



Digital Transformation and Managerial Cost Efficiency: Empirical Evidence from Chinese A-Share Firms

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Abstract. Using a sample of Chinese A-share listed firms from 2012 to 2024, this study examines whether digital transformation (DT) is associated with lower managerial cost burden. DT is measured from digital-related keyword frequencies in the MD&A sections of annual reports. Firms with stronger DT tend to have a lower management expense ratio, while the relationship is weaker for broader expense measures. Additional tests suggest that total asset turnover is the main channel, and the effect is stronger among non-state-owned firms, firms in eastern China, and manufacturing firms.

Keywords: digital transformation; managerial cost burden; operating efficiency; management expense ratio; total asset turnover; heterogeneity

1 Introduction

1.1 Research Background

As the digital economy expands, digital transformation has moved beyond informatization to deeper changes in process design and governance. By embedding digital technologies into routine operations, firms may improve information transparency, internal control, and resource allocation, thereby lowering coordination costs. Yet DT is costly and organizationally demanding, so its cost-side benefits cannot be assumed. (Vial, 2019; Verhoef et al., 2021).^[1,2]

1.2 Research Gap and Motivation

Existing research shows that DT can promote innovation, productivity, and high-quality development. However, less is known about whether DT changes firms' internal expense structure, especially management-related expenses. This issue matters because management expenses reflect coordination, supervision, and organizational discipline, where digital systems should matter most. (Bharadwaj et al., 2013; Warner and Wäger, 2019).^[3,4]

1.3 Research Objectives and Questions

This study addresses three related questions. First, is DT associated with a lower management expense ratio among Chinese listed firms? Second, does this relationship operate through improvements in operational efficiency, especially total asset turnover? Third, does the strength of the relationship vary across firms with different ownership structures, regional conditions, and industry characteristics?

1.4 Theoretical Framework: Socio-Technical Systems Theory

This paper draws on socio-technical systems (STS) theory, which stresses the fit between technical systems and organizational arrangements. The perspective is useful here because management-related costs arise from coordination, communication, supervision, and control. When digital technologies are embedded effectively in routines, they can reduce friction in these activities; when the fit is weak, digital investment may instead generate adjustment costs. (Trist and Bamforth, 1951).^[5]

1.5 Research Design and Contributions

Against this background, this study uses Chinese A-share listed firms from 2012 to 2024 to examine the relationship between DT and firms' cost burden. A text-based DT indicator is constructed from the MD&A sections of annual reports, and the main tests use firm- and year-fixed effects.

This study makes three contributions. First, it focuses on management expense intensity rather than broad performance outcomes. Second, it shows that the cost-side effect of DT is concentrated in managerial and coordination-related expenses rather than all expenditure categories. Third, the mechanism and heterogeneity results indicate that the association is more likely to emerge when firms face stronger implementation incentives and can translate digital investment into better asset utilization.

1.6 Structure of the Paper

The remainder of the paper is organized as follows. Section 2 develops the hypotheses. Section 3 describes the data, variables, and empirical strategy. Section 4 reports the empirical results. Section 5 discusses the findings, and Section 6 concludes.

2 Theoretical Background and Hypothesis Development

2.1 Introduction to Socio-Technical Systems Theory (STS)

DT is not merely a technology investment but a broader restructuring of processes, organization, and governance. Its consequences may include better information transparency, more efficient decision-making, and stronger internal control, all of which can lower coordination and monitoring costs. Compared with broader operating cost measures, management expenses provide a clearer window into whether digitalization

improves internal organizational efficiency. (Sebastian et al., 2017; Nambisan et al., 2017).^[6,7]

When socio-technical alignment improves, digital systems can shorten information chains, reduce repetitive communication, strengthen traceability, and support process control. Conversely, if digital systems are adopted without organizational adaptation, firms may incur implementation costs without clear efficiency gains. STS theory therefore helps explain why the cost effect of DT may be heterogeneous and concentrated in management-related domains.

2.2 Digital Transformation and Its Organizational Implications

From an STS perspective, DT changes how firms coordinate, monitor, and execute tasks. Digital systems can make information flows timelier, improve process visibility, and support standardized routines, thereby reducing administrative frictions and improving resource deployment. (Brynjolfsson and Hitt, 2000; Zhu et al., 2006).^[8,9]

At the same time, digital initiatives require investment in infrastructure, software, integration, training, and organizational adaptation. During implementation, firms may also face temporary disruption or duplicated systems. The net cost effect therefore depends on whether digital investment produces lasting improvements in routines and efficiency.

2.3 Organizational Cost Burden and Efficiency

In this paper, organizational cost burden mainly refers to internal expenses related to administration, coordination, supervision, and control. The management expense ratio provides the most direct proxy because it captures management-related outlays relative to revenue. Broader measures such as the operating expense ratio or operating cost ratio are also shaped by market, financing, and production conditions.

A likely channel is operating efficiency. When digital systems improve information sharing and process coordination, firms may manage inventory, receivables, and total assets more efficiently. Higher turnover allows a given stock of resources to support more output and revenue, helping dilute expense intensity and reduce managerial cost burden. (Mithas et al., 2012).^[10]

2.4 Boundary Conditions: Ownership, Region, and Industry

STS theory also suggests that the value of DT varies across organizational and environmental conditions. Firms differ in governance incentives, implementation capacity, and competitive pressure, while regions and industries differ in digital infrastructure, complementary services, and process standardization. These differences may affect whether digital investment becomes measurable cost savings.

2.4.1 Ownership Structure: SOEs vs Non-SOEs.

Ownership matters because it shapes incentives and implementation discipline. Non-state-owned firms usually face stronger competitive pressure, harder budget constraints, and clearer performance targets, making it more likely that digital tools are combined with process redesign and cost accountability. State-owned enterprises may translate DT into observable cost savings more slowly.

2.4.2 Regional and Industry Variations.

Regional and industry conditions may also matter. Firms in more digitally developed regions benefit from better infrastructure, stronger service ecosystems, and richer digital talent. Manufacturing is also more standardized and data-intensive, making it easier to embed digital systems in production planning, quality control, equipment management, and supply-chain coordination.

2.5 Hypothesis Development

Overall, DT should reduce managerial cost burden when digital systems are effectively integrated into organizational routines and when implementation conditions are favorable.

2.5.1 Hypothesis 1: Digital Transformation and Organizational Cost Burden.

More specifically, DT can reduce repetitive work and communication losses through automation and system integration. It can also strengthen supervision through traceability and real-time information, improving budget discipline and coordination efficiency. Therefore, higher DT is expected to be associated with a lower management expense ratio.

H1. A higher level of digital transformation is associated with a lower management expense ratio.

2.5.2 Hypothesis 2: The Mediating Role of Operational Efficiency.

Administrative savings alone are unlikely to explain the cost-side consequences of DT. A more plausible pathway is that DT improves the efficiency of the operating system and thereby reduces expense intensity. If digital systems raise turnover efficiency, they can ease managerial cost burden indirectly.

H2. Improvements in operational efficiency partially mediate the negative association between digital transformation and management-related organizational cost burden.

2.5.3 Hypothesis 3: Moderating Effects of Ownership.

The cost-reducing effect of DT is unlikely to be uniform across firms. Because its realization depends on governance discipline and incentives, the effect should be stronger in non-state-owned firms than in state-owned firms.

H3. The negative relationship between digital transformation and management-related organizational cost burden is stronger in non-state-owned firms than in state-owned firms.

2.5.4 Hypothesis 4: Moderating Effects of Region.

Regional conditions also matter because digital infrastructure, service ecosystems, and talent supply shape the implementation cost of DT. The negative relationship between DT and managerial cost burden should therefore be stronger in more digitally developed regions.

H4. The negative relationship between digital transformation and management-related organizational cost burden is stronger for firms located in more digitally developed regions.

2.5.5 Hypothesis 5: Moderating Effects of Industry.

Industry characteristics are another likely boundary condition. Because manufacturing processes are more standardized and easier to digitize, the negative relationship between DT and managerial cost burden should be stronger in manufacturing firms.

H5. The negative relationship between digital transformation and management-related organizational cost burden is stronger in manufacturing firms than in non-manufacturing firms.

3 Research Design

3.1 Sample and Data

The sample consists of Chinese A-share listed firms from 2012 to 2024. Financial statement data and firm characteristics are primarily obtained from the CSMAR database, while the DT indicator is manually constructed from the MD&A sections of firms' annual reports. The analysis excludes financial firms, ST and *ST firms, and observations with missing values for the main variables. To reduce the influence of extreme observations, continuous variables are winsorized at the 1st and 99th percentiles.

The dataset includes information on management, selling, and financial expenses, operating costs, revenue, total assets, inventory, accounts receivable, net cash flow from operating activities, ownership, industry, and region.

After data screening, the benchmark sample used in the fixed-effects regressions contains 43,725 firm-year observations, while the broader descriptive sample contains 43,845 observations.

3.2 Variable Definitions

3.2.1 Dependent Variables.

The analysis measures firms' cost burden mainly through expense intensity. Two dependent variables are used: the management expense ratio (MC), defined as man-

agement expenses divided by operating revenue, and the operating expense ratio (Opex), defined as the sum of management, selling, and financial expenses divided by operating revenue.

The primary outcome variable is the management expense ratio (MC), which captures administrative, coordination, and monitoring costs and thus serves as the main indicator of managerial cost burden.

The operating expense ratio (Opex) is used to test whether the association extends to a broader set of expenses. For robustness, the analysis also uses the operating cost ratio (Cost), measured as operating costs divided by operating revenue.

3.2.2 Independent Variable.

The core explanatory variable is digital transformation intensity (Digital). It is constructed from MD&A text by counting the frequency of digital-related keywords and then applying the logarithmic transformation $\ln(1 + \text{keyword count})$.

This specification reduces the influence of extreme observations, allows firms with zero keyword counts to remain in the sample, and makes the disclosure-based proxy easier to interpret.

Digital should therefore be interpreted as a disclosure-based proxy for digital transformation rather than a direct measure of digital expenditure.

3.2.3 Mechanism and Heterogeneity Variables.

Table 1 To examine the mechanism, the study uses inventory turnover, accounts receivable turnover, and total asset turnover as indicators of operational efficiency. Ownership structure, regional location, and industry affiliation are then introduced to assess whether the association between DT and cost burden varies across institutional and operating environments.

Table 1. Variable definitions

Variable Type	Symbol	Variable Name	Definition
Dependent variable	MC	Management expense ratio	Management expenses divided by operating revenue
Dependent variable	Opex	Operating expense ratio	(Selling expenses + management expenses + financial expenses) divided by operating revenue
Dependent variable (robustness)	Cost	Operating cost ratio	Operating costs divided by operating revenue
Independent variable	Digital	Digital transformation intensity	Natural logarithm of one plus the total frequency of digital-related keywords in the MD&A section of annual reports, i.e., $\ln(1 + \text{total keyword frequency})$. Keywords include digitalization, cloud computing, big data,

Variable Type	Symbol	Variable Name	Definition
			artificial intelligence, intelligent manufacturing, industrial internet, ERP, etc.
Mechanism variable	InvTurn	Inventory turnover	Operating costs divided by average inventory
Mechanism variable	ARturn	Accounts receivable turnover	Operating revenue divided by average accounts receivable
Mechanism variable	ATO	Total asset turnover	Operating revenue divided by average total assets
Heterogeneity variable	SOE	Ownership	Equals 1 for state-owned enterprises, and 0 otherwise
Heterogeneity variable	Province	Regional distribution	Eastern = 1, Central = 2, Western = 3, based on registered location
Heterogeneity variable	Industry	Industry attribute	Equals 1 for manufacturing firms, and 0 otherwise
Control variable	Size	Firm size	Natural logarithm of total assets
Control variable	Lev	Leverage	Total liabilities divided by total assets
Control variable	ROA	Return on assets	Net profit divided by average total assets
Control variable	Growth	Growth	Growth rate of operating revenue
Control variable	CFO	Operating cash flow	Net cash flow from operating activities divided by total assets
Control variable	Tang	Asset tangibility	Fixed assets divided by total assets
Control variable	Age	Firm age	Report year minus year of establishment
Control variable	Top1	Ownership concentration	Shareholding ratio of the largest shareholder

3.3 Empirical Specification

The baseline model is specified as follows:

$$\text{CostBurden}_{i,t} = \alpha_0 + \alpha_1 \text{Digital}_{i,t} + \alpha_2 \text{Controls}_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where $CostBurden_{i,t}$ denotes the cost-burden measure of firm i in year t , measured primarily by MC and supplemented by Opex and Cost in alternative specifications; $Digital_{i,t}$ denotes digital transformation intensity; $Controls_{i,t}$ is the vector of firm-level controls; μ_i and λ_t are firm and year fixed effects; and $\varepsilon_{i,t}$ is the error term.

The empirical analysis mainly relies on firm- and year-fixed-effects models, with the coefficient on Digital as the central parameter of interest. Additional stepwise regressions are used for the mechanism analysis.

To examine the mechanism, the following mediation equations are estimated:

$$Mediator_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \beta_2 Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

$$CostBurden_{i,t} = \gamma_0 + \gamma_1 Digital_{i,t} + \gamma_2 Mediator_{i,t} + \gamma_3 Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where $Mediator_{i,t}$ is alternatively measured by InvTurn, ARturn, and ATO. Mediation is supported when Digital significantly affects the efficiency measure and the mediator enters significantly in the cost-burden regression while reducing the Digital coefficient.

To assess heterogeneity, the sample is partitioned by ownership, region, and industry.

4 Empirical Results

Table 2 reports descriptive statistics for the main variables. The benchmark regression sample contains 43,725 firm-year observations. The management expense ratio (MC), operating expense ratio (Opex), and operating cost ratio (Cost) show substantial cross-firm variation.

Digital transformation intensity (Digital) has a mean of 1.020 and ranges from 0 to 4.710, suggesting marked heterogeneity in firms' digitalization. The turnover indicators also vary widely across firms.

Table 2. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Management expense ratio (MC)	43,725	0.086	0.071	0.008	0.451
Operating expense ratio (Opex)	43,725	0.174	0.140	0.013	0.782
Operating cost ratio (Cost)	43,725	0.711	0.178	0.159	1.034
Digital transformation intensity (Digital)	43,725	1.020	1.269	0.000	4.710
Firm size (Size)	43,725	22.239	1.295	19.887	26.309
Leverage (Lev)	43,725	0.417	0.209	0.054	0.938
Return on assets (ROA)	43,725	0.033	0.069	-0.297	0.200
Revenue growth (Growth)	43,725	0.136	0.378	-0.592	2.284

Variable	Obs.	Mean	Std. Dev.	Min	Max
Operating cash flow (CFO)	43,725	0.048	0.068	-0.157	0.242
Asset tangibility (Tang)	43,725	0.207	0.155	0.002	0.679
Ownership concentration (Top1)	43,725	33.724	14.884	8.380	74.820
Firm age (Age)	43,725	17.304	8.785	3.000	34.000

Table 3 reports the baseline regression results. In the preferred firm- and year-fixed-effects specification, Digital is significantly and negatively associated with MC, but not robustly related to broader expense measures.

The economic magnitude is modest but meaningful. A one-unit increase in Digital is associated with a 0.001 decline in MC, about 1.2% of the sample mean.

These estimates exploit within-firm changes over time and therefore provide the main evidence that stronger DT is associated with lower managerial cost burden.

Table 3. Baseline regression results: cost burden indicators

Variable	(1)MC	(2)Opex	(3)Cost	(4)MC	(5)Opex	(6)Cost
Digital	0.004*** (0.001)	0.003** (0.001)	-0.003* (0.001)	-0.001** (0.001)	-0.002 (0.001)	0.001 (0.001)
Size	- 0.018*** (0.001)	- 0.024*** (0.002)	-0.004* (0.002)	- 0.026*** (0.002)	- 0.034*** (0.003)	- 0.009*** (0.003)
Lev	- 0.036*** (0.005)	-0.006 (0.010)	0.314*** (0.011)	0.027*** (0.006)	0.142*** (0.011)	0.152*** (0.009)
ROA	-0.022* (0.012)	-0.038* (0.022)	-0.020 (0.014)	-0.009 (0.007)	-0.020* (0.012)	-0.023* (0.014)
Growth	- 0.022*** (0.001)	- 0.049*** (0.003)	- 0.025*** (0.003)	- 0.027*** (0.001)	- 0.051*** (0.002)	- 0.017*** (0.002)
CFO	- 0.130*** (0.010)	- 0.073*** (0.022)	- 0.529*** (0.024)	- 0.091*** (0.007)	- 0.123*** (0.011)	- 0.260*** (0.013)
Tang	0.005 (0.005)	- 0.036*** (0.010)	0.178*** (0.014)	0.016** (0.008)	0.042*** (0.014)	0.119*** (0.013)
Age	0.001*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	—	—	—
SOE	-0.005** (0.002)	- 0.030*** (0.005)	0.021*** (0.006)	—	—	—

Top1	- 0.000*** (0.000)	- 0.001*** (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	- 0.001*** (0.000)
_cons	0.488*** (0.016)	0.725*** (0.032)	0.623*** (0.039)	0.658*** (0.035)	0.892*** (0.058)	0.865*** (0.056)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	No	No	No
Firm fixed effects	No	No	No	Yes	Yes	Yes
Obs.	43,845	43,845	43,845	43,725	43,725	43,725
Adj. R ²	0.233	0.124	0.261	0.664	0.740	0.832

Notes: Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Columns (1)-(3) include industry and year fixed effects, whereas Columns (4)-(6) include firm and year fixed effects. Age and SOE are absorbed in the firm fixed-effects specification and are therefore omitted. Differences in the number of observations across columns arise from the fixed-effects structure and sample availability.

4.1 Robustness Tests

4.1.1 One-Period Lag of the Explanatory Variable.

As shown in Table 4, the coefficient on the lagged DT variable remains significantly negative for MC, which supports the benchmark result. At the same time, Digital_lag1 is significantly negative for Eff_ROA but significantly positive for Eff_ATO, suggesting a transitional adjustment process in which digital investment first improves asset turnover rather than all efficiency measures simultaneously.

Table 4. Robustness test: one-period lag of digital transformation

Variable	(1)MC	(2)Opex	(3)Eff_ROA	(4)Eff_ATO
Digital_lag1	-0.002*** (0.001)	-0.002 (0.001)	-0.004*** (0.001)	0.009*** (0.003)
Size	-0.027*** (0.002)	-0.037*** (0.003)	0.019*** (0.001)	-0.036*** (0.010)
Lev	0.028*** (0.007)	0.148*** (0.011)	-0.185*** (0.005)	0.034 (0.028)
ROA	-0.010 (0.007)	-0.020 (0.014)	—	—

Variable	(1)MC	(2)Opex	(3)Eff_ROA	(4)Eff_ATO
Growth	-0.028*** (0.001)	-0.052*** (0.002)	0.037*** (0.001)	0.161*** (0.005)
CFO	-0.089*** (0.007)	-0.117*** (0.012)	0.207*** (0.008)	0.515*** (0.030)
Tang	0.013 (0.009)	0.038** (0.015)	-0.083*** (0.007)	-0.107*** (0.041)
Top1	0.000 (0.000)	0.000 (0.000)	0.001*** (0.000)	0.000 (0.000)
_cons	0.686*** (0.037)	0.938*** (0.063)	-0.320*** (0.028)	1.369*** (0.218)
Firm fixed effects	Controlled	Controlled	Controlled	Controlled
Year fixed effects	Controlled	Controlled	Controlled	Controlled
Obs.	38,578	38,578	38,578	38,578
Adj. R ²	0.674	0.750	0.529	0.800

Notes: This table reports the robustness test using one-period-lagged digital transformation. All regressions include firm and year fixed effects. Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.1.2 Alternative Fixed-Effects Specification.

Table 5 reports an alternative specification with industry and year fixed effects. The estimates differ from the benchmark firm-fixed-effects results, highlighting the importance of controlling for unobserved firm heterogeneity.

This contrast is informative rather than contradictory. Because the industry-year specification does not absorb time-invariant firm characteristics, the firm-fixed-effects results are more closely aligned with the paper's within-firm research question.

Table 5. Alternative specification: industry and year fixed effects

Variable	(1)MC	(2)Opex	(3)Cost	(4)Eff_ROA	(5)Eff_ATO
Digital	0.004*** (0.001)	0.003** (0.001)	-0.003* (0.001)	-0.003*** (0.000)	0.005 (0.004)
Size	-0.018*** (0.001)	-0.024*** (0.002)	-0.004* (0.002)	0.010*** (0.000)	-0.009* (0.006)
Lev	-0.036*** (0.005)	-0.006 (0.010)	0.314*** (0.011)	-0.121*** (0.003)	0.415*** (0.028)
ROA	-0.022* (0.010)	-0.038* (0.015)	-0.020 (0.011)	—	—

Variable	(1)MC	(2)Opex	(3)Cost	(4)Eff_ROA	(5)Eff_ATO
	(0.012)	(0.022)	(0.014)		
Growth	-0.022*** (0.001)	-0.049*** (0.003)	-0.025*** (0.003)	0.038*** (0.001)	0.144*** (0.007)
CFO	-0.130*** (0.010)	-0.073*** (0.022)	-0.529*** (0.024)	0.355*** (0.008)	1.117*** (0.052)
Tang	0.005 (0.005)	-0.036*** (0.010)	0.178*** (0.014)	-0.060*** (0.003)	-0.215*** (0.038)
Age	0.001*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	-0.001*** (0.000)	-0.001 (0.001)
SOE	-0.005** (0.002)	-0.030*** (0.005)	0.021*** (0.006)	0.005*** (0.001)	0.012 (0.017)
Top1	-0.000*** (0.000)	-0.001*** (0.000)	0.000 (0.000)	0.000*** (0.000)	0.002*** (0.000)
_cons	0.488*** (0.016)	0.725*** (0.032)	0.623*** (0.039)	-0.157*** (0.009)	0.572*** (0.116)
Industry fixed effects	Controlled	Controlled	Controlled	Controlled	Controlled
Year fixed effects	Controlled	Controlled	Controlled	Controlled	Controlled
Obs.	43,845	43,845	43,845	43,845	43,845
Adj. R ²	0.233	0.124	0.261	0.394	0.092

Notes: This table reports the alternative specification with industry and year fixed effects. Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.2 Mechanism Analysis

Table 6 reports the first-step mechanism results. DT is positively associated with total asset turnover and weakly positively associated with inventory turnover, suggesting that total asset turnover is the most stable efficiency channel.

In the second step, Tables 7 and 8 show that the turnover indicators enter the MC and Opex regressions with generally negative and significant coefficients. The most robust pattern appears for ATO. Once ATO is included, the coefficient on Digital declines noticeably and becomes statistically insignificant in both the MC and Opex regressions. This suggests that improved total asset turnover is an important channel through which DT is associated with lower expense intensity.

Table 6. Step 1 of the mechanism test: digital transformation and operating efficiency

Variable	(1)Inventory turnover (InvTurn)	(2)Accounts receivable turnover (ARturn)	(3)Total asset turnover (ATO)
Digital	1.1250* (1.91)	-1.6781*** (-2.64)	0.0078** (2.54)
Obs.	43,051	43,051	43,051

Notes: This table reports Step 1 of the mechanism test for operating efficiency. *t*-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7. Step 2 of the mechanism test: dependent variable = management expense ratio (MC)

Variable	(1)MC (with InvTurn)	(2)MC (with ARturn)	(3)MC (with ATO)
Digital	-0.0015** (-2.28)	-0.0016** (-2.47)	-0.0009 (-1.56)
Mediator	-0.0000** (-2.12)	-0.0000*** (-5.78)	-0.0754*** (-25.44)
Obs.	43,051	43,051	43,051

Notes: *t*-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All regressions include the full set of control variables, firm and year fixed effects, and firm-clustered standard errors. Control-variable coefficients are omitted for brevity.

Table 8. Step 2 of the mechanism test: dependent variable = operating expense ratio (Opex)

Variable	(1)Opex (with InvTurn)	(2)Opex (with ARturn)	(3)Opex (with ATO)
Digital	-0.0020* (-1.94)	-0.0022** (-2.19)	-0.0010 (-1.11)
Mediator	-0.0001* (-1.68)	-0.0001*** (-7.96)	-0.1255*** (-25.97)
Obs.	43,051	43,051	43,051

Notes: *t*-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All regressions include the full set of control variables, firm and year fixed effects, and firm-clustered standard errors. Control-variable coefficients are omitted for brevity.

4.3 Heterogeneity Analysis

4.3.1 Ownership Heterogeneity.

Table 9 reports the ownership heterogeneity results. The coefficient on Digital is significantly negative for MC in non-SOEs, while the interaction term $SOE \times Digital$ is positive and significant, implying that the negative association is weaker in SOEs.

This pattern is consistent with differences in governance incentives: non-SOEs face stronger market discipline and harder budget constraints, making digital investment more likely to be linked to process redesign and cost accountability.

Table 9. Heterogeneity analysis: ownership

Variable	(1)MC	(2)Opex
Digital	-0.002** (0.001)	-0.002 (0.001)
SOE \times Digital	0.002* (0.001)	0.000 (0.002)
Controls	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Obs.	43,725	43,725
Adj. R ²	0.664	0.740

*Notes: This table reports heterogeneity by ownership. The coefficient on Digital captures the reference-group effect, and $SOE \times Digital$ captures the incremental effect for state-owned enterprises. All regressions include controls and firm and year fixed effects. Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.*

4.3.2 Regional Heterogeneity.

Table 10 presents the regional heterogeneity analysis. The coefficient on Digital is significantly negative in eastern China for both MC and Opex, whereas the interaction terms for the central and western regions weaken or offset this association.

This pattern is consistent with regional differences in digital infrastructure, supporting services, and skilled labor supply. This is in line with prior work emphasizing the role of complementary capabilities and ecosystem conditions in digital transformation (Verhoef et al., 2021).

Table 10. Heterogeneity analysis: regional distribution

Variable	(1)MC	(2)Opex
Digital	-0.002***	-0.002*

Variable	(1)MC	(2)Opex
	(0.001)	(0.001)
Central region × Digital	0.002 (0.002)	0.001 (0.003)
Western region × Digital	0.003* (0.002)	0.002 (0.003)
Controls	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Obs.	43,725	43,725
Adj. R ²	0.664	0.740

Notes: This table reports heterogeneity by region, using eastern China as the reference group. All regressions include controls and firm and year fixed effects. Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.3.3 Industry Heterogeneity.

Table 11 reports the industry heterogeneity results. For MC, the coefficient on Digital is not significant in non-manufacturing firms, whereas the interaction term Manufacturing × Digital is significantly negative, suggesting a stronger managerial cost effect in manufacturing.

This result is intuitive because manufacturing processes are more standardized, modular, and data-intensive, making it easier for digital tools to generate observable managerial efficiency gains. Similar arguments appear in prior studies of enterprise digitalization and organizational redesign (Sebastian et al., 2017).

Table 11. Heterogeneity analysis: industry attribute

Variable	(1)MC	(2)Opex
Digital	0.002 (0.001)	0.005** (0.002)
Manufacturing × Digital	-0.005*** (0.001)	-0.011*** (0.002)
Controls	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Obs.	43,725	43,725

Variable	(1)MC	(2)Opex
Adj. R ²	0.664	0.740

*Notes: This table reports heterogeneity by industry, using non-manufacturing firms as the reference group. All regressions include controls and firm and year fixed effects. Firm-clustered standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.*

Overall, the heterogeneity tests show that the cost-reducing effect of DT is more pronounced among non-state-owned firms, firms in eastern China, and manufacturing firms.

5 Discussion

5.1 Interpretation of Results

The main result is that DT is linked primarily to a lower management expense ratio rather than to an across-the-board reduction in all cost categories. The mechanism analysis further suggests that improved operational efficiency, especially total asset turnover, is a plausible transmission channel. The evidence therefore points to a cost-side role of DT that works through better organizational execution rather than uniform reductions in every type of expense.

5.2 Theoretical Implications

Using data on Chinese A-share listed firms from 2012 to 2024, this study examines the cost-side consequences of digital transformation and identifies both a possible mechanism and several boundary conditions. The evidence indicates that DT is associated with a lower management expense ratio, partly through improvements in operational turnover efficiency, and that the effect is stronger among non-state-owned firms, firms in eastern China, and manufacturing firms.

The findings also refine the STS interpretation of DT. The clearest effects appear in management-related domains and in settings where implementation incentives and process standardization are stronger.

5.3 Practical Implications

These findings have practical implications. Firms should integrate digital systems with process redesign, budget control, and internal control rather than treating DT as a purely technical project. At the policy level, the results point to the importance of stronger digital infrastructure and service ecosystems. This recommendation is consistent with prior research showing that IT value depends on organizational change rather than technology spending alone (Brynjolfsson and Hitt, 2000; Mithas et al., 2012).

The heterogeneity results further suggest that firms facing weaker external support or more rigid governance structures need greater complementary investment in implementation capability, organizational adaptation, and managerial incentives.

6 Conclusion

Using data on Chinese A-share listed firms from 2012 to 2024, this study shows that DT is significantly associated with a lower management expense ratio, while the evidence is weaker for broader expense measures. Improved total asset turnover appears to be the main channel, and the effect is more pronounced among non-state-owned firms, firms located in eastern China, and manufacturing firms.

At the firm level, digital transformation should be integrated with process redesign, budget discipline, and internal coordination if digital investment is to generate observable cost benefits. At the policy level, improving digital infrastructure and complementary service ecosystems remains important.

This study also has several limitations. The text-based DT measure mainly captures disclosed digital orientation rather than the actual intensity or quality of implementation. Although the fixed-effects design reduces omitted-variable bias, the results should still be interpreted cautiously rather than as definitive causal effects. Future research could combine text-based indicators with project-level data and stronger identification strategies.

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References

1. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 28(2), 118-144.
2. Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889-901.
3. Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly*, 37(2), 471-482.
4. Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52(3), 326-349.
5. Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal-getting. *Human Relations*, 4(1), 3-38.

6. Sebastian, I. M., Ross, J. W., Beath, C. M., Mocker, M., Moloney, K. G., & Fonstad, N. O. (2017). How big old companies navigate digital transformation. *MIS Quarterly Executive*, 16(3), 197-213.
7. Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly*, 41(1), 223-238.
8. Brynjolfsson, E., & Hitt, L. M. (2000). Beyond computation: Information technology, organizational transformation and business performance. *Journal of Economic Perspectives*, 14(4), 23-48.
9. Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: A technology diffusion perspective on e-business. *Management Science*, 52(10), 1557-1576.
10. Mithas, S., Tafti, A., Bardhan, I., & Goh, J. M. (2012). Information technology and firm profitability: Mechanisms and empirical evidence. *MIS Quarterly*, 36(1), 205-224.

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