.000936)	(0.00171)
Tobin Q	-0.0583***	-0.0583***	0.0163***
	(0.00241)	(0.00241)	(0.00426)
Asset	0.0888***	0.0888***	0.221***
	(0.00373)	(0.00373)	(0.00645)
Board size	(0.0170)	0.0393**	-0.0217
	0.189***	(0.0170)	(0.0293)
Gearing	0.808***	0.808***	-0.247***
	(0.0191)	(0.0191)	(0.0328)
Block	0.189***	0.189***	-0.240***
	(0.0243)	(0.0243)	(0.0426)
Constant	-1.938***	-1.938***	-4.133***
	(0.0894)	(0.0894)	(0.153)
Observations	37,835	37,835	37,835
R-squared	0.848	0.151	0.282
Year & Industry	yes	yes	yes

Standard errors in parentheses

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

5.7 Heterogeneity test

1) The nature of property rights of enterprises is one of the main sources influencing the behavior of enterprises due to the differences in interest claims and behavior patterns. The sample can be divided into two categories according to the nature of property rights, state-owned enterprises, and non-state-owned enterprises. As seen in the columns of Table 7, the coefficient of Digital and Z-score is -0.217 passing the 1% test in the non-state-owned sample and -0.202 insignificant in the state-owned sample. It shows that digital transformation of enterprises has a more significant effect on reducing the financial risk of non-state-owned enterprises. This may be because SOEs play the role of "stabilizer" in dealing with risk challenges, resolutely preventing, and resolving various production and operation risks, and continuously strengthening risk control in key areas such as debt, investment, and finance. Compared with private enterprises, which maximize shareholders' interests, pursue economic benefits, and seek economic development, most of the transaction decisions of SOEs are closely related to the footsteps of the state, so they have a more

rigorous control of financial risks. However, non-state-owned enterprises are more flexible, adaptable, and radical in making decisions, and adapting to the competitive market economy. The implementation of digital transformation can promote the deep integration of traditional production enterprises and improve the output efficiency of production enterprises. Compared with the robustness of state-owned enterprises, non-state-owned enterprises face greater financial risks, so digital transformation has a more significant inhibiting effect on non-state-owned enterprises.

2) Intra-industry competition represented by industry concentration can influence corporate governance, information disclosure (Zhihong Yi et al., 2010), and surplus management (Xiafei Zhou et al., 2014) of firms. The higher industry concentration indicates that the market tends to be more monopolistic, and its idiosyncratic risk is less and more likely to be sought after by the market. On the contrary, companies with low industry concentration have difficulty in establishing and maintaining long-term competitive advantage due to their idiosyncratic risk. Therefore, the sample is divided into two categories of monopolistic and competitive firms by industry concentration. As seen in the columns of Table 7, the coefficient of Digital and Z-score is -0.0740 insignificant in monopolistic firms, while the coefficient of competitive firms sample is -0.259, which passes the 1% test. It indicates that the digital transformation of firms has a more significant effect on reducing the financial risk of competitive firms.

Table 7 Regression results of industry concentration based on different property rights attributes

VARIABLES	Non-State Owned Enterprises	State-owned enterprises	Monopolistic industry	Competitive industries
Digital	-0.202***	-0.217	-0.0740	-0.259***
	(0.0342)	(0.0342)	(0.0683)	(0.0415)
GDP	0.00132**	0.217***	-0.00141	0.00176**
	(0.000669)	(0.0471)	(0.00141)	(0.000775)
Block	3.420***	8.878***	2.201***	3.287***
	(0.262)	(0.502)	(0.575)	(0.316)
ROA	9.359***	3.778***	9.887***	9.076***
	(0.384)	(0.365)	(0.747)	(0.469)
PB	0.0575***	0.000343	0.103***	0.0269**
	(0.0103)	(0.000926)	(0.0198)	(0.0125)
Tobin Q	1.272***	0.0799***	1.323***	1.285***
	(0.0263)	(0.0141)	(0.0514)	(0.0321)
Asset	-0.328***	-1.274***	-0.557***	-0.291***
	(0.0385)	(0.0356)	(0.0803)	(0.0483)
Board size	-0.117	-0.502***	0.0352	-0.0333
	(0.195)	(0.0551)	(0.400)	(0.238)
Gearing	-19.97***	-23.10***	-20.18***	-20.21***
	(0.202)	(0.279)	(0.400)	(0.251)
Constant	18.01***	17.78***	17.04***	18.78***
	(0.947)	(0.860)	(0.947)	(0.860)
Observations	37,835	37,835	37,835	37,835
R-squared	0.408	0.407	0.408	0.407
Year & Industry	yes	yes	yes	yes

Standard errors in parentheses

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

This may be due to the fact that firms in low industrial concentration industries have a large number of similar firms and more balanced power, and intense competition leads to serious product homogenization, and products can be substituted by competitors in the consumer choice purchase process. To survive and develop in the fierce market competition, operators urgently need to adopt digital transformation strategies to enhance their competitive advantages and quickly gain access to

the market. Therefore, the high degree of digital transformation of competitive companies has a more significant effect on the suppression of financial risk.

(3) Wei Zhang (2022) pointed out that digital transformation of enterprises is the key to the development of a digital economy, and the key factors of digital transformation of enterprises are closely related to research expenditures. In order to verify the heterogeneity of research investment in digital transformation to reduce corporate financial risk, this paper categorizes samples with greater than or equal to the median annual research investment as a high research investment group, otherwise as low research investment group, and conducts group test, the regression results show that the coefficient of Digital and Z-score of high research investment group is -0.320 through 1% test, while the coefficient of low research investment group is -0.0318, with a significant difference in the coefficient size, indicating that the economic consequences of digital transformation are more prominent when the research investment is higher. The reason for this may be that in companies with a high level of R&D spending their digital transformation is higher. The level of R&D expenditures of companies shows their commitment and importance to innovation, and the percentage of research expenditures is an important factor in promoting the layout of digital transformation, which helps companies to rapidly improve their technology, promote economic growth through technological innovation, enhance their competitiveness and reduce financial risks.

(4) High-tech industry is a knowledge-intensive and technology-intensive type of industry, and to verify the heterogeneous performance of enterprises under different technology levels, the sample enterprises are divided into "high-tech enterprises" and "non-high-tech enterprises" by referring to the method of Peng Hongxing and Mao Xinshu (2017). The sample enterprises are divided into two sub-samples: "high-tech enterprises" and "non-high-tech enterprises". Compared with non-high-tech enterprises, the digital transformation of enterprises has a greater reduction effect on the financial risk of high-tech enterprises.

Table 8 Regression results based on different research inputs and whether they belong to high-tech industries

VARIABLES	High investment in research	A small investment in research	High and New	Non-high-tech
Digital	-0.320*** (0.0536)	-0.0318 (0.0429)	-0.295*** (0.0550)	-0.0547 (0.0450)
GDP	-0.000565 (0.000943)	0.00194** (0.000934)	-0.00221** (0.00107)	0.00244*** (0.000895)
Block	4.693*** (0.435)	0.588* (0.330)	2.989*** (0.492)	1.358*** (0.356)
ROA	9.475*** (0.592)	9.023*** (0.486)	8.607*** (0.672)	9.177*** (0.477)
PB	0.0460*** (0.0168)	0.0588*** (0.0123)	0.0484** (0.0209)	0.0585*** (0.0119)
Tobin Q	1.445*** (0.0403)	1.114*** (0.0339)	1.534*** (0.0481)	1.207*** (0.0324)
Asset	-0.600*** (0.0691)	-0.115** (0.0460)	-0.396*** (0.0779)	-0.149*** (0.0503)
Board size	-0.255 (0.312)	-0.125 (0.241)	0.345 (0.333)	-0.489* (0.254)
Gearing	-24.01*** (0.337)	-16.92*** (0.243)	-25.96*** (0.397)	-17.20*** (0.249)
Constant	17.88*** (0.860)	18.58*** (0.860)	18.01*** (0.947)	17.78*** (0.860)
Observations	37,835	37,835	37,835	37,835
R-squared	0.408	0.407	0.408	0.407

Year & Industry	yes	yes	yes	yes
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Standard errors in parentheses

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

The possible reasons for this are: high-tech industries are more perceptive to technological innovation and have a higher degree of digital transformation. In contrast, non-high-tech industries are usually traditional industries with traditional and relatively backward production and operation modes, and the breadth and depth of digital technology applications are not as high as in high-tech industries. And depending on the scale of digitalization efforts, digital transformation may be costly and may cause a financial burden if it is not possible to change the entire company's technology by introducing new hardware and software. Therefore, the implementation process of a digital transformation strategy is not as effective as that of high-tech companies in reducing financial risks in traditional companies.

6. Conclusion and Insights

The article empirically examines the impact of digital transformation on corporate financial risk and its mechanism of action, using the data of A-share non-financial listed companies from 2009-2021. The study finds that digital transformation significantly reduces corporate financial risk; there are substitution effects of internal control quality and marketization process on the suppression effect of digital transformation and corporate financial risk; further study shows that the suppression effect of digital transformation on corporate financial risk is more significant in non-state-owned enterprises and competitive industries, and the impact of digital transformation on mitigating financial risk is more obvious in high-tech enterprises and when research investment is higher. It is more obvious. With the support of a digital transformation strategy, enterprises can reduce financial risk to promote healthy growth. After fully considering the effects of a series of issues such as endogeneity and robustness, the conclusions of the article remain robust.

In summary, the article proposes the following policy insights: First, the government should increase investment in digital technology infrastructure, promote the deep integration of digital technology and the real economy, and provide a solid foundation for the digital transformation of enterprises. Second, the wide application of digital technology may strengthen the monopolistic behavior of some enterprises, the government should strengthen market supervision, maintain market order, form a perfect monitoring mechanism for the development of the digital economy, and effectively curb the monopolistic behavior of the industry. It should also deal with the relationship between competition policy and other policies to avoid the loss of efficiency caused by the blind development of the digital economy. Third, digital transparency exposes companies to increasing pressure from consumers, collaborators, and communities to increase corporate social responsibility. With the popularity of digital platforms such as cloud and e-commerce, many companies are subject to mutual monitoring mechanisms, and in order to gain the level of trust of strategic partners and bring financial resources, advanced technology, and management experience to the company, companies should actively participate in activities that strengthen corporate social responsibility, build a responsible brand image, improve the reputation and competitiveness of the company, and increase its financial stability.

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