CAN DIGITAL TRANSFORMATION ENHANCE INFORMATION DISCLOSURE QUALITY?

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Abstract: Amid the rapid development of the artificial intelligence era, digital technology has become deeply embedded in corporate development, and the implementation of digital transformation has emerged as a primary driver for the transformation and upgrading of the real economy. This paper examines a sample of Shanghai and Shenzhen A-share listed companies from 2010 to 2021. By quantifying the degree of corporate digital transformation through text mining and constructing a moderated mediation model, this study analyzes the underlying mechanism linking digital transformation, internal control, and information disclosure quality. It further explores the moderating role of the marketization process. The findings indicate that corporate digital transformation significantly enhances information disclosure quality, with this effect being more pronounced in state-owned enterprises (SOEs), high-tech firms, and industries with high market concentration. The mechanism analysis reveals that internal control plays a partial mediating role in the relationship between digital transformation and information disclosure quality. Furthermore, the marketization process moderates both the direct effect and the mediation effect. A higher degree of marketization strengthens the positive impact of digital transformation on disclosure quality. This moderation of the mediation effect is primarily concentrated on the first stage of the path, amplifying the positive influence of digital transformation on internal control. These conclusions enrich the literature on the economic consequences of digital transformation and the determinants of information disclosure quality, and they hold significant practical implications for firms implementing digital transformation and innovating their business models.
Keywords: Digital transformation; Internal control; Information disclosure quality; Marketization process; Moderated mediation effect

1 INTRODUCTION

Driven by the rapid development of the digital economy and the advancement of Industry 4.0, corporate digital transformation has emerged as a crucial strategic shift for adapting to contemporary trends. In its *China Digital Economy Development Report (2022)*, the China Academy of Information and Communications Technology (CAICT) called for the deepening of corporate digital transformation and upgrading, the implementation of digital management, and the creation of data-driven operational management systems to ensure effective information feedback. The digital economy has become both a "stabilizer" and an "accelerator" for the national economy. In 2021, its scale reached 45.5 trillion CNY, accounting for nearly 40% of GDP, with industrial digitalization comprising over 80% of this total. It is evident that the digital economy is now of paramount importance for promoting high-quality economic development, and corporate digital transformation has become an indispensable step for industrial upgrading. Fundamentally, corporate digital transformation involves leveraging next-generation information technologies to enhance capabilities in data collection, processing, and analysis. This, in turn, optimizes the allocation of internal and external resources, drives technological, organizational, and managerial change, and ultimately enhances a firm's core competitiveness [1]. Information disclosed by a firm enables external users to make objective assessments of its operating status, making high-quality disclosure a critical safeguard for sound investment decisions. When information asymmetry or managerial opportunism leads to earnings manipulation and compromises the disclosure process, the resulting information becomes distorted, thereby lowering disclosure quality. In this context, digital transformation has been shown to effectively curb real earnings management activities [2]. Furthermore, digital transformation can reshape a firm's internal operational mechanisms, strengthening internal controls and thereby influencing accounting information comparability [3]—a key attribute of information disclosure quality. Therefore, proceeding from this critical trend, this study investigates a key economic consequence of digital transformation. It explores the pathway through which digitalization impacts information disclosure quality, with internal control as the mediating mechanism. Building on this, the study further examines how disparities in the external environment—specifically, the uneven development of the marketization process—moderate this causal chain and its overall effect. This research aims to provide actionable strategies and pathways for firms to achieve high-quality information disclosure. Simultaneously, it enriches the literature on the economic consequences of digital transformation and provides a decision-making basis for firms seeking to accelerate their digitalization efforts.

2 HYPOTHESIS DEVELOPMENT

2.1 Digital Transformation and Information Disclosure Quality

Digital transformation represents a multi-faceted overhaul of a firm's business processes, business models, and strategic thinking. It not only triggers disruptive changes in production management and daily operations but also influences a firm's motivation and ability to adhere to accounting standards, thereby affecting its financial reporting process and the quality of its information disclosure. This influence manifests in two primary ways.

First, digital transformation can curb managerial opportunism and strengthen the monitoring of potential earnings management activities. By deeply embedding digital technologies, firms can make information generated by all parties more transparent, thus enhancing disclosure quality. The rapid growth of the digital economy has intensified market competition, which can increase a firm's liquidity risk and place considerable pressure on its earnings [4]. Such pressure often incentivizes managerial earnings management, leading to suboptimal accounting policy choices that artificially inflate profits and degrade the quality of disclosed information. The implementation of digital transformation can mitigate this issue by suppressing managerial opportunism [5]. Specifically, the adoption of intelligent technologies during transformation facilitates the creation of real-time monitoring mechanisms based on both operational and financial data [6-7]. Digital enablement allows for the seamless sharing of data across departments, which not only enhances internal collaboration and oversight but also makes managerial decisions regarding accounting policies and estimates more transparent. This increased transparency provides external stakeholders with timely access to crucial information via digital platforms, thereby strengthening external monitoring and compelling firms to disclose higher-quality information.

Second, digital transformation improves a firm's internal information environment, alleviating information asymmetry between the firm and outside stakeholders, which in turn leads to higher disclosure quality. The information a firm discloses is a cornerstone for stakeholders' investment decisions; high-quality disclosure enhances the decision-usefulness of information and reduces the cost of decision errors [8]. In practice, however, managers may engage in opportunistic behaviors, leveraging their authority and informational advantages to interfere with the information reporting process. Digital transformation counters this by employing technologies like big data, artificial intelligence, and blockchain to optimize information transmission methods and efficiency. This ensures that information remains shared and transparent throughout its entire lifecycle—from production and transmission to final reporting—thus improving the information environment and, consequently, the quality of disclosure [9]. Specifically, digitalization enhances a firm's data analytics capabilities. AI can convert data from various departments into standardized, structured information, which helps optimize business processes and improves the accuracy and timeliness of information flows, laying a solid foundation for enhanced disclosure quality [10]. Based on this analysis, we propose the following hypothesis:

Hypothesis 1 (H1): Digital transformation is positively associated with information disclosure quality.

2.2 Digital Transformation and Internal Control

The quality of a firm's internal control is reflected across five key components: the control environment, risk assessment, control activities, information and communication, and monitoring. Digital transformation impacts all five of these areas. First, it fosters a deep integration of digital technology into the firm, fundamentally improving the control environment. Digital technologies permeate the entire process of production, operation, and management, blurring traditional organizational boundaries and enabling more efficient and diverse connections between internal and external entities. This interconnectedness of equipment, products, and resource systems facilitates data sharing, gives rise to digital management practices, and promotes a flatter organizational structure [11-12]. Second, technologies like cloud computing, AI, and blockchain enable the generation and aggregation of vast amounts of data, providing real-time insights into customer demand and market changes. This supports the development of risk-warning models, allowing firms to proactively identify, assess, and respond to potential risks. Third, digital transformation influences control activities by shifting business processes from traditional to digital and intelligent modes. It also reshapes the workforce, as firms increasingly seek to cultivate and recruit hybrid talent with expertise in both management and big data analytics, thereby fundamentally improving internal management efficiency. Fourth, it revolutionizes information and communication by transforming hierarchical information structures into networked ones. Digital platforms not only enhance the efficiency of data processing but also reduce information distortion during transmission [13-14]. Finally, digital transformation strengthens internal monitoring. The shared data resources on digital platforms create an inherent internal oversight system, while the move toward flatter organizational structures further enhances routine supervision. Therefore, as digital transformation improves all five components of internal control, we hypothesize:

Hypothesis 2 (H2): Digital transformation is positively associated with the quality of internal control.

2.3 The Mediating Role of Internal Control

Digital transformation strengthens a firm's internal control monitoring mechanisms. High-quality information disclosure depends on the reliability of financial reports, which in turn is closely linked to the effectiveness of these mechanisms. Consequently, strong internal control enhances information disclosure quality [15]. Specifically, effective internal control significantly improves earnings quality. A higher quality of internal control indicates a more robust corporate governance structure [16], which is better equipped to restrain managerial earnings manipulation [17-18]. Since earnings management directly affects the truthfulness and accuracy of disclosed information, stringent internal controls

are crucial for improving disclosure quality. Given our argument in H2 that digital transformation enhances internal control quality, we posit that this enhancement is a key pathway through which digitalization ultimately improves information disclosure.

Hypothesis 3 (H3): Internal control partially mediates the relationship between digital transformation and information disclosure quality.

2.4 The Moderating Role of the Marketization Process on the Digital Transformation-Disclosure Quality Relationship

The marketization process represents a systemic transition involving dynamic changes across economic, social, legal, and political spheres. Regional differences in geographical location led to variations in resource endowments, market environments, and the direction and intensity of state policies [19]. Regions with a higher degree of marketization typically exhibit more advanced economic development and a faster adoption of next-generation information technologies, providing the necessary infrastructure for digital transformation. According to signaling theory, a higher degree of marketization facilitates a smoother flow of information within the market. This helps transforming firms to acquire more external environmental information in a timely manner [20], which aids in the construction and application of digital platforms and enhances the efficiency of internal information transmission. This fundamentally alleviates information asymmetry and provides both the technological and environmental foundation for improving information disclosure quality.

Hypothesis 4 (H4): The marketization process positively moderates the relationship between digital transformation and information disclosure quality.

2.5 The Moderating Role of the Marketization Process on the Digital Transformation-Internal Control Relationship

The external supervisory environment also varies with the degree of marketization. Regions with a higher marketization process tend to have more developed and sounder legal and institutional frameworks. In these regions, the separation of government and enterprise is more complete, legal oversight and penalties are stricter, and the economic order is more stable. This fosters a stronger external monitoring mechanism, which deters opportunistic behaviors like earnings management. As digital transformation improves internal control through data sharing and efficient information flows, this effect is amplified by the strong external oversight present in highly marketized environments. The combination of internal digital monitoring and external market discipline creates a powerful synergy, further strengthening the positive impact of digital transformation on internal control quality. Based on this analysis, we propose:

Hypothesis 5 (H5): The marketization process positively moderates the relationship between digital transformation and internal control.

Based on the theoretical analysis above, we construct a model illustrating the mechanisms through which digital transformation affects corporate information disclosure quality, as shown in Figure 1.
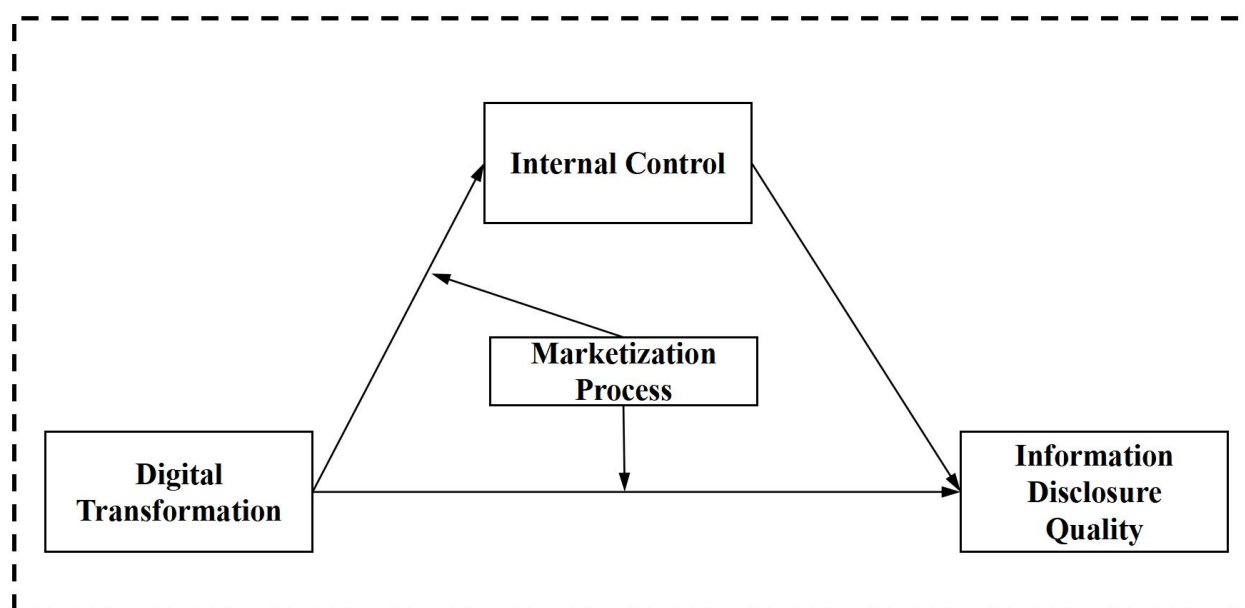

Figure 1 Theoretical Model

3 RESEARCH DESIGN

3.1 Sample Selection and Data Sources

This study selects a sample of companies listed on the Shanghai and Shenzhen A-share markets, using panel data from the period 2010-2021. The sample was refined according to the following criteria: (1) financial firms, such as banks, securities firms, and insurance companies, were excluded due to their unique asset structures; (2) firms with an operational history of less than one year were excluded; (3) firms designated as ST, *ST, or PT during the study period, as well as those with significant missing data, were excluded.

The data for this study were sourced as follows: data on digital transformation were extracted from corporate annual reports; internal control data were obtained from the DIB database; marketization process data were sourced from the China Marketization Index database; information disclosure quality data were based on the rating results from the Shenzhen Stock Exchange website; and other financial data were primarily collected from the CSMAR database. After applying the exclusion criteria, all continuous variables were winsorized at the 1% level to mitigate the influence of outliers. The final sample consists of 20,168 firm-year observations. All empirical analyses were conducted using Stata 17.0.

3.2 Variable Definitions

3.2.1 Dependent variable: information disclosure Quality ($QID_{i,t}$)
Based on the information disclosure quality ratings provided by the Shenzhen Stock Exchange, we measure this variable by quantifying the four rating levels: A, B, C, and D are assigned values of 4, 3, 2, and 1, respectively. A higher score indicates higher information disclosure quality.

3.2.2 Independent variable: digital transformation ($DT_{i,t-1}$)
Corporate digital transformation is a key strategy in the era of big data and artificial intelligence, and information related to it is most likely to be reflected in comprehensive and guiding documents like annual reports. Therefore, following the methodology of Wu et al., we measure the degree of digital transformation by the frequency of related keywords in corporate annual reports. First, referencing the structured keyword list developed by [21]—which covers five dimensions: artificial intelligence, big data technology, cloud computing technology, blockchain technology, and digital technology application—we use Python's Jieba library to extract and sum the frequencies of these keywords from the annual reports. To account for the typical right-skewed distribution of this data, we take the natural logarithm of the total frequency plus one.

3.2.3 Mediating variable: internal control ($IC_{i,t-1}$)
The quality of internal control is measured using the DIB Internal Control Index. Given the large scale of this index, we take the natural logarithm of the index value plus one to facilitate comparison with the other core variables in this study.

3.2.4 Moderating variable: marketization process ($Mkt_{i,t}$)
This variable is measured using the marketization index developed by Fan Gang and Wang Xiaolu [22].

3.2.5 Control variables
We include a standard set of control variables: Return on Assets (ROA), calculated as net profit divided by the average of total assets; Leverage (LEV), measured as total liabilities to total assets; Cash Flow Ratio (Cash), calculated as cash flow from operating activities divided by main business revenue; Firm Size (Size), the natural logarithm of year-end total assets; Firm Age (Age), the natural logarithm of the number of years since establishment; Growth (Growth), the firm's main business revenue divided by the average main business revenue of the previous period; Proportion of Independent Directors (Bind), the ratio of independent directors to the total number of board members; First Largest Shareholder's Holding (First dummy), a dummy variable equal to 1 if the first largest shareholder's stake is above the sample mean, and 0 otherwise; Audit Opinion (Opinion), a dummy variable equal to 1 for a standard unqualified audit opinion, and 0 otherwise; and Auditor Size (Big4), a dummy variable equal to 1 if the firm is audited by one of the Big Four accounting firms, and 0 otherwise. We also control for industry and year fixed effects.

3.3 Model Construction

3.3.1 Mediation effect model
Drawing on the mediation effect testing procedures proposed by Baron and Kenny [23]and Wen et al. [24].

$$QID_{i,t} = \alpha_1 + \beta_1 DT_{i,t-1} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (1)$$

$$IC_{i,t-1} = \alpha_2 + \beta_2 DT_{i,t-1} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (2)$$

$$QID_{i,t} = \alpha_3 + \beta_3 DT_{i,t-1} + \delta_1 IC_{i,t-1} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (3)$$

3.3.2 Moderated Mediation Effect Model (First Stage)
Following the testing procedures for moderated mediation proposed by Wen and Ye [25], we construct the following models to test our hypotheses.

$$QID_{i,t} = \alpha_4 + \beta_4 DT_{i,t-1} + \lambda_1 Mkt_{i,t} + \mu_1 DT_{i,t-1} * Mkt_{i,t} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (4)$$

$$IC_{i,t-1} = \alpha_4 + \beta_4 DT_{i,t-1} + \lambda_2 Mkt_{i,t} + \mu_2 DT_{i,t-1} * Mkt_{i,t} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (5)$$

$$QID_{i,t} = \alpha_5 + \beta_5 DT_{i,t-1} + \lambda_3 Mkt_{i,t} + \mu_3 DT_{i,t-1} * Mkt_{i,t} + \varphi IC_{i,t-1} + \sum \gamma control + \sum Year + \sum Ind + \varepsilon \qquad (6)$$

First, to test the moderating effect of the marketization process ($Mkt_{i,t}$) on the relationship between digital transformation ($DT_{i,t-1}$) and information disclosure quality ($QID_{i,t}$), we examine the coefficient μ_1 of the interaction

term $DT_{i,t-1} * Mkt_{i,t}$ in model (4). If this coefficient is statistically significant, it indicates that the moderation of the main effect is supported. Second, to test the moderating effect of the marketization process（$Mkt_{i,t}$）on the first stage of the mediation path, we examine two coefficients: the coefficient of the interaction term μ_2 in model (5) , and the coefficient φ of the internal control（$IC_{i,t-1}$）in model (6). If both coefficients are statistically significant, it confirms the existence of a moderated mediation effect.

4 EMPIRICAL ANALYSES

4.1 Descriptive Statistics

The descriptive statistics for the main variables are presented in Table 1. The mean of Information Disclosure Quality (*QID*) is 2.893 with a standard deviation of 0.762, indicating some variation in disclosure ratings among firms. While the overall quality is good, there is significant room for improvement in certain companies. For Digital Transformation *(DT)*, the mean is 1.225 with a standard deviation of 1.472, and the values range from 0 to 4.976, suggesting a considerable disparity in the degree of digitalization across firms. The Internal Control *(IC)* variable has a mean of 6.29, indicating a generally high level of internal control quality. However, with a standard deviation of 0.734 and a range from 0 to 6.805, significant differences exist between firms. The Marketization Process *(Mkt)* has a mean of 7.315 and a standard deviation of 1.579, with values ranging from -0.243 to 9.571, clearly showing the phenomenon of uneven regional development in marketization. Among the control variables, the mean for ROA is 0.04 (ranging from -0.236 to 0.196), and the mean for leverage is 0.375 with a standard deviation of 0.214. The means for cash flow ratio, firm size, firm age, growth, and independent director proportion are 0.179, 23.058, 2.833, 0.184, and 0.395, respectively. The mean for the first largest shareholder's holding dummy is 0.426. Additionally, approximately 93.1% of firms in the sample received a standard unqualified audit opinion, while only 5.9% engaged one of the Big Four accounting firms for their external audits. In summary, the descriptive statistics reveal significant heterogeneity among listed companies in terms of their operational and financial status, as well as their management and organizational structures.

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
QID	20,168	2.893	0.762	1.000	4.000
DT	20,168	1.225	1.472	0.000	4.976
IC	20,168	6.290	0.734	0.000	6.805
Mkt	20,168	7.315	1.579	-0.243	9.571
ROA	20,168	0.040	0.058	-0.236	0.196
LEV	20,168	0.375	0.214	0.059	0.899
Cash	20,168	0.179	0.150	0.016	0.747
Size	20,168	23.058	1.303	18.339	27.942
Age	20,168	2.833	0.416	1.587	3.579
Growth	20,168	0.184	0.563	-0.558	3.903
Bind	20,168	0.395	0.061	0.316	0.582
First dummy	20,168	0.426	0.151	0.070	0.750
Opinion	20,168	0.931	0.168	0.000	1.000
Big4	20,168	0.059	0.243	0.000	1.000

4.2 Correlation Analysis

A correlation analysis of the main study variables is presented in Table 2. The correlation coefficient between Digital Transformation *(DT)* and Information Disclosure Quality *(QID)* is 0.056 and is significant at the 1% level, providing preliminary evidence that digital transformation enhances disclosure quality. The correlation coefficients for the mediator (Internal Control) and the moderator (Marketization Process) with *QID* are 0.102 and 0.137, respectively, both significant at the 1% level. This suggests that both factors are also positively associated with information disclosure quality, although further regression analysis is required to establish causality.

Table 2 Correlation Matrix of Key Variables

Variable	*QID*	*DT*	*IC*	*Mkt*
QID	1			
DT	0.056***	1		
IC	0.102***	0.055***	1	
Mkt	0.137***	0.216***	0.149***	1

*Note: ***, *, and * indicate significance at the 1%, 5%, and 10% levels, respectively (the same applies hereafter).*

4.3 Regression Analysis

The results of the mediation effect tests are shown in columns (1), (2), and (3) of Table 3. In Model (1), the regression coefficient of $DT_{i,t-1}$ on $QID_{i,t}$ is 0.0009 and is significant at the 1% level. This indicates that a higher degree of digital transformation is associated with higher information disclosure quality, thus supporting H1. In Model (2), the

regression coefficient of $DT_{i,t-1}$ on $IC_{i,t-1}$ is 0.0021 and is also significant at the 1% level, demonstrating that digital transformation enhances the quality of internal control. This validates H2. In Model (3), after including the mediator, the coefficient of $DT_{i,t-1}$ on $QID_{i,t}$ remains significant at 0.0008 (p < 0.01), but its magnitude is smaller than in Model (1). This finding, combined with the significance of the $IC_{i,t-1}$ variable in the model, confirms that internal control acts as a partial mediator in the relationship between digital transformation and information disclosure quality. This supports H3.

The results of the moderated mediation tests are presented in columns (4), (5), and (6) of Table 3. First, in Model (4), the interaction term $(DT_{i,t-1} * Mkt_{i,t})$ has a coefficient of 0.0483 and is significant at the 1% level. This confirms that the marketization process positively moderates the relationship between digital transformation and information disclosure quality. The positive effect of digitalization on disclosure is stronger in regions with a higher degree of marketization, thus supporting H4. Second, in Model (5), the interaction term $(DT_{i,t-1} * Mkt_{i,t})$ has a coefficient μ_2 of 0.0629 and is significant at the 1% level. In Model (6), the coefficient of the mediator $IC_{i,t-1}$ remains significant at 0.0023 (p < 0.01). Together, these results confirm the existence of a moderated mediation effect in the first stage of the path. The marketization process moderates the mediating effect of internal control by strengthening the positive influence of digital transformation on internal control quality, thereby validating H5.

Table 3 Regression Analysis Results

Variable	Model（1）	Model（2）	Model（3）	Model（4）	Model（5）	Model（6）
	$QID_{i,t}$	$IC_{i,t-1}$	$QID_{i,t}$	$QID_{i,t}$	$IC_{i,t-1}$	$QID_{i,t}$
$DT_{i,t-1}$	0.0009***	0.0021***	0.0008***	0.0007**	0.0021***	0.0009***
	（3.76）	（6.85）	（3.68）	（1.83）	（6.84）	（3.75）
$IC_{i,t-1}$	—	—	0.0011***	—	—	0.0023***
			（2.93）			（3.62）
$Mkt_{i,t}$	—	—	—	0.0362***	0.1784***	0.0298***
				（9.72）	（4.285）	（8.87）
$DT_{i,t-1} * Mkt_{i,t}$	—	—	—	0.0483***	0.0629***	0.0393***
				（7.488）	（5.338）	（7.224）
$ROA_{i,t}$	-0.0036***	0.0017	-0.0037***	-0.0160***	0.0016	-0.0166
	（-2.94）	（0.89）	（-2.89）	（-5.201）	（0.87）	（-1.344）
$LEV_{i,t}$	-0.0048***	-0.0055**	-0.0051***	-0.0053**	-0.0049**	-0.0048**
	（-8.91）	（-1.74）	（-9.01）	（-3.29）	（-1.91）	（-1.82）
$Cash_{i,t}$	0.0006（0.47）	0.1211***	0.0006（0.48）	0.0008***	0.1187***	0.0006***（6.59）
		（5.02）		（6.53）	（4.97）	
$Size_{i,t}$	-0.0024**	0.0570**	-0.0030**	-0.0235**	0.0317**	-0.0214**
	（-1.75）	（1.92）	（-1.69）	（-1.76）	（1.76）	（-1.83）
$Age_{i,t}$	-0.0029***	0.0003**	-0.0026***	-0.0062***	0.0005**	-0.0078***
	（-8.24）	（1.87）	（-9.12）	（-6.56）	（1.89）	（-7.47）
$Growth_{i,t}$	-0.0006	0.0008**	-0.0007	-0.0005**	0.0021**	-0.0016**
	（-1.21）	（1.89）	（-1.27）	（-1.68）	（1.78）	（-1.73）
$Bind_{i,t}$	0.0009	0.0021**	0.0008	0.0012	0.0030**	0.0036*
	（0.32）	（1.69）	（0.30）	（0.47）	（1.86）	（1.59）
$First\_dummy_{i,t}$	-0.0031**	-0.0294**	-0.0036**	-0.0046**	-0.0285**	-0.0039**
	（-1.89）	（-1.85）	（-1.93）	（-1.77）	（-1.70）	（-1.73）
$Opinion_{i,t-1}$	0.0045***	0.0204***	0.0052***	0.0061**	0.0236***	0.0084**
	（6.03）	（4.47）	（6.95）	（1.84）	（4.65）	（1.84）
$Big4_{i,t-1}$	-0.0052**	0.2311***	-0.0059**	-0.0078**	0.2326***	-0.0066**
	（-1.93）	（3.76）	（-1.79）	（-1.77）	（4.05）	（-1.86）
Cons	0.0299***	0.3655***	0.0317***	0.0225***	0.3104***	0.0238***
	（9.63）	（10.02）	（8.48）	（6.35）	（11.73）	（7.15）
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	20,168	20,168	20,168	20,168	20,168	20,168
Adj-R^2	0.1766	0.2387	0.2291	0.1904	0.1297	0.1756
F	58.9030***	49.7321***	53.0384***	63.0643***	46.2037***	49.3992***

4.4 Robustness Checks

4.4.1 Endogeneity test

Although key control variables were included, the determinants of information disclosure quality are complex, and the potential for omitted variable bias exists. To address this endogeneity concern, we employ an instrumental variable (IV) approach. We use the one-year lagged industry average of digital transformation（$In\_DT_{i,t-1}$）as the instrument. This variable is theoretically correlated with a firm's individual level of digital transformation but is unlikely to directly affect its information disclosure quality, thus satisfying the requirements for a valid instrument. We further conducted diagnostic tests to validate the instrument, with the results shown in Table 4. The first-stage F-statistic is 57.7834 (p <

0.001), passing the exogeneity test. The Sargan statistic is 0, and the Cragg-Donald Wald F-statistic is 56.3362, indicating no issues with over-identification or weak instruments. We then performed a two-stage least squares (2SLS) regression, with the results presented in columns (1) and (2) of Table 4. The findings are consistent with the baseline regression results, and the coefficients in the 2SLS model are even larger, confirming the robustness of our initial conclusions.

4.4.2 Alternative measure of digital transformation

The degree of digital transformation may vary across industries. To eliminate this industry-level effect, we adopt the measurement method of Yuan [13] and use an industry-adjusted digital transformation indicator ($Adj\_DT_{i,t-1}$). This metric reflects a firm's level of digitalization relative to its industry peers. The regression results using this alternative measure are shown in column (3) of Table 4. The coefficient of $Adj\_DT_{i,t-1}$ is 0.0009 and is significant at the 1% level, demonstrating that our findings remain robust after changing the measurement of the independent variable.

Table 4 Robustness Checks

	2SLS		Alternative Measure of DT
	$DT_{i,t-1}$	$QID_{i,t}$	$QID_{i,t}$
$DT_{i,t-1}$		0.0011***	
		（3.89）	
$In\_DT_{i,t-1}$	0.0438***		
	（10.56）		
$Adj\,DT_{i,t-1}$			0.0009***
			（3.92）
$ROA_{i,t}$	0.0178***	-0.0054***	-0.0046***
	（7.93）	（-4.03）	（-2.38）
$LEV_{i,t}$	0.0046**	-0.0056***	-0.0042***
	（1.74）	（-8.02）	（-8.77）
$Cash_{i,t}$	0.0323**	0.0005	0.0007
	（1.85）	（0.46）	（0.49）
$Size_{i,t}$	0.2689***	-0.0026**	-0.0045**
	（7.34）	（-1.95）	（-1.79）
$Age_{i,t}$	0.0054**	-0.0056***	-0.0045***
	（1.91）	（-6.73）	（-9.49）
$Growth_{i,t}$	0.0163**	-0.0008	-0.0008
	（1.95）	（-0.94）	（-0.95）
$Bind_{i,t}$	0.1746*	0.0013	0.0011
	（1.43）	（0.53）	（0.63）
$First\_dummy_{i,t}$	-0.3765**	-0.0034**	-0.0037**
	（-1.74）	（-3.45）	（-1.92）
$Opinion_{i,t-1}$	0.1179**	0.0046***	0.0068***
	（1.88）	（6.04）	（6.49）
$Big4_{i,t-1}$	0.2168**	-0.0045**	-0.0077**
	（1.73）	（-1.93）	（-1.86）
$Cons$	0.0047	0.0311***	0.0357***
	（0.85）	（9.88）	（8.90）
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	20,168	20,168	20,168
Adj-R^2	0.2676	0.1967	0.2375
F	57.7834***		53.0384***
C-D Wald F test	56.3362		
P-value	0		
Sargon Test	0		

4.4.3 Bootstrap test for the difference in mediation effects

To further ensure the reliability of the empirical results, this study employs a bootstrap analysis to test the significance of the difference in the mediation effect across different levels of marketization. Specifically, we conduct a simple slope analysis at one standard deviation above and below the mean of the marketization process variable to verify whether the difference in the mediation effect between these groups is statistically significant. The results are presented in Table 5. As shown in the table, the 95% confidence intervals for the effects do not contain zero. This indicates that the mediating effect of internal control is significantly stronger in environments with a higher degree of marketization, once again validating H4 and H5.

Table 5 Bootstrap Test for the Difference in Mediation Effects

Marketization Process	Effect	Boot SE	95% Confidence Interval

			Lower Bound	Upper Bound
-1 Standard Deviation	0.128	0.054	0.059	0.317
Mean	0.127	0.054	0.060	0.320
+1 Standard Deviation	0.437	0.089	0.285	0.617

5 FURTHER ANALYSES: HETEROGENEITY TESTS

Having confirmed through baseline regressions and multiple robustness checks that digital transformation enhances information disclosure quality, we now explore whether this effect varies across different contexts. Differences in industry competition and firm characteristics could lead to variations in the impact of digitalization. Therefore, this study conducts a heterogeneity analysis from the perspectives of industry concentration, ownership structure, and technological attributes. The results are presented in Table 6.

From the perspective of industry concentration, the positive effect of digital transformation on information disclosure quality is more pronounced in firms within highly concentrated industries ($\beta = 0.0012$, $p < 0.01$). This suggests that in more competitive environments, firms are more motivated to leverage digital transformation to improve information sharing and transparency. Doing so helps attract external investors and solidify their competitive advantage within the industry.

From the perspective of ownership structure, the effect is stronger for state-owned enterprises (SOEs) than for non-SOEs ($\beta = 0.0136$, $p < 0.01$). This finding underscores the leading role SOEs should continue to play in responding to the trends of the digital economy, continuously improving their information disclosure systems and enhancing disclosure quality.

From the perspective of technological attributes, the impact of digital transformation on disclosure quality is significantly stronger for high-tech firms ($\beta = 0.0026$, $p < 0.01$). Compared to their non-high-tech counterparts, high-tech firms inherently possess a more advanced digital foundation and stronger innovation capabilities, making them more willing and able to adopt and apply digital technologies. This advantage should be fully utilized to strengthen the governance effects of their digital transformation, thereby driving the transformation of non-high-tech firms and elevating the overall information disclosure quality across all industries.

Table 6 Heterogeneity Analysis Results

Variable	Industry Concentration		Ownership Structure		Technological Attribute	
	High	Low	SOEs	Non-SOEs	High-Tech	Non-High-Tech
$DT_{i,t-1}$	0.0012***	0.0004	0.0136***	0.0005（0.97）	0.0026***	0.0010
	（3.83）	（1.02）	（4.09）		（4.15）	（1.27）
Cons	0.0299***	0.1603***	0.2046***	0.1375***	0.2003***	0.0729***
	（9.63）	（11.69）	（6.82）	（8.38）	（8.92）	（6.65）
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	8,734	11,434	9,045	11,123	8,092	12,076
Adj-R^2	0.2045	0.1987	0.2011	0.1895	0.2134	0.1994
F	47.4554***	50.2846***	49.6775***	46.9022***	47.0981***	50.6566***

6 CONCLUSIONS

In the era of the digital economy, digital transformation has become an essential path for firms to achieve high-quality development. Implementing digital transformation has a profound and comprehensive impact on all aspects of a firm, including its production and operations, resource allocation, financial decision-making, and business models. Using a sample of Shanghai and Shenzhen A-share listed companies, this paper established a series of regression models, including a moderated mediation model, to empirically test the mechanisms linking digital transformation, internal control, and corporate information disclosure quality. It also explored the moderating role of the marketization process. The main conclusions are as follows:

First, the implementation of digital transformation significantly enhances corporate information disclosure quality. A higher degree of digitalization leads to higher disclosure quality, an effect that is more pronounced in state-owned enterprises (SOEs), high-tech firms, and highly concentrated industries. Further analysis reveals that internal control plays a partial mediating role in this relationship; that is, digital transformation improves disclosure quality in part by enhancing the quality of internal control.

Second, the marketization process positively moderates the relationship between digital transformation and information disclosure quality. The positive impact of digitalization on disclosure is stronger in regions with a higher degree of marketization.

Third, the moderated mediation analysis confirms that the marketization process moderates the first stage of the mediation path. Specifically, it strengthens the positive effect of digital transformation on internal control, which in turn enhances the overall mediating role.

Under the current wave of digitalization, increasing the emphasis on and support for corporate digital transformation is crucial. Accelerating this process not only promotes the rapid development of China's digital economy at the macro level but also effectively enhances corporate information disclosure quality and improves the information environment of the capital market at the micro level. Therefore, this study offers the following recommendations:

First, government departments should continue to strengthen digital infrastructure construction, implement relevant support policies, and optimize industry market structures. They should leverage the leading role of SOEs and the developmental advantages of high-tech firms, encouraging all companies to integrate digital technologies into every facet of production, operation, and management. By fostering a competitive mindset and enhancing the efficiency of data integration, transmission, and disclosure, firms can standardize their disclosures. Digital transformation can thus fortify the bridge of communication between external information users and internal management, alleviating information asymmetry at the procedural level and curbing managerial opportunism at the source, thereby ensuring high-quality information disclosure.

Second, firms must increase the depth and scope of their digital technology application. While creating a favorable information environment, they must also prioritize the establishment of intelligent risk-warning and assessment systems. This will minimize the probability of risk occurrence, improve internal control quality, and consequently enhance information disclosure quality.

Finally, regarding the marketization process, government bodies should further advance market-oriented reforms. This includes strengthening external oversight during the digital transformation process, ensuring that firms are held accountable for continuously providing high-quality information to the capital market.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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