

Digital Transformation and Firm Value: Empirical Evidence from Chinese Listed Companies

Shuyi Zhu

Nanjing Audit University, Nanjing, Jiangsu, 211800, China

Abstract

Against the background of the rapid development of the digital economy, digital transformation has become an important strategic means for firms to enhance their core competitiveness and market value. This paper takes listed companies in China's Shanghai and Shenzhen A-share markets from 2012 to 2023 as samples to empirically test the impact of digital transformation on firm value, and explores its mechanism and heterogeneity characteristics. The research finds that digital transformation significantly improves firm value, and this effect is mainly achieved by improving resource allocation efficiency and enhancing technological innovation capability. Further heterogeneity analysis shows that digital transformation has a more significant value-promoting effect in non-state-owned enterprises, highly competitive industries, and firms facing high financing constraints. This study enriches micro-level evidence on the digital economy's impact and offers theoretical and practical inspiration for firms and policymakers to tailor strategies based on firm characteristics.

Keywords

Digital Transformation; Firm Value; Total Factor Productivity; R&D Investment.

1. Introduction

With the continuous advancement of a new round of scientific and technological revolution and industrial transformation, the digital economy is increasingly becoming a key force driving high-quality economic development. It has not only profoundly reshaped the traditional industrial structure, but also reconstructed the logic of resource allocation and the mode of value creation. In recent years, the Chinese government has attached great importance to the development of the digital economy. *The 14th Five-Year Plan (2021-2025) for the Development of Digital Economy* proposed to take the deep integration of digital technology and the real economy as the main line to promote economic transformation. The report to the 20th National Congress of the Communist Party of China emphasized the need to accelerate the development of the digital economy and promote the deep integration of the digital economy and the real economy. Multi-level policy guidance has provided a clear direction and institutional guarantee for the development of the digital economy. The economic effect of the digital economy has gradually emerged, becoming an important engine for building a modern economic system, and has continuously stimulated the enthusiasm of firms for digital transformation. On the one hand, the construction of digital infrastructure is accelerating, and the value of data elements continues to be released, providing solid support for enterprise transformation; on the other hand, digital technology is deeply embedded in all aspects of production, management, and circulation, promoting a significant improvement in resource allocation efficiency. According to the *White Paper on the Global Digital Economy (2023)* released by the China Academy of Information and Communications Technology, the added value of the digital economy in 51 major countries worldwide has reached 41.4 trillion US dollars, accounting for nearly half of GDP. The digital economy is becoming a new engine for global economic growth. At the same time, the *China Digital Economy Development Index Report (2024)* shows that the scale of

China's digital economy has exceeded 50 trillion yuan, accounting for more than 40% of GDP, and its driving effect on economic growth is becoming increasingly prominent. This indicates that the digital economy has not only become a core driving force for growth at the macro level, but also brings unprecedented transformation opportunities and value creation space for enterprises at the micro level.

Against this background, digital transformation has become an important strategic path for firms to respond to external environmental changes, achieve endogenous growth, and enhance long-term value. The penetration of digital technology is profoundly changing the way firms organize production, the logic of operation and management, and the composition of competitive advantages. From optimizing resource allocation to improving production efficiency, from enhancing technological innovation capability to improving information transparency, digital transformation is not only a tool for firms to adapt to the new technological paradigm, but also a key means for them to release potential value in the capital market and build sustainable competitiveness. Therefore, in-depth exploration of whether and how digital transformation affects firm value will be not only helpful for understanding the economic logic behind firm strategic adjustments, but also has important practical significance for improving the policy support system and promoting the high-quality development of the digital economy.

In view of this, this paper selects data of listed companies in Shanghai and Shenzhen A-share markets from 2012 to 2023 to study the relationship between digital transformation and firm value. Compared with existing research, the marginal contributions of this paper may lie in: First, from the perspective of firm value and focusing on the micro level of firm digital transformation, enriching the research perspective on the economic consequences of digital transformation; Second, by constructing mechanism models, this paper reveals the internal logic of how digital transformation affects firm value through efficiency improvement and innovation drive, and expands the causal chain between digital technology application and firm performance and resource allocation; Third, based on the research conclusions, this paper identifies key moderating variables that influence the effect of digital transformation through heterogeneity analysis, providing micro-level empirical evidence for enterprise-level policy differentiation and targeted policy support.

2. Literature Review and Research Hypotheses

2.1. Literature Review

With the rise of the digital economy, digital transformation has become a key factor in promoting the development of firms. Firms have achieved transformation in production and service processes by applying digital technologies to replace traditional labor and technology (Ebert and Duarte, 2018) [1]. Existing research mainly explores the economic effects of digital transformation from a micro perspective. Digital transformation not only improves the output efficiency of firms and increases total factor productivity (Zhao et al., 2021) [2], but also improves capital market performance and enhances stock liquidity (Wu et al., 2021) [3]. In the process of digital system reconstruction, the profitability of firms has increased significantly, which is attributed to cost reduction, optimal resource allocation and enhanced independent research and development capabilities (He and Liu, 2019) [4]. In addition, digital transformation can also improve corporate environmental performance by reducing financing constraints and promoting green technology innovation (Gao and Wang, 2023) [5]. In the digital age, adaptive organizational learning is particularly important for corporate management changes. Digital technology has promoted changes in corporate organizational structure, marketing model and production model (Qi and Xiao, 2020) [6]. The cross-system digital transformation of firms has further improved management capabilities and governance levels

(Xiao, 2023) [7]. The returns brought by different digital projects also vary, affecting the investment and management decisions of firms (Liu et al., 2021) [8].

Firm value is an important indicator to measure the overall performance and market recognition of firms. In recent years, changes in the market environment and the evolution of internal management of firms have made the factors affecting firm value more diversified. External factors such as macroeconomic fluctuations, financial development and policy environment will affect the capital cost and cash flow of firms, and then affect the firm value (Graham and Dodd, 1934) [9]. The improvement of the level of marketization helps to reduce transaction costs and institutional barriers, thereby improving resource allocation efficiency and firm value (Xia and Fang, 2005) [10]; however, fierce market competition may prompt firms to take improper actions, thereby damaging firm value (Branco and Villas-Boas, 2015) [11]. In addition, price distortions in the capital market will bring investment constraints and affect the effectiveness of firm value (Fang, 2022) [12]. At the corporate level, the disclosure of intellectual property information helps to enhance firm value (Liu and Bao, 2020) [13], while the disclosure of environmental information may restrict firm development and reduce firm value (Yang and Xi, 2019) [14].

2.2. Theoretical Hypothesis

Digital transformation affects the governance efficiency, resource allocation, and strategic positioning of firms on multiple levels. Its impact on firm value can be analyzed from the following aspects:

First, from the perspective of transaction cost, digital transformation can reduce the transaction cost and agency cost of firms. By improving the efficiency of information acquisition, optimizing decision-making processes, and strengthening coordination, firms can reduce internal and external costs, improve resource utilization, and thus enhance organizational operational efficiency. Meanwhile, by building digital technology platforms, accumulating data assets and knowledge resources, firms can form technical and organizational capabilities that are difficult to imitate, strengthen their competitive advantage in the market, and improve their value assessment in the capital market.

Second, from the perspective of input-output, firm value is closely related to the efficiency of its resource allocation. Digital transformation helps firms improve production efficiency by optimizing management processes, reducing resource waste, and improving operational efficiency. Based on the improvement of data collection and analysis capabilities, digital transformation promotes the enhancement of performance feedback mechanisms and plan execution, strengthens the profitability and growth potential of firms, and thereby increases their market value.

Third, from the perspective of technological innovation, digital transformation can promote firms to enhance innovation capability and expand technological boundaries. Digital transformation can improve the output rate of innovation results through data-driven R&D innovation, and promote industrial collaboration and knowledge flow, accelerating the application of new technologies. Continuous technological innovation not only increases product added value and market competitiveness of firms, but also transmits long-term development potential to the capital market, enhancing firm valuation.

Based on the above analysis, this paper proposes the following hypothesis:

Hypothesis 1: Digital transformation improves firm value.

3. Research Design

3.1. Sample Selection and Data Sources

This paper selects data of listed companies in Shanghai and Shenzhen A-share markets from 2012 to 2023 as the research sample. The relevant firm data are obtained from the China Stock Market & Accounting Research Database (CSMAR). The original data are processed as follows: ST and *ST company samples are excluded; financial industry company samples are excluded; samples with missing key data are excluded. A total of 33,936 observations are finally obtained as the initial sample of this paper. A 1% winsorization is applied to the main continuous variables to eliminate the potential estimation bias caused by extreme values.

3.2. Variable Selection

Explained variable (TobinQ). Tobin's Q was first proposed by economist James Tobin, which compares the market valuation of a firm with the replacement cost of its assets, effectively capturing the capital market's expectation and evaluation of the firm's long-term development prospects and sustainable profitability. In this article, it is specifically measured by the ratio between a physical asset's market value and its replacement value. Considering that the replacement cost is difficult to measure in actual operation, this paper calculates Tobin's Q by dividing the sum of liabilities and the stock value of tradable and non-tradable shares by total assets.

Explanatory variable (DT). Digital transformation (DT) is the core explanatory variable in this paper, which comes from the CSMAR database. The measurement of this variable is based on a multidimensional evaluation system, which includes six core dimensions: strategic leadership, technology-driven, organizational empowerment, environmental support, digital achievements, and digital applications. These are comprehensively weighted to construct the DT index. Additionally, Wu Fei et al. (2021) [3] collected and organized the annual report texts of A-share listed companies in Shanghai and Shenzhen, extracting keywords related to digital transformation. After excluding expressions containing negative terms such as "no," "none," or "not," they counted the frequency of indicators at different levels, such as artificial intelligence, blockchain, cloud computing, big data, and the application of digital technologies. After weighting and summarizing the frequencies of various indicators, an evaluation index reflecting the comprehensive progress of firms' digital transformation was constructed. This paper refers to this method for robustness testing.

Control variables. Referring to existing studies, this paper sets control variables including firm size (size), firm age (age), return on assets (ROA), gearing ratio (lev), firm growth (growth), cash flow ratio (cflow), and ownership concentration (Top1). Year and individual fixed effects are also controlled. The summary of the main statistics is presented in Table 1.

3.3. Model Construction

In order to study the implementation effect of digital transformation on firm value, this paper adopts the following two-way fixed effect econometric model:

$$TobinQ_{i,t} = \alpha + \beta DT_{i,t} + \gamma Controls_{i,t} + \mu_i + \theta_t + \varepsilon_{i,t} \quad (1)$$

Subscripts i and t represent firms and years, respectively. Firm value (TobinQ) is the explained variable, and digital transformation (DT) is the explanatory variable. *Controls* reflects all the control variables in this paper. μ_i denotes firm fixed effects, θ_t denotes time fixed effects, and $\varepsilon_{i,t}$ is the random disturbance term.

3.4. Descriptive Statistics

As shown in Table 1, the mean of firm value (TobinQ) is 2.063, with a standard deviation of 1.367, indicating that the average market value of the sample firms is relatively high compared to their book value of assets, and the volatility of their market value is considerable. The standard deviation of the digital transformation (DT) indicator is 1.420, suggesting significant differences in the input and outcomes of digital transformation among firms. Moreover, the standard deviation of DT is close to the mean (1.521), indicating a large disparity in the degree of digital transformation across firms. The characteristics of the control variables are consistent with the findings of existing literature (Wang et al., 2023) [15].

Table 1. Descriptive statistics

Variable	Measurement	Obs.	Mean	S.D.	Min	Max
TobinQ	= (liabilities + the stock value of tradable and non-tradable shares) / total assets	33936	2.063	1.367	0.834	8.841
DT	CSMAR enterprise digital transformation index	33936	1.521	1.420	0.000	5.193
size	The natural logarithm of the total assets	33936	22.202	1.300	19.680	26.265
age	= the survey year - the registered year + 1	33936	11.040	7.918	1.000	30.000
ROA	The ratio of net profit to total asset	33936	0.041	0.070	-0.266	0.227
lev	The ratio of total debt to total asset	33936	0.416	0.209	0.053	0.941
cflow	The ratio of net cash flow to total assets	33936	0.047	0.069	-0.173	0.243
growth	= (Current period operating income - previous period operating income) / previous period operating income	33936	0.367	0.972	-0.740	6.729
Top1	Shareholding ratio of the largest shareholder	33936	0.217	0.177	0.002	0.680

4. Empirical Results and Robustness Test

4.1. Baseline Regression Results

Table 2. Baseline regression results

Variable	TobinQ				
	(1)	(2)	(3)	(4)	(5)
DT	0.047*** (9.041)	0.094*** (20.016)	0.091*** (19.254)	0.074*** (9.234)	0.035*** (3.156)
size		-0.534*** (-83.058)	-0.537*** (-86.809)	-0.594*** (-42.570)	-0.623*** (-19.104)
age		0.023*** (23.905)	0.023*** (24.437)	0.027*** (11.032)	0.267*** (3.046)
ROA		2.785*** (24.285)	2.722*** (24.663)	2.129*** (20.031)	2.057*** (12.450)
lev		0.111*** (2.726)	0.132*** (3.373)	0.566*** (10.157)	0.679*** (6.332)
cflow		0.961*** (9.086)	0.989*** (9.696)	0.671*** (7.004)	0.713*** (6.160)
growth		0.022*** (3.218)	0.010 (1.512)	-0.002 (-0.314)	-0.020** (-2.496)
Top1		1.248*** (29.698)	1.224*** (30.333)	1.910*** (38.123)	1.872*** (22.642)
Constant	1.991*** (183.253)	13.025*** (100.077)	13.117*** (104.472)	14.077*** (48.891)	12.071*** (10.369)
Year	NO	NO	YES	NO	YES
Firm	NO	NO	NO	YES	YES
N	33936	33936	33936	33591	33591
R-squared	0.002	0.212	0.279	0.565	0.642

Note: The values in brackets in the table are t values, ***, ** and * are significant at the 1%, 5% and 10% levels respectively, the same below.

Table 2 reports the baseline regression results of this paper. In column (1), the explained variable in the regression process only includes TobinQ, without controlling for year and individual fixed effects. Column (2) adds other control variables on the basis of column (1). Columns (3) and (4) control for year fixed effects and individual fixed effects respectively. Column (5) controls for both individual and year fixed effects simultaneously based on the previous specifications. The regression results show that the regression coefficient of TobinQ is significantly greater than 0 at the 1% level from column (1) to column (5), indicating that digital transformation significantly improves firm value. Moreover, the universality and stability of digital transformation across different years and firms are confirmed, and Hypothesis 1 is supported.

4.2. Robustness Test

4.2.1. Replace Explanatory Variable

With the aim of ensuring the robustness of the research conclusions and avoid potential bias caused by the measurement method of digitalization level, this paper conducts a robustness test by replacing the explanatory variable with a conceptually similar one. Drawing on the method of Wu Fei et al. (2021) [3], the annual reports of A-share listed companies in Shanghai and Shenzhen are cleaned and analyzed. By extracting core terms related to digital transformation, removing negative expressions, and counting the frequency of digital technology-related words, a digital transformation index is constructed to serve as a substitute variable reflecting the digitalization level of firms. Column (1) of Table 3 shows that the estimated coefficient of DT_new is 0.034, which passes the statistical test at the 1% significance level, verifying that digital transformation has a significantly positive effect on firm value, supporting the robustness of Hypothesis 1.

4.2.2. Replace Explained Variable

In order to effectively avoid the contingency bias that may result from a single indicator and enhance the credibility of the research findings, this paper re-examines the empirical results by replacing the measurement indicator of the explained variable. Damodaran (2012) [16] points out that the enterprise value multiple method has advantages in controlling for differences in capital structure and ensuring valuation consistency, and it is an important indicator for assessing firm valuation. The specific calculation formula of enterprise value multiple (EVM) is: $(\text{market value of equity} + \text{net debt}) / \text{earnings before interest, taxes, depreciation and amortization (EBITDA)}$. This indicator reflects the multiple of a firm's overall market value relative to its operating cash flow, incorporating valuation perspectives of both equity and debt financing. As shown in column (2) of Table 3, the estimated coefficient of the digitalization variable DT is 0.011, which is significantly positive at the 5% level. It proves that after changing the measurement method of the explained variable, the positive effect of digital transformation on the value of enterprise remains significant, strengthening the reliability of Hypothesis 1.

Table 3. Robustness tests

Variable	(1)	(2)	(3)
	Replace explanatory variable	Replace explained variable	Explanatory variable lagged one period
	TobinQ	EVM	TobinQ
DT_new	0.034*** (3.085)		
DT		0.011** (2.419)	
DT_L1			0.018* (1.725)
size	-0.622*** (-19.099)	-0.141*** (-10.949)	-0.696*** (-19.669)
age	0.266*** (3.045)	-0.090** (-2.292)	0.229** (2.560)
ROA	2.056*** (12.442)	-8.763*** (-61.266)	2.187*** (12.511)
lev	0.679*** (6.331)	-0.066 (-1.504)	0.551*** (4.725)
cflow	0.712*** (6.152)	-0.139** (-2.504)	0.720*** (5.821)
growth	-0.020** (-2.494)	0.002 (0.475)	-0.023*** (-2.787)
Top1	1.872*** (22.643)	0.626*** (20.417)	1.731*** (20.165)
Constant	12.067*** (10.368)	7.708*** (15.630)	14.101*** (10.908)
Year	YES	YES	YES
Firm	YES	YES	YES
N	33591	30837	28886
R-squared	0.642	0.720	0.678

4.2.3. Endogeneity Problem

The formation of firm value often exhibits a certain lag effect, and digital transformation, as a strategic investment, may influence firm value gradually over several subsequent periods after implementation. To enhance the reliability of the research conclusions and control potential endogenous bias, this paper introduces a lag treatment by lagging the core explanatory variable DT by one period, that is, using the firm's digital transformation level in the previous period (DT_L1) as the explanatory variable for regression. Therefore, using the lagged digital transformation variable helps to verify the temporal consistency and directional stability of the impact of digital transformation on firm value. As shown in column (3) of Table 3, the regression coefficient of DT_L1 is 0.018, which is significantly positive at the 10% level, demonstrating that the promoting effect of digital transformation on firm value has a sustained temporal characteristic, and Hypothesis 1 remains convincing.

5. Further Analysis

5.1. Mechanism Analysis

5.1.1. Output Efficiency

Previous studies have shown that the introduction of digital technology helps alleviate information asymmetry and reduce agency costs (Mo et al., 2024) [17], thereby optimizing the internal governance structure of firms. According to transaction cost theory, in a digital environment, firms can integrate information, coordinate processes, and monitor execution more efficiently, thus significantly reducing internal transaction costs and improving the efficiency of resource allocation. In addition, from the perspective of the production function, digital tools can improve the marginal productivity of capital and labor, thereby enhancing the output efficiency of firms. This improvement in efficiency is reflected in the increase in total factor productivity (TFP), which represents an enhanced ability of firms to comprehensively utilize technological, organizational, and institutional resources in the production process. Referring to the method of Lu Xiaodong and Lian Yujun (2012) [18], this paper constructs a TFP indicator based on intermediate output indicators such as raw material input. This indicator effectively captures the comprehensive output efficiency of firms under given factor inputs and provides an ideal explained variable for mechanism analysis. As shown in column (1) of Table 4, the regression coefficient of the digital transformation indicator DT is 0.036, which is significantly positive at the 1% level, verifying its mechanism of improving the total factor productivity of firms.

Total factor productivity is a key indicator for measuring the output efficiency and resource utilization efficiency of firms. It means that firms can increase output with the same or fewer inputs, optimize production processes, reduce marginal costs, and thereby enhance profitability and profit margins. This improvement in efficiency not only reduces operating costs by improving production efficiency and optimizing resource allocation, but also enhances market competitiveness by providing higher-quality and lower-cost products or services, enabling firms to respond more accurately to changes in market demand, expand market share, and increase sales revenue. The improvement in total factor productivity also contributes to enhancing the dynamic organizational capability of firms, making them more adaptable to the market environment and more resilient to risks, helping firms respond flexibly to market fluctuations, adjust strategies in a timely manner, and stabilize profit flows. Such stability and predictability can enhance investor confidence, build a good corporate reputation, and attract more capital investment. In conclusion, the improvement in total factor productivity can effectively promote the growth of firm value, not only by directly improving their profitability, but in the long term, the consolidation of competitive position and enhancement of operational stability will also be transformed into a sustained increase in their market value through the capital market valuation mechanism.

5.1.2. Innovation Capability

Existing literature has pointed out that corporate innovation plays a core role in achieving macroeconomic growth and enhancing industry competitiveness (Hunady et al., 2014) [19]. In the context of the digital economy, data assets, information infrastructure, and digital talents have become key new strategic resources. Firms continuously enhance their innovation capability and R&D efficiency by increasing investment in digital infrastructure and technological research and development, strengthening technological reserves and the accumulation of knowledge capital. On the one hand, the application of digital technologies improves firms' efficiency in collecting and processing information, enhances their sensitivity to technological trends and market changes, and provides a more agile decision-making foundation for innovation. On the other hand, through investing in the construction of digital

platforms, introducing intelligent tools, and optimizing R&D processes, firms gather and reorganize internal resources, improve the effectiveness of R&D investment and the efficiency of outputs, thereby promoting the transformation of technological reserves into innovation outcomes and generating innovation performance (Wu et al., 2021; Huang et al., 2021) [3][20]. This paper adopts the R&D input ratio (RDratio), that is, the proportion of firm R&D expenditure to operating income, as a proxy variable for innovation input to conduct mechanism testing. As shown in column (2) of Table 4, the coefficient of DT is 0.085 and is significantly positive at the 5% level, indicating that digital transformation helps promote firms to increase R&D investment and provides more favorable conditions for technological innovation by increasing the supply of innovation resources.

Table 4. Mechanism analysis

Variable	TobinQ	
	(1)	(2)
	TFP	RDratio
DT	0.036*** (6.464)	0.085** (2.506)
size	0.559*** (37.312)	-0.065 (-0.693)
age	-0.041 (-0.761)	-0.679 (-0.969)
ROA	1.693*** (21.321)	-10.671*** (-17.053)
lev	0.294*** (5.624)	-3.052*** (-8.642)
cflow	0.572*** (9.556)	-1.526*** (-4.188)
growth	-0.009* (-1.886)	-0.051 (-1.330)
Top1	-0.027 (-0.962)	0.058 (0.352)
Constant	-3.840*** (-5.437)	15.095** (2.020)
Year	YES	YES
Firm	YES	YES
N	30537	28727
R-squared	0.907	0.830

Innovation is an important source driving sustainable growth and enhancing market value for firms. Continuous technological innovation and R&D investment not only enhance the core competitiveness of firms, but also significantly improve their performance in capital markets by increasing product added value, optimizing production processes, and exploring new markets. Under the logic of capital market, innovation carries a strong signaling effect. According to the theory of information asymmetry, when investors cannot fully observe the future performance of firms, firms can convey their long-term development intentions and growth potential to the external market through continuous R&D investment, thereby achieving a higher level of valuation. Resource-based theory indicates that technological patents and human resources accumulated through continuous R&D activities constitute

strategic resources that are difficult to imitate, laying an important foundation for firms to establish a unique market competitive position and acquire sustainable value creation capabilities. In summary, by increasing R&D investment, firms can enhance their own value on multiple levels, including technological accumulation, market competitiveness, and capital valuation.

5.2. Heterogeneity Test

5.2.1. Results of Samples by Property Type

With the purpose of testing the moderating effect of property rights structure on the effect of digital transformation, this paper conducts group regression analysis based on enterprise ownership type. The empirical results shown in columns (1) and (2) of Table 5 indicate that in the sample of non-state-owned enterprises, the regression coefficient of digital transformation (DT) on firm value (TobinQ) is 0.032, significantly positive at the 5% level; while in the sample of state-owned enterprises, the regression coefficient is not statistically significant. This suggests that the promoting effect of digital transformation on firm value does exhibit significant ownership heterogeneity and is more obvious in non-state-owned enterprises. This may be due to the fact that non-state-owned enterprises have greater autonomy in resource utilization, making digital technologies easier to implement and more deeply integrated with production and management processes, thereby improving resource allocation efficiency and marginal productivity. In contrast, state-owned enterprises are affected by administrative intervention and institutional rigidity, leading to lower efficiency in digital investment. The friction between technology introduction and institutional reform limits the positive impact of digital transformation on firm value. Moreover, state-owned enterprises generally face “soft budget constraints” (Gao et al., 2022) [21], and experience less pressure from financing and market competition, lacking efficiency preference and performance orientation in advancing digital transformation. Non-state-owned enterprises, however, under stronger market pressure and profit-oriented goals, are more inclined to apply digital tools to value creation and pursue capital market returns. In addition, state-owned enterprises are more likely to be constrained by multiple objectives such as policy mandates and social responsibilities. Their managerial incentive mechanisms are relatively weak, the internal motivation for digital transformation is insufficient, and the chain of outcome conversion is longer with weaker transmission effects. These institutional differences make it difficult for digital transformation to fully unleash its value-enhancing potential in state-owned enterprises.

5.2.2. Results of Samples by Market Competition Level

To further investigate whether the marginal effect of digital transformation on firm value is moderated by the external market environment, this paper conducts a heterogeneity analysis from the perspective of market competition. According to industrial organization theory, the characteristics of market structure systematically influence firms’ strategic decisions and operational performance. In a highly competitive market environment, firms face greater survival pressure and technological updating pressure, and are often more motivated to utilize digital transformation to optimize operational efficiency and achieve differentiated competition, thereby obtaining sustainable market positions and recognition from the capital market. It is thus hypothesized that for firms facing higher levels of market competition, the impact of digital transformation on firm value is more likely to be stimulated or amplified. To test this hypothesis, this paper uses the Herfindahl-Hirschman Index (HHI) to measure the intensity of industry competition, and divides the observations into high and low competition intensity groups based on the sample mean for group testing. Columns (3) and (4) of Table 5 report the analysis results: the regression coefficient of DT in the high market competition group is 0.046, significantly positive at the 1% level; whereas in the low market competition group, it is not significant. This result supports the moderating role of the market competition

environment in the value effect of digital transformation, confirming that its promoting effect is more prominent in highly competitive market structures. It indicates that the promoting effect of digital transformation on firm value is more evident in a highly competitive market environment.

5.2.3. Results of Samples by Degree of Financing Constraints

Table 5. Heterogeneity tests

Variable	TobinQ					
	(1)	(2)	(3)	(4)	(5)	(6)
	State-owned enterprises	Non-state-owned enterprises	High competition market	Low competition market	High financing constraints	Low financing constraints
DT	0.024	0.032**	0.046***	0.026	0.078***	0.008
	(0.016)	(0.014)	(0.013)	(0.021)	(0.016)	(0.012)
size	-0.616***	-0.648***	-0.575***	-0.692***	-0.972***	-0.200***
	(0.058)	(0.040)	(0.037)	(0.065)	(0.041)	(0.041)
age	0.138***	0.608**	0.243**	0.192	0.446***	-0.007
	(0.037)	(0.259)	(0.101)	(0.159)	(0.113)	(0.044)
ROA	2.284***	2.019***	1.967***	2.012***	1.216***	5.059***
	(0.338)	(0.187)	(0.203)	(0.307)	(0.174)	(0.435)
lev	0.364*	0.703***	0.599***	0.565***	0.724***	0.647***
	(0.208)	(0.126)	(0.126)	(0.186)	(0.123)	(0.134)
cflow	0.316*	0.911***	0.642***	0.900***	0.483***	0.281*
	(0.178)	(0.147)	(0.140)	(0.223)	(0.156)	(0.156)
growth	-0.019**	-0.023**	-0.019**	-0.027*	-0.013	0.003
	(0.009)	(0.012)	(0.009)	(0.016)	(0.013)	(0.008)
Top1	0.805***	2.422***	1.897***	1.818***	2.230***	1.039***
	(0.108)	(0.111)	(0.099)	(0.154)	(0.116)	(0.106)
Constant	13.086***	10.444***	11.288***	14.477***	17.856***	5.548***
	(1.322)	(2.324)	(1.307)	(2.241)	(1.369)	(1.150)
Year	YES	YES	YES	YES	YES	YES
Firm	YES	YES	YES	YES	YES	YES
N	11401	22109	22104	10487	16146	10862
R-squared	0.684	0.632	0.649	0.652	0.661	0.734

As a strategic transformation characterized by long-term orientation, systemic integration, and capital intensity, digital transformation imposes high demands on a firm's ability to sustain capital supply. To further identify the boundary conditions of the impact of digital transformation on firm value, this paper introduces financing constraints as a moderating variable for heterogeneity testing. Based on the distribution characteristics of the White & Wu Index (WW index), the sample is divided into two subgroups with high and low financing constraints for empirical testing. Columns (5) and (6) of Table 5 report the results. In the high financing constraint group, the regression coefficient of DT is 0.078, significantly positive at the 1% level, while the corresponding regression coefficient in the low financing constraint group is not significant. This difference indicates that the value-enhancing effect of digital transformation is more prominent in firms with higher financing constraints. This may be because, under limited external funding and tight resource allocation, highly constrained firms rely more on improving internal governance and technical means to enhance resource utilization efficiency. Digital transformation can improve operational efficiency by increasing

information transparency, optimizing processes, and strengthening cost and risk control. The marginal benefits it brings are more significant for financially constrained firms. Meanwhile, such firms often suffer from severe information asymmetry, making it difficult for investors to accurately assess their business prospects and limiting their financing capacity. Digital transformation helps improve information disclosure quality and compliance management in firms with high financing constraints, thereby sending positive signals to capital markets, alleviating information asymmetry, improving market pricing, and ultimately enhancing firm value expectations.

6. Conclusion and Enlightenment

6.1. Research Conclusion

The digital economy is increasingly becoming a core driving force for promoting high-quality economic development, and the digital transformation of firms is regarded as a key approach to improving resource allocation efficiency and reconstructing competitive advantages. Based on panel data of A-share listed companies in Shanghai and Shenzhen from 2012 to 2023, this paper empirically examines the impact of digital transformation on firm value, explores the mechanisms through enhancing efficiency and innovation capability, and conducts heterogeneity analysis by incorporating ownership structure, market competition intensity, and financing constraints. The main conclusions are as follows: First, digital transformation significantly enhances firm value. After a series of robustness tests, the conclusion remains valid, indicating that the implementation of digital strategies by firms has a significant effect on increasing market value. Second, the mechanism analysis shows that digital transformation enhances firms' operational efficiency and innovation capability by improving total factor productivity and R&D investment intensity, thereby forming an endogenous driving force for promoting firm value. Finally, the heterogeneity analysis reveals that the impact of digital transformation on firm value is more significant in non-state-owned enterprises, firms with higher market competition environment and those with higher financing constraints, emphasizing the moderating roles of ownership structure, market environment, and resource endowments in realizing the value of digital transformation.

6.2. Policy Suggestions

Based on the above research findings, the following recommendations are put forward:

First, strengthen the construction of digital infrastructure and improve the institutional support system. The government should accelerate the construction of a digital China initiative to improve the digital development environment for enterprises, especially by providing small and medium-sized enterprises with fair and accessible digital resources. At the same time, systems for the confirmation of data asset rights, circulation, and privacy protection should be improved to establish a sound institutional environment for the digital economy and eliminate institutional barriers to enterprise digital transformation.

Second, implement categorized policies and leverage the advantages of ownership and industry differences. The government should formulate differentiated policies based on different ownership types and market environments. For state-owned enterprises, performance evaluation and management incentives should be strengthened to enhance the level of digital application; for non-state-owned enterprises, more institutional guarantees and financial support should be provided to encourage rapid development through digital transformation. Meanwhile, tax reductions, fiscal subsidies, and other means should be used to support enterprises with high external competition and high financing constraints in increasing R&D investment, promoting the deep integration of technological innovation and digitalization.

Third, optimize resource allocation and promote deep integration of digitalization with production and operation. Firms should optimize resource allocation and improve operational efficiency by building digital platforms and introducing interdisciplinary digital technology talents. At the same time, firms should formulate digital strategies suited to their development stage and industry characteristics to ensure deep integration of digital transformation with production and operation, and to unlock the innovative potential of digital technology.

References

- [1] Ebert C, Duarte C H C. Digital transformation [J]. *IEEE Softw.*,2018,35(4):16-21.
- [2] Zhao Chenyu, Wang Wenchun, Li Xuesong. How Does Digital Transformation Affect the Total Factor Productivity of Enterprises? [J]. *Finance & Trade Economics*,2021,42(07):114-129.
- [3] Wu Fei, Hu Huizhi, Lin Huiyan, et al. Enterprise Digital Transformation and Capital Market Performance: Empirical Evidence from Stock Liquidity [J]. *Journal of Management World*,2021, 37(07):130-144+10.
- [4] He Fan, Liu Hongxia. The Performance Improvement Effect of Digital Transformation Enterprises from the Digital Economy Perspective [J]. *Reform*,2019,(04):137-148.
- [5] Gao Houbin, Wang Qiangrui. "Green Gifts": the Impact of Digital Transformation on Corporate Environmental Performance---- Empirical Evidence from A-share Listed Companies in China's Manufacturing Industry [J]. *Journal of Henan Normal University (Philosophy and Social Sciences Edition)*,2023,50(05):88-94.
- [6] Qi Yudong, Xiao Xu. Transformation of Enterprise Management in the Era of Digital Economy [J]. *Journal of Management World*,2020,36(06):135-152+250.
- [7] Xiao Jinghua. Cross-system Digital Transformation and Adaptive Changes of Management [J]. *Reform*,2020,(04):37-49.
- [8] Liu Shuchun, Yan Jinchun, Zhang Sixue, et al. Can Corporate Digital Transformation Promote Input-Output Efficiency? [J]. *Journal of Management World*,2021,37(05):170-190+13.
- [9] Graham B, Dodd D. *Security Analysis: principles and technique* [M]. New York: Whittlesey House (McGraw- Hill Book Co.),1934.
- [10] Xia Lijun, Fang Yiqiang. Government Control, Institutional Environment and Firm Value:Evidence from the Chinese Securities Market [J]. *Economic Research Journal*,2005,(05):40-51.
- [11] Branco F, Villas-Boas J M. Competitive vices [J]. *Journal of Marketing Research*,2015,52(6):801-816.
- [12] Fang Jian. Have Asset Price Distortions Constrained Corporate Investment?---- A Theoretical and Empirical Analysis Based on Tobin's Q [J]. *Finance and Economy*,2022,(01):4-11.
- [13] Liu Xiaoyu, Bao Xinzhong. Intellectual Property Information Disclosure and Value Relevance of Listed Companies [J]. *Science and Technology Management Research*,2020,40(08):218-222.
- [14] Yang Guozhong, Xi Yuting. Empirical Study on Financing Constraints of Green Technology Innovation Activities of Enterprises [J]. *Journal of Industrial Technology and Economy*,2019, 38(11):70-76.
- [15] Wang Shouhai, Sun Xiaocheng, Liu yewei. The Impact of Digital Transformation on Corporate Tax Avoidance: A Discussion on the Moderating Role of Digital Finance Development [J]. *Journal of Anhui University (Philosophy and Social Sciences Edition)*,2023,47(05):123-135.
- [16] Damodaran A. *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset* [M].3rd ed. Hoboken, NJ: John Wiley & Sons, 2012.
- [17] Mo Dongyan, Fang Fang, Wang Yang. The Impact of Digital Transformation on Corporate Dual Agency-costs [J]. *Journal of Beijing Normal University (Social Sciences)*,2024,(02):130-141.
- [18] Lu Xiaodong, Lian Yujun. Estimation of Total Factor Productivity of Industrial Enterprises in China:1999-2007 [J]. *China Economic Quarterly*,2012,11(02):541-558.
- [19] Hunady J, Orviska M, Sarkanova B. Determinants of European Firm's Innovation and the Role of Public Financial Support [J]. *European Financial and Accounting Journal*, 2014,9(1):62-84.

- [20] Huang Dayu, Xie Huobao, Meng Xiangyu, et al. Digital Transformation and Enterprise Value---- Empirical Evidence based on Text Analysis Methods [J]. *Economist*,2021,(12):41-51.
- [21] Gao Lifang, Li Lu. A Study on the Impact of Enterprise Diversification on Bank Loan Financing [J]. *Journal of Anhui University (Philosophy and Social Sciences Edition)*,2022,46(03):118-131.