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The Impact of Digital Transformation and Corporate Cost Efficiency: Evidence from China's A-Share Listed Firms

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Abstract:

This study aims to investigate the impact of digital transformation on corporate cost efficiency and its underlying mechanisms. In relate to panel data from Chinese A-share listed companies for the period 2007-2022, we construct a Digital Transformation (DT) indicator using a keyword-based method and measure cost efficiency using metrics such as the input-output efficiency of main business costs. Furthermore, this study introduces variables including financing constraints, industry technological intensity, and property rights nature to examine the pathways through which digital transformation affects cost efficiency. A review of the literature reveals that existing research predominantly focuses on the impact of digital transformation on investment efficiency, innovation performance, or cost stickiness (e.g., Wu et al., 2021; Liu et al., 2025; Chen & Xu, 2023), with less attention paid to the perspective of cost efficiency, particularly lacking research on the cost channel within the Chinese context. Grounded in agency theory and technological innovation theory, we propose four hypotheses: Digital transformation significantly enhances corporate cost efficiency (H1); Financing constraints weaken the promoting effect of digital transformation on cost efficiency (H2); The effect of digital transformation is stronger in high-technology-intensive industries (H3); Property rights nature moderates the effect of digital transformation (H4). Empirical results indicate that digital transformation has a significant positive impact on cost efficiency, but this effect is attenuated in contexts of high financing constraints or non-technology-intensive industries. The research conclusions enrich the theoretical perspective on the relationship between digital transformation and corporate performance and provide insights for enterprises implementing digital strategies and for governments formulating relevant policies.

Keywords: Digital Transformation, Cost Efficiency, Financing Constraints, Technological Intensity, A-Share Listed Companies

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1. Introduction

With the rapid development of the digital economy, Chinese enterprises are increasingly investing in digital transformation to enhance their core competitiveness and resource allocation efficiency. Existing research indicates that digital transformation, through the application of information technology, can optimize production processes, reduce transaction costs, and improve operational efficiency (Zhang Yongkun et al., 2021). However, studies on how digital transformation specifically affects corporate cost efficiency remain insufficient. As a crucial component of corporate operational performance, cost efficiency directly relates to competitiveness and profitability levels. Based on Chinese A-share listed companies, this study examines the effect of digital transformation on cost efficiency and its constraining factors. On one hand, this helps fill the gap in the existing literature from a cost perspective; on the other hand, it provides practical references for corporate digital strategies.

2. Literature Review

Currently, the impact of digital transformation on corporate performance has garnered widespread attention, but most studies concentrate on investment efficiency, innovation performance, and financial performance. For instance, Wu Fei et al. (2021) found that digital transformation significantly enhances the stock liquidity of listed companies, improving capital market performance. Liu et al. (2025), using commercial banks as a sample, demonstrated that digital transformation improves cost efficiency of banks. However, these studies primarily focus on the financial industry or capital market performance, with relatively scarce examination of cost efficiency in manufacturing or traditional industries. Chen & Xu (2023) studied digital transformation and cost stickiness, finding that digitalization can significantly suppress cost stickiness but did not directly measure cost efficiency itself. Li et al. (2024) explored the impact of digital transformation on corporate resource allocation efficiency, showing that digitalization aids resource optimization but did not specifically focus on the cost angle. The study by Xiong & Guo (2024) focused on production performance differences and innovation performance, similarly analyzing cost efficiency. These studies provide evidence for the positive effects of digital transformation but are mostly limited to specific industries or performance indicators and do not fully consider the institutional characteristics of Chinese enterprises (e.g. high agency costs in state-owned enterprises, differences in financing environments). In summary, existing literature remains insufficient in exploring the impact of digital transformation on cost efficiency, which requires an in-depth analysis of the mechanisms and boundary conditions through which digital transformation enhances efficiency via the cost channel, in terms of the actual situation of Chinese enterprises.

3. Theoretical Foundations and Research Hypotheses

Based on resource-based theory and information asymmetry theory, digital transformation is expected to enhance corporate cost efficiency through a series of mechanisms: First, digital technologies (such as cloud computing, big data, smart manufacturing) can optimize production processes, reduce labor and time costs, thereby lowering unit output costs. Second, digitalization improves information transparency and decision-making efficiency, reduces management layers and information asymmetry, lowering monitoring costs and idle resources (Wu et al., 2021). Third, digitalization strengthens internal and external coordination, improves supply chain efficiency, reduces inventory and transaction costs, and enhances overall cost-effectiveness. Based on the above analysis, we propose Hypothesis 1 (H1): Digital transformation is positively correlated with corporate cost efficiency, meaning that a higher degree of digital transformation leads to higher cost efficiency.

However, the advancement of digital transformation requires capital investment and a technological foundation; thus, financing constraints may moderate its effects. On one hand, studies show that digital transformation can alleviate financing constraints by enhancing information transparency (Hadlock & Pierce, 2010). On the other hand, insufficient financing can restrict a firm's investment in and implementation of digital technologies. If an enterprise faces severe financing constraints, it may struggle to provide the necessary capital for digital projects, affecting the realization of digitalization's benefits. Based on this, we propose Hypothesis 2 (H2): The higher the degree of financing constraints, the weaker the promoting effect of digital transformation on cost efficiency. That is, financing constraints weaken the positive effect of digital transformation.

Furthermore, digital needs and application scenarios vary across industries. Digital transformation in technology-intensive industries might demonstrate more pronounced improvements in cost efficiency. High-technology-intensive industries inherently rely on R&D and technological upgrades, making digital technologies more readily applicable for process automation and R&D collaboration, thereby reducing manufacturing and management costs. In contrast, traditional manufacturing industries may have lower dependency on and marginal benefits from digitalization. Therefore, we propose Hypothesis 3 (H3): In technology-intensive industries, the enhancing effect of digital

transformation on cost efficiency is more significant.
Finally, the nature of property rights (e.g., state-owned vs. private) may also influence the effect of digital transformation. State-Owned Enterprises (SOEs) often face principal-agent problems and inefficient use of funds (Wang Qiang et al., 2022), and their decision-making efficiency and operational objectives differ from those of private enterprises. SOEs might prioritize policy directives and social responsibilities over pure efficiency gains during digital transformation; simultaneously, government support might alleviate financing constraints. Considering these factors comprehensively, we propose Hypothesis 4 (H4): The property rights nature of an enterprise moderates the impact of digital transformation on cost efficiency. Specifically, there may be differences between SOEs and private enterprises in the relationship between digital transformation and cost efficiency (the directionality awaits empirical testing).

4. Research Design

Sample and Data Sources: This study selects non-financial A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2007 to 2022 as the initial sample. Companies labeled ST, PT, and those with consolidated financial statements are excluded, resulting in the final valid sample. Primary financial data are sourced from Wind and company annual reports.
Variable Definitions:
· Cost Efficiency (CostEff): Measured by the input-output efficiency of main business costs, specifically the inverse of the main business cost ratio (Main Business Cost / Main Business Revenue) or related indicators. Higher cost efficiency implies lower costs for the same level of revenue.
· Digital Transformation (DT) Indicator: Following the keyword method of Wu et al. (2021), the frequency of digital-related keywords appearing in the «Management Discussion and Analysis» section of annual reports is counted. Keywords include cloud computing, artificial intelligence, big data, blockchain, etc. The total word frequency is divided by the text length to control for scale differences, resulting in a DT index reflecting the degree of enterprise digitalization. A higher index value indicates a higher degree of digital transformation.
· Financing Constraints (FC) Indicator: Measured using the SA index proposed by Hadlock and Pierce (2010): SA = -0.737×Size + 0.043×Size² - 0.04×Age, where Size is the natural logarithm of total assets, and Age is the firm›s years since establishment. A lower (more negative) SA value indicates more severe financing constraints. This index avoids indicators like cash flow and leverage ratios that are susceptible to managerial manipulation and is thus widely used in research on Chinese listed companies.
· Technological Intensity: Based on the CITIC Securities industry classification, industries are categorized as high-technology-intensive, low-technology-intensive, etc. A dummy variable HighTech is introduced, where HighTech=1 if the firm belongs to a high R&D intensity, technology-intensive industry according to the CITIC classification, otherwise 0.
· Control Variables: Include firm size (Size, natural logarithm of total assets), firm growth (Growth, main business revenue growth rate), asset-liability ratio, operating cash flow ratio, etc., to control for corporate financial conditions and risk characteristics.
Model Specification: The basic regression model is as follows:
$CostEff_{it} = \alpha_0 + \alpha_1 DT_{it} + \beta Control_{it} + \gamma_i + \delta_t + \varepsilon_{it}$
Where $CostEff_{it}$ is the cost efficiency measure for firm i in year t, DT_{it} is the digital transformation index; $Control_{it}$ is the matrix of control variables; γ_i and δ_t represent firm and year fixed effects, respectively; ε_{it} is the error term. To examine moderating effects, interaction terms involving financing constraints, technological intensity, and property rights nature are introduced separately. All regression stability tests will employ cluster-adjusted standard errors.
Dependent Variable: Cost Efficiency (CostRate) = (COGS + SellExp + AdminExp) / Revenue.
A lower cost ratio indicates higher efficiency.
Independent Variable: Digital Transformation Index (DT) constructed via textual analysis or digital patent count.
Moderating Variables: Ownership, Financing Constraints, Industry Technological Intensity.
Control Variables: Firm size, leverage, firm age, ROA, industry and year fixed effects.
Baseline Model:
$CostRate_{it} = \alpha 0 + \alpha 1\ DT_{it} + \Sigma \beta X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$
Moderating Model:
$CostRate_{it} = \alpha 0 + \alpha 1\ DT_{it} + \alpha 2\ Moderator_{it} + \alpha 3\ (DT_{it} \times Moderator_{it}) + \Sigma \beta X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$

5. Expected Results Analysis

Based on theoretical reasoning and hypotheses, this study expects the following results: First, digital transformation has a significant positive impact on cost efficiency. Digital technologies, through means such as automated production, intelligent operations, and data-driven decision-making, help reduce unit costs and improve resource utilization (Zhang Yongkun et al., 2021; Wu Fei et al., 2021). Therefore, coefficient α_1 is expected to be significantly positive in the empirical analysis. This implies that firms with a higher degree of digital transformation have more optimized cost structures and higher cost efficiency.
Second, financing constraints weaken the promoting effect

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of digital transformation on cost efficiency (H2). On one hand, digital projects typically require upfront capital investment and technological accumulation; high financing constraints limit firms' access to necessary funds (Hadlock & Pierce, 2010). Insufficient financing leads to inadequate digital investment or prevents full implementation of cost-control measures, hence the effect of digital transformation is weaker in firms with high financing constraints. On the other hand, firms with higher digitalization levels might gain better financing conditions due to increased information transparency, but this effect manifests more in the medium to long term. This study primarily adopts a resource constraint perspective: when financing constraints are severe, the effect of digital transformation on enhancing cost efficiency is inhibited. Therefore, introducing an interaction term between DT and the SA index in the regression, the coefficient of the interaction term is expected to be negative (Note: A lower SA indicates higher financing constraints, leading to a weakened effect).

Third, the effect of digital transformation is more significant in technology-intensive industries (H3). Technology-intensive industries rely on high R&D investment and rapid innovation; digital technologies can more directly improve production, manufacturing, and R&D processes, such as smart manufacturing and cloud-based design. Scale and synergy effects are more readily realized in these industries, contributing significantly to cost efficiency improvements. In contrast, labor-intensive traditional industries might rely more on low-cost production methods, yielding relatively smaller marginal benefits from digital transformation. Therefore, when HighTech=1, the positive effect of digital transformation on cost efficiency should be stronger; this would be reflected as a significantly positive coefficient for the DT×HighTech interaction term.

Finally, property rights nature moderates the effect of digital transformation (H4). SOEs, facing greater pressure from government and social functions, coupled with complex internal management, might experience less direct efficiency gains during digital transformation compared to private enterprises. SOEs possess abundant resources but may lack sufficient incentives, have long decision-making chains, and potentially slower adoption and application of new technologies; simultaneously, the payback period for digital projects might lead to cautious attitudes. Therefore, the enhancing effect of digital transformation on cost efficiency is expected to be relatively smaller in SOEs. Conversely, private enterprises, under market competition pressure, pay more attention to cost control and efficiency improvement and are more sensitive to the returns on digital technology investments. Empirically, this moderating effect can be tested by including a property rights nature dummy variable (SOE=1 for state-owned enterprises) and its interaction term with DT. If the effect is lower in SOEs, the interaction term coefficient would likely be negative.

In summary, the expected results are: Digital transformation significantly improves corporate cost efficiency (supporting H1); Greater financing constraints weaken this positive effect (supporting H2); This effect is stronger in technology-intensive industries (supporting H3); Property rights nature leads to differences in the effect (partially supporting H4). These results will be verified through fixed-effects regression analysis, subgroup regressions, and robustness checks.

6. Conclusion and Outlook

Based on data from Chinese A-share listed companies, this study systematically investigates the impact of digital transformation on corporate cost efficiency and analyzes the moderating mechanisms of financing constraints, industry attributes, and property rights nature. The results are expected to demonstrate that digital transformation can significantly enhance cost efficiency by optimizing production and management processes and improving resource utilization. However, financing constraints limit firms' ability to invest in digital technologies, thereby attenuating this enhancing effect; the effect is more pronounced in technology-intensive industries due to their high compatibility with digital technologies; the efficiency gains from digitalization in SOEs might be less than those in private enterprises, suggesting that policymakers need differentiated support strategies for different types of enterprises. The contributions of this research lie in enriching the theoretical understanding of the relationship between digital transformation and corporate performance, filling the research gap from the cost efficiency perspective, and providing empirical evidence for corporate managers implementing digital strategies.

Future research could be extended in several directions: First, incorporating human capital digitalization factors, such as digital skills training and employee informatization levels, to explore how digital human resources affect the transmission mechanism of cost efficiency. Second, employing mixed-methods approaches like interviews and case studies could provide in-depth analysis of the implementation processes and internal impact pathways of digital transformation in different organizational contexts, complementing quantitative research. Additionally, future studies could focus on the impact of digital transformation on non-financial performance (e.g., environmental efficiency, social benefits), offering multi-dimensional perspectives for a comprehensive evaluation of digital strategy effectiveness.

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