



Digital Transformation and Corporate Social Responsibility: Evidence from Chinese Listed Firms

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Abstract. With the digital economy rapidly evolving, digital transformation now underpins corporate sustainability. With CSMAR data covering Chinese A-share firms from 2009 to 2023, this study provides empirical evidence on how digital transformation influences corporate social responsibility (CSR) and examine the underlying pathways. This study reports a statistically significant rise in CSR performance among firms undertaking digital transformation., and the finding persists under numerous alternative specifications and robustness procedures. Mechanism analyses further reveal that digital transformation operates through three primary pathways: (1) increasing R&D investment to stimulate innovation activities; (2) improving disclosure quality and external monitoring by enhancing information transparency; and (3) optimizing governance structures to mitigate risks and agency problems, thereby strengthening CSR fulfillment. Heterogeneity analyses show that the effect is stronger for firms situated in eastern China, for firms with less severe financing constraints, for firms at the growth stage, and for firms operating in technology-intensive industries. Overall, this study contributes fresh empirical evidence on the linkage between digital transformation and CSR and delineates implications for policymakers, corporations, and investors seeking to foster deeper integration between digital strategy and CSR practices.

Keywords: Digital transformation, Corporate social responsibility, R&D investment, Information transparency, Governance structure, Heterogeneity analysis

1 Introduction

As the digital economy expands worldwide, digital transformation has progressively evolved into the central catalyst for corporate strategy realignment and value reconfiguration. With the widespread diffusion and penetration of new-generation information technologies such as artificial intelligence, big data, blockchain, and cloud computing,

firms' business models, organizational structures, and governance logics are undergoing profound changes (Li, 2020^[1]). The traditional growth model driven primarily by capital and labor has become insufficient to meet the demands of high-quality development (Brynjolfsson et al., 2021^[2]; Pan et al., 2022^[3]). Instead, digital technologies, through the reorganization of production factors, the extension of value chains, and the innovation of business models, provide new momentum for corporate growth (Zhou et al., 2025^[4]). Digital transformation not only improves firms' resource allocation efficiency and operational transparency but also reshapes their interactions with employees, customers, suppliers, and the general public (Lindberg et al., 2021^[5]; Liu and He, 2024^[6]). As a result, it encourages enterprises to place greater emphasis on social responsibility and on creating public value, alongside economic performance. Thus, digital transformation serves not only as an important tool for enhancing competitiveness but also as an institutional arrangement that promotes sustainable development (ElMasah and Mohieldin, 2020^[7]).

Concurrently, corporate social responsibility (CSR) has shifted over the past few decades from a focus on "compliance" to one of "strategic choice". CSR is not only regarded as a way to enhance corporate reputation and brand value but has also been shown to reduce financing constraints, increase market trust, and improve long-term performance (Zhao and Xiao, 2019^[8]; Le, 2022^[9]). Particularly in China, as the economy shifts from high-speed growth to high-quality development, issues such as green and low-carbon transition, common prosperity, and social equity have attracted heightened attention, making CSR an increasingly integral component of both policy guidance and market evaluation systems (Chen, 2023^[10]; Fu et al., 2024^[11]). At the regulatory level, beginning in 2008, the Shanghai and Shenzhen exchanges rolled out compulsory CSR reporting requirements for specified listed firms, thereby strengthening institutional constraints. At the societal level, investors and the public have raised their expectations for CSR fulfillment, transforming it from an external pressure into an endogenous strategic demand (Sun et al., 2024^[12]). However, whether firms can effectively incorporate CSR into their strategies under the dual constraints of institutional regulations and social expectations largely depends on their level of digital transformation in terms of technology, governance, and strategy (Zheng and Zhang, 2023^[13]).

Although prior work has documented CSR's associations with firm performance and value, and other studies have investigated how digital transformation influences innovation outcomes, disclosure practices, and governance arrangements, few studies integrate these strands to establish how digitalization relates to CSR. The existing literature is mainly concentrated in two dimensions: first, the economic consequences of CSR, emphasizing its roles in enhancing reputational capital, lowering the cost of capital, and improving firm performance (Kelley et al., 2019^[14]; Vitolla et al., 2020^[15]; Liu and Lu, 2021^[16]); and second, the economic effects of digital transformation, focusing on how technological empowerment improves innovation efficiency, enhances the information environment, and optimizes governance (Xue et al., 2022^[17]; Wu and Jin, 2022^[18]; Yuan et al., 2023^[19]). However, the intersection of these two streams of research is limited. Specifically, the core question of whether digital transformation significantly improves CSR performance has not been directly addressed. Moreover, most studies

remain at the level of conceptual discussion or case studies, lacking large-sample empirical evidence. In China's institutional and market environment, how digitalization shapes CSR may diverge from Western experience. For instance, in China, digital transformation is often jointly driven by national policy directives and capital market regulations, while CSR carries both policy constraints and market incentives (Sahasranamam et al., 2020^[20]; Long et al., 2020^[21]; Wu, 2023^[22]). This unique context provides fertile ground for studying their interactions, but relevant research is still relatively scarce.

In this context, this study addresses two principal questions: (1) Is digital transformation associated with statistically significant improvements in CSR performance? (2) Through what channels does this relationship operate? (3) Does this effect vary across different firm characteristics and external environments? To answer these questions, the study develops a systematic analysis at the theoretical, methodological, and policy levels.

This study makes three primary contributions. First, at the theoretical level, it constructs a logical framework illustrating how digital transformation promotes CSR, proposing three parallel mechanisms — R&D investment, information transparency, and governance-structure optimization — thereby broadening the research interface linking digital transformation with CSR. Second, methodologically, we leverage a broad sample of Chinese A-share companies (2009–2023), construct a digital-transformation index using CSMAR data, and pair it with multi-dimensional CSR indicators for testing; this design strengthens both the robustness and the external validity of the findings. Third, at the policy and practice level, the study reveals the synergistic effects between digital transformation and CSR and highlights the differentiated roles of governments in institutional and policy design, firms in strategic integration and implementation, and investors in external oversight through capital market mechanisms. This provides new evidence on CSR's internal logic under digitalization and offers policy and managerial guidance to better align digital initiatives with sustainability goals.

2 Theoretical Analysis and Research Hypothesis

2.1 The overall effect of digital transformation on CSR

Corporate digitalization affects CSR participation along three channels: it increases the incremental returns to CSR, reduces the costs at the margin, and enhances the transformation efficiency from CSR activities to reputational capital. Consider a firm that maximizes the discounted sum of profits and reputation capital over discrete time periods. Let $\beta \in (0,1)$ denote the discount factor, D the degree of digital transformation, S_t the CSR effort, R_t the stock of reputation capital, $C_S(S_t; D)$ the cost function of CSR effort, $\eta(D)$ the digital-enhanced marginal return of CSR, $\phi(D)$ the conversion efficiency of CSR into reputation capital, and $\mu(\cdot)$ the reputation loss function associated with information asymmetry, where the degree of opacity $\sigma_t(D)$ decreases with D . The firm's objective and the dynamics of reputation capital are specified as follows:

$$\max_{\{S_t\}_{t \geq 0}} \sum_{t=0}^{\infty} \beta^t [\Pi^0(A_t) + \eta(D)S_t - C_S(S_t; D) + \theta R_t] \quad (1)$$

$$R_{t+1} = (1 - \delta)R_t + \phi(D)S_t - \mu(\sigma_t(D)) \quad (2)$$

The model rests on three assumptions: the CSR cost is strictly convex in effort; digitalization reduces the marginal cost of undertaking CSR; and both the marginal payoff to CSR and the conversion efficiency are increasing functions of D . Reputation loss increases with opacity, while opacity decreases with D :

$$\frac{\partial^2 C_S}{\partial S^2} > 0, \frac{\partial^2 C_S}{\partial S \partial D} < 0, \eta'(D) > 0, \phi'(D) > 0, \mu'(\cdot) > 0, \frac{d\sigma_t(D)}{dD} < 0 \quad (3)$$

The first-order condition in S_t takes the following form:

$$\eta(D) + \beta\theta\phi(D) = \frac{\partial C_S(S_t; D)}{\partial S_t} \quad (4)$$

Differentiating with respect to D and applying the implicit function theorem yields:

$$\frac{dS^*}{dD} = \frac{\eta'(D) + \beta\theta\phi'(D) - \frac{\partial^2 C_S}{\partial S \partial D}}{\frac{\partial^2 C_S}{\partial S^2}} > 0 \quad (5)$$

Equation (5) shows that digital transformation raises the optimal CSR effort through three reinforcing channels: increasing marginal benefits, reducing marginal costs, and strengthening the role of CSR in building reputation capital. Therefore, we derive the following testable hypothesis.

Hypothesis 1: A higher level of digital transformation significantly increases corporate CSR engagement.

2.2 R&D investment mechanism

The impact of digital transformation on CSR operates through a direct channel and a complementary R&D channel. By improving information processing, resource allocation, and knowledge accumulation, digital transformation enables firms to conduct R&D activities more efficiently, thereby strengthening the complementarity between innovation and CSR. On the one hand, R&D provides green technologies, energy-saving processes, and products designed with social responsibility in mind, improving the efficiency of CSR implementation. On the other hand, CSR practices can reinforce the application and diffusion of R&D outcomes, forming a mutually reinforcing cycle.

Let knowledge capital K_t accumulate according to the following dynamic process:

$$K_{t+1} = (1 - \rho)K_t + \psi(D)f(R_t) \quad (6)$$

Where R_t denotes R&D investment, ρ is the depreciation rate of knowledge, $f'(R_t) > 0$, $f''(R_t) < 0$, and $\psi'(D) > 0$. The marginal return of CSR depends on the stock of knowledge capital, which is strengthened by digital transformation:

$$\tilde{\eta}(D, K_t)S_t, \frac{\partial \tilde{\eta}}{\partial K} > 0, \frac{\partial^2 \tilde{\eta}}{\partial D \partial K} \geq 0 \quad (7)$$

The joint utility function in terms of CSR effort and R&D investment exhibits supermodularity if:

$$\frac{\partial^2 U}{\partial S \partial R} = \frac{\partial \bar{\eta}}{\partial K} \cdot \frac{\partial K'}{\partial R} \geq 0 \quad (8)$$

Where $K' = (1 - \rho)K + \psi(D)f(R)$. Since $\psi'(D) > 0$, an increase in digital transformation raises both optimal CSR effort S^* and optimal R&D investment R^* .

Hypothesis 2: Digital transformation promotes CSR by stimulating R&D investment and strengthening their complementarity.

2.3 Information transparency mechanism

Digital transformation reshapes the information environment by improving disclosure quality, reducing asymmetry, and enabling stakeholders to more accurately evaluate CSR activities. Adoption of big data, AI, blockchain allows firms to make information disclosure more precise, with faster turnaround, thereby lowering the capital market discount imposed on CSR activities under opacity.

Suppose that the market observes a noisy signal of CSR effort:

$$y = S + \varepsilon, \varepsilon \sim N(0, \sigma^2(I, D)) \quad (9)$$

Where $\sigma^2(I, D)$ denotes the noise variance, which decreases with disclosure investment I and digital transformation D . The conditional variance of CSR effort, given the observed signal, is:

$$Var[S|y] = \frac{\sigma_0^2 \cdot \sigma^2(I, D)}{\sigma_0^2 + \sigma^2(I, D)} \quad (10)$$

Where σ_0^2 is the prior variance. A lower conditional variance indicates that investors can better identify CSR effort, thus reducing capital costs.

The firm's objective is:

$$\max_{S, I} \eta(D)S - C_S(S; D) - C_I(I; D) - \kappa(Var[S|y]) \quad (11)$$

Where $\kappa(\cdot)$ represents the discount in firm value due to information risk, with $\kappa' > 0$. The first-order condition in I takes the following form:

$$\kappa'(Var) \cdot \frac{\partial Var}{\partial \sigma^2} \cdot \frac{\partial \sigma^2}{\partial I} = \frac{\partial C_I}{\partial I} \quad (12)$$

Since $\partial \sigma^2 / \partial D < 0$ and $\partial C_I / \partial D < 0$, it follows that $dI^* / dD > 0$, meaning that firms will optimally increase disclosure effort as digital transformation rises.

For CSR effort, the first-order condition is:

$$\eta(D) = \frac{\partial C_S(S; D)}{\partial S} + \kappa'(Var) \cdot \frac{\partial Var}{\partial S} \quad (13)$$

As digital transformation reduces information variance and raises the effective marginal benefit of CSR, we obtain $dS^* / dD > 0$.

Hypothesis 3: Digital transformation enhances CSR engagement by improving information transparency and reducing the capital market discount associated with information asymmetry.

2.4 Governance structure mechanism

Corporate governance is a crucial internal determinant of CSR engagement. Digital transformation enhances governance effectiveness by improving monitoring efficiency, increasing detectability of managerial behavior, and reducing agency costs. By leveraging real-time data and advanced analytics, digitalization makes opportunistic behaviors more observable and increases the effectiveness of oversight from shareholders and boards, thereby incentivizing managers to allocate more resources to CSR activities that improve long-term firm value.

The manager's utility function is specified as:

$$U_M = w - \Phi(e) + v(p) - \zeta S \quad (14)$$

Where w is wage compensation, e denotes effort, $\Phi(e)$ is the convex effort cost function, p is private benefit consumption, S is CSR effort, and $\zeta > 0$ represents the disutility of CSR for the manager.

Firm value is defined as:

$$V = \Pi^0 + \eta(D)S - \chi(p) - E[Crash(p, \sigma)] \quad (15)$$

Where $\chi(p)$ captures losses from private benefits, and $Crash(p, \sigma)$ denotes stock price crash risk, which increases in both private benefits p and opacity σ .

Let the probability of detecting opportunistic behavior be $\pi = \pi(D, G)$, which increases with digital transformation D and governance investment G . The optimal private benefit is determined by the first-order condition:

$$v'(p)(1 - \pi(D, G)) = \lambda \quad (16)$$

Where λ represents the shadow value of constraints. Since $\partial\pi/\partial D > 0$ and $\partial\pi/\partial G > 0$, it follows that $\frac{\partial p^*}{\partial D} < 0$ and $\frac{\partial p^*}{\partial G} < 0$.

The optimal CSR effort satisfies:

$$\eta(D) - (1 - \tau(\pi)) = +\text{compliance cost} \quad (17)$$

Where $\tau(\pi)$ represents the fraction of CSR returns reduced by insufficient monitoring, with $\partial\tau/\partial\pi < 0$. Thus, as digitalization and governance strengthen, τ decreases, implying $\frac{\partial S^*}{\partial D} > 0$ and $\frac{\partial S^*}{\partial G} > 0$.

Hypothesis 4: Digital transformation enhances CSR engagement by improving governance effectiveness, reducing managerial private benefits, and mitigating crash risk.

3 Study Design

3.1 Samples and data

The study exploits CSMAR's 2009–2023 dataset for China's A-share listings. 2009 is adopted as the study's start year for two principal reasons. First, from 2008 the Shang-

hai and Shenzhen exchanges incrementally imposed CSR-reporting obligations on selected listed issuers, and by 2009 organized CSR datasets had become accessible. Second, this period marks the substantive advancement of digital transformation in Chinese firms, with significant improvements in both the availability and completeness of relevant data.

To ensure data reliability, the following sample-screening procedures were conducted: (1) financial institutions—banks, securities firms, and insurance companies—were excluded from the sample because their distinctive asset compositions and regulatory frameworks could confound the association between digital transformation and CSR; (2) firms classified as ST or *ST were removed from the sample to prevent bias arising from financially distressed companies; (3) removed sample observations that lacked values for primary measures, notably CSR and digital-transformation indicators; and (4) all continuous measures are winsorized at the 1% and 99% tails to mitigate outliers. Subsequently, the final dataset comprises 20,249 firm-year observations, ensuring both robustness and representativeness of the results.

3.2 Definition of variables

3.2.1 Corporate social responsibility (CSR). Corporate social responsibility (CSR) refers to firms' voluntary and strategic commitment to integrate social, environmental, and ethical concerns into their business operations and interactions with stakeholders, beyond mere legal compliance. In this study, CSR captures the extent to which firms internalize social obligations and convert them into actionable practices that contribute to sustainable development and stakeholder welfare.

Empirically, we measure CSR engagement using the China Stock Market and Accounting Research (CSMAR) database's CSR index. This index systematically evaluates firms across multiple responsibility dimensions—employee welfare, environmental stewardship, occupational health and safety, supplier safeguards, consumer protection, shareholder and creditor rights, and the establishment of internal CSR management systems. For each dimension, CSMAR assigns a value of 1 if the firm demonstrates strengths in that area and 0 otherwise; summing across categories yields the composite CSR score (Yuan et al., 2022^[23]).

The CSMAR CSR score is particularly suitable in the context of digital transformation, as digital technologies can strengthen firms' ability to disclose information, engage stakeholders, and optimize governance processes—all of which are core elements of CSR implementation. Thus, the CSR index serves as a comprehensive and comparable proxy for assessing how firms' social responsibility practices evolve alongside their digital transformation efforts.

3.2.2 Digital transformation (DIGI). Digital transformation is defined as a firm's comprehensive process of integrating digital technologies—such as artificial intelligence, big data analytics, cloud computing, and blockchain—into its business model, organizational structure, and governance system to achieve strategic renewal and enhance value creation. It reflects not only technological adoption but also the broader

reconfiguration of capabilities, processes, and culture required to compete effectively in the digital era.

Following prior research (Brown et al., 2024^[24]; Yang et al., 2025^[25]), we operationalize digital transformation by examining the frequency of “digital transformation”-related keywords appearing in the Management Discussion and Analysis (MD&A) sections of firms’ annual reports. The MD&A section captures managerial narratives about strategic priorities and future orientations, making it a reliable source for identifying firms’ digitalization focus. After extracting and normalizing keyword frequencies, we employ an entropy-weighting method to synthesize them into a unified digital transformation index (DIGI).

This index quantitatively represents a firm’s strategic emphasis on digitalization and its progress in embedding digital technologies into core operations. As such, DIGI provides a valid and scalable measure for examining how varying levels of digital transformation influence CSR performance across Chinese listed firms.

3.2.3 Control variables. This study alleviates concerns about omitted-variable bias and bolster the robustness of the regression estimates by including a broad set of control variables capturing firm attributes; operating performance and market valuation; corporate governance; external audit; and the composition of the investor base. Firm characteristics are measured by size (Size), age (Age), leverage ratio (Lev), asset tangibility (Tang), and capital intensity (CapInt), which capture differences in scale, operating experience, financial leverage, asset composition, and capital investment. Operating performance and market value are proxied by return on assets (Roa) and Tobin’s Q (TobinQ), together with the revenue growth rate (Growth) as an additional control, which reflect profitability, market valuation, and growth potential, respectively. Corporate governance is accounted for by the largest shareholder’s ownership concentration (Top1), board size (Board), managerial shareholding ratio (ManHold), and CEO duality (DUAL), capturing ownership structure, board independence and size, managerial incentives, and concentration of power. We further measure external monitoring using a dummy equal to 1 if the auditor is a Big Four firm (AUDIT) together with the fraction of shares held by institutions (InsHold); these measures proxy audit quality and the monitoring discipline exerted by institutional investors.

3.3 Model setting and descriptive statistics

3.3.1 Model setting. To investigate the impact of digital transformation on CSR, the following baseline regression model is estimated:

$$CSR_{i,t} = \alpha + \beta \times DIGI_{i,t} + \gamma \times Controls_{i,t} + \delta_i + \theta_t + \varepsilon_{i,t} \quad (18)$$

Where $CSR_{i,t}$ is the CSR score for firm i in year t ; $DIGI_{i,t}$ serves as the focal regressor for the intensity of digital transformation; $Controls_{i,t}$ is a vector of control covariates; δ_i and θ_t indicate firm and year fixed effects, respectively; and $\varepsilon_{i,t}$ denotes the disturbance term.

We quantify the partial effect of digitalization on CSR using a two-way fixed-effects model that absorbs firm and year effects. A significantly positive β is consistent with a higher level of CSR performance in more digitalized firms.

3.3.2 Descriptive statistics. According to the descriptive statistics reported in Table 1, the CSR score averages 5.05 (SD = 2.55), and the observed distribution extends from 0 to 8. This suggests substantial variation across Chinese listed firms: some actively undertake multi-dimensional CSR responsibilities, while others lag significantly behind.

For DIGI, the sample mean is 21.57 and the standard deviation equals 34.17, while the distribution runs from 0 to 287. The results underscore wide dispersion in firms' digital-transformation intensity: early movers exhibit considerable progress in digital uptake, whereas most enterprises are still at early or pilot stages. This degree of variation facilitates more precise estimation of digitalization's impact on CSR outcomes.

Table 1. Descriptive statistics

	N	Mean	Sd	Min	P50	Max
CSR	20249	5.0500	2.5461	0.0000	6.0000	8.0000
DIGI	20249	21.5675	34.1669	0.0000	9.0000	287.0000
Size	20249	22.5106	1.2562	19.8980	22.3304	26.5794
Roa	20249	0.0419	0.0518	-0.2152	0.0377	0.2227
Age	20249	2.9625	0.3215	1.3863	2.9957	3.6889
Lev	20249	0.4343	0.1839	0.0518	0.4334	0.8771
Tang	20249	0.9298	0.0777	0.4593	0.9545	1.0000
TobinQ	20249	1.9306	1.1411	0.7635	1.5675	9.5402
Growth	20249	0.1349	0.3001	-0.6677	0.0937	2.2761
CapInt	20249	2.1946	1.7280	0.3212	1.7291	13.1931
Top1	20249	34.8393	14.9266	8.1100	32.8800	76.4400
Board	20249	2.2237	0.2318	1.6094	2.1972	2.8904
ManHold	20249	0.1074	0.1768	0.0000	0.0027	0.6867
DUAL	20249	0.2448	0.4300	0.0000	0.0000	1.0000
AUDIT	20249	0.0744	0.2625	0.0000	0.0000	1.0000
InsHold	20249	46.4101	24.2888	0.0485	48.7458	93.0852

Notes: Table 1 provides the descriptive statistics for all variables, including explanatory variables, dependent variables, and control variables.

4 Empirical Results

4.1 Benchmark regression

According to the baseline results in Table 2, which examine CSR's response to digitalization, the estimated coefficient on DIGI is uniformly positive and significant ($p < 0.01$) across alternative specifications, providing evidence in favor of H1.

Specifically, with firm and year fixed effects dropped in column (1), the coefficient on DIGI is 0.010 and precisely estimated ($p < 0.01$); this maps a one-unit increase in digitalization to about 0.01 additional CSR points. Considering that the CSR score ranges only from 0 to 8, this result has substantial economic significance. In the two-

way FE specifications reported in columns (2)–(5), the DIGI coefficient shrinks to around 0.002 and remains strongly significant ($p < 0.01$), supporting the consistency of our conclusions.

Even after absorbing firm-specific unobservables and year-level disturbances, the impact of digital transformation continues to be statistically significant and robust. This suggests that the observed impact is not merely a reflection of inherent firm attributes or macroeconomic fluctuations but rather an independent and persistent outcome of firms' digital strategies. In other words, by leveraging AI, big data, and cloud computing, firms optimize resource allocation and streamline operations while simultaneously intensifying CSR commitments in areas including disclosure practices, environmental protection, and worker welfare.

Table 2. Benchmark regression results

Variables	(1) CSR	(2) CSR	(3) CSR	(4) CSR	(5) CSR
DIGI	0.010*** (19.13)	0.003*** (4.62)	0.002*** (3.33)	0.002*** (3.23)	0.002*** (3.22)
Size			0.356*** (9.56)	0.364*** (9.64)	0.369*** (9.36)
Roa			0.670* (1.90)	0.539 (1.49)	0.544 (1.50)
Age			0.600*** (2.76)	0.536** (2.41)	0.528** (2.36)
Lev			-0.346** (-2.29)	-0.377** (-2.49)	-0.382** (-2.51)
Tang			0.577** (2.08)	0.555** (2.00)	0.555** (2.00)
TobinQ			-0.003 (-0.20)	-0.007 (-0.41)	-0.006 (-0.35)
Growth			-0.067 (-1.50)	-0.084* (-1.85)	-0.084* (-1.83)
CapInt				-0.033** (-2.23)	-0.033** (-2.24)
Top1				0.000 (0.04)	0.000 (0.15)
Board				-0.007 (-0.10)	-0.005 (-0.07)
ManHold				-0.283 (-1.47)	-0.303 (-1.49)
DUAL					0.015 (0.35)
AUDIT					-0.046 (-0.42)
InsHold					-0.000 (-0.28)
Constant	4.836*** (230.59)	4.988*** (282.34)	-5.183*** (-4.80)	-5.013*** (-4.48)	-5.082*** (-4.51)

Firm FE	No	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Observations	20,249	20,249	20,249	20,249	20,249
R-squared	0.02	0.63	0.64	0.64	0.64

Notes: ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. t-statistics are reported in parentheses beneath each coefficient.

4.2 Endogeneity test

To evaluate CSR's response to digitalization, endogeneity concerns may bias the baseline regression estimates. First, a potential reverse channel exists: superior CSR performers, facing external social pressure, may be more prone to undertake digital-transformation initiatives, resulting in a two-way causal relationship. Second, unobserved organizational traits (e.g., managers' preferences and corporate culture) could affect digital transformation and CSR at the same time, giving rise to omitted-variable bias.

We address these issues by implementing an IV design and fitting 2SLS regressions. Specifically, we use the one-period lag of the digital transformation index (L.DIGI) as the instrumental variable. This choice is justified because L.DIGI is highly correlated with current digital transformation, reflecting path dependence in firms' digital strategies, while its effect on current CSR performance is primarily mediated through contemporaneous digitalization, ensuring its plausibility as an exogenous instrument.

As shown in Table 3, the IV regressions indicate that, in the first stage, the lag of digital transformation (L.DIGI) is positively and strongly linked to the contemporaneous measure (DIGI); the estimated coefficient (0.573) is significant at the 1% threshold, thereby confirming instrument relevance. Cragg–Donald Wald F registers 777.4, surpassing the Stock–Yogo 10% cutoff (16.38), indicating that weak IV is unlikely to be an issue.

At the second stage, the estimated effect of DIGI (0.002) retains significance at the 5% threshold; thus, even under the IV correction, digital transformation continues to have a positive and statistically significant impact on CSR outcomes. The finding accords with the benchmark regressions and provides additional support for the robustness and reliability of the central conclusion.

Table 3. Instrumental variable regression results

Variables	(1) First stage DIGI	(2) Second stage CSR
L.DIGI	0.573*** (0.005)	
DIGI		0.002** (0.001)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
Observations	18,004	18,004
R-squared	0.840	0.007
Cragg-Donald Wald F		777.4
Stock-Yogo 10%		16.38

4.3 Robustness test

4.3.1 Alternative model specifications. To examine whether the digital transformation–CSR relationship is sensitive to specification choices, we extend the baseline regression by incorporating additional fixed effects. Conditioning on firm and year effects, we progressively include city- and industry-level fixed components, minimizing bias from geographic variation and sector characteristics.

Table 4 summarizes the estimates. Across all specifications, DIGI remains positive and statistically different from zero at the 1% level. In columns (1)–(2), after absorbing city fixed effects, the DIGI coefficient is 0.002 ($p < 0.01$), indicating that geographic heterogeneity does not drive the result. Turning to column (3), adding industry fixed effects increases the estimated effect of DIGI to 0.003 while retaining significance at the 1% threshold; hence, controlling for industry-level variation makes the positive impact of digital transformation on CSR more salient.

Findings point to a CSR response to digitalization that transcends regional and sectoral boundaries, revealing a general, systematic regularity. In other words, firms improve governance, optimize resource allocation, and strengthen information disclosure through digitalization, thereby enhancing CSR engagement, regardless of geographic or industrial context. This evidence underscores the robustness and generality of the main conclusion under a variety of specification choices.

Table 4. Alternative model specifications

Variables	(1)	(2)	(3)
	CSR	CSR	CSR
DIGI	0.002*** (3.19)	0.002*** (3.36)	0.003*** (5.59)
Constant	-4.307*** (-3.77)	-3.094*** (-2.67)	-7.081*** (-13.11)
Firm FE	Yes	Yes	No
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Industry FE	No	Yes	Yes
Controls	Yes	Yes	Yes
Observations	20,249	20,249	20,249
R-squared	0.64	0.65	0.31

4.3.2 Alternative dependent variable. In the baseline regression, CSR performance is measured using a composite CSR score that reflects firms’ responsibilities across multiple dimensions. As an additional robustness check, we adopt an alternative measure of CSR — CSR disclosure quality (CSRQUA). This indicator is obtained from the CSR sub-database in CSMAR, based on the “Basic Information Table of CSR Reports of

Listed Firms,” which evaluates disclosure across 12 aspects. We code the following aspects: third-party assurance of the report; compliance with the GRI Sustainability Reporting Guidelines; and disclosure covering shareholder and creditor protection, employee rights, supplier and customer protection, environmental sustainability, public relations and philanthropic activities, CSR-system building, production safety, and reported shortcomings in corporate responsibility. Disclosed items are coded 1 (0 otherwise), and the composite disclosure score is scaled to the unit interval [0,1].

Table 5 displays regression results for models that take CSRQUA as the dependent variable. In all reported models, the estimated effect of DIGI is positive and statistically non-zero at the 1% threshold. Evidence from the robustness exercise confirms the central result: corporate digitalization yields significant improvements in CSR outcomes, spanning substantive responsibility execution and the quality of CSR disclosure. Agreement across the various CSR proxies provides additional evidence of the findings’ reliability and their explanatory capacity.

Table 5. Alternative dependent variable results

Variables	(1) CSRQUA	(2) CSRQUA	(3) CSRQUA	(4) CSRQUA
DIGI	0.002*** (2.96)	0.002*** (2.88)	0.002*** (3.06)	0.003*** (5.24)
Constant	-7.064*** (-6.44)	-6.225*** (-5.60)	-5.229*** (-4.63)	-9.588*** (-18.14)
Firm FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
City FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	20,249	20,249	20,249	20,249
R-squared	0.65	0.65	0.66	0.33

4.3.3 Excluding major events. During the period 2009–2023, China’s capital market and macroeconomic environment experienced several major shocks, including the 2015 stock-market turmoil, the 2018 U.S.–China trade dispute, and the onset of COVID-19 in 2020. These unexpected events may have significantly affected firms’ digital transformation strategies and CSR practices, potentially biasing the regression results. To examine whether our conclusions are driven by such external shocks, we omit observations for the impacted years and re-estimate the regressions.

Table 6 displays the regression results re-estimated on the sample excluding those years. Consistently across model variants, DIGI is positive and significant at the 1% threshold, with effect sizes lying between 0.002 and 0.003. The estimates remain in line with the baseline specifications, indicating that CSR gains under digitalization are unlikely to be artifacts of contemporaneous macro shocks; instead, they are consistent with a more fundamental channel.

In other words, regardless of whether firms operate under relatively stable conditions or during periods of turbulence, digital transformation consistently enhances information transparency, strengthens governance effectiveness, and promotes innovation investment, thereby sustaining improvements in CSR performance.

Table 6. Regression results excluding major events

Variables	(1)	(2)	(3)	(4)
	CSR	CSR	CSR	CSR
DIGI	0.002*** (3.11)	0.002*** (2.88)	0.002*** (3.01)	0.003*** (4.97)
Constant	-5.339*** (-4.21)	-4.786*** (-3.72)	-3.586*** (-2.75)	-7.558*** (-12.08)
Firm FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
City FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	15,875	15,873	15,873	15,874
R-squared	0.65	0.65	0.66	0.33

4.3.4 Excluding the four municipalities. China’s four municipalities — Beijing, Shanghai, Tianjin, and Chongqing — often exhibit unique characteristics in terms of economic development, institutional environment, and regulatory systems. For example, Beijing and Shanghai host a large number of central state-owned enterprises and multinational corporations, while Tianjin and Chongqing have distinct industrial structures and policy frameworks. Such differences may lead firms in these regions to display patterns of digital transformation and CSR engagement that diverge from those in other areas. If not properly addressed, these distinctive features could bias the overall regression results.

To rule out this channel, the sample is purged of firms headquartered in the four municipalities, after which we run the specifications again; the corresponding results are in Table 7. Across all model specifications, Consistently, DIGI is positive and significant—at either the 1% or 5% level depending on the specification—with magnitudes between 0.002 and 0.004. The evidence accords with the baseline regressions, implying that the beneficial effect of digital transformation on CSR does not stem from idiosyncrasies specific to firms located in the four municipalities.

Taken together, the findings imply that the beneficial influence of digital transformation on CSR holds widely across Chinese listed firms, rather than being limited to specific institutional or economic environments. This finding substantiates that the study’s main conclusion is robust and broadly generalizable.

Table 7. Regression results excluding the four municipalities

Variables	(1)	(2)	(3)	(4)
	CSR	CSR	CSR	CSR
DIGI	0.002** (2.32)	0.002** (2.17)	0.002*** (2.62)	0.004*** (5.56)
Constant	-6.839*** (-5.46)	-5.860*** (-4.60)	-4.516*** (-3.48)	-6.747*** (-11.06)
Firm FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
City FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	16,449	16,449	16,449	16,452
R-squared	0.64	0.64	0.65	0.33

4.3.5 Adding macro-level control variables. The baseline models primarily account for firm-level characteristics. However, macroeconomic conditions may also affect CSR performance. For instance, regional economic development, industrial structure, and the availability of financial resources can influence firms' strategic choices, potentially shaping both digital transformation and CSR engagement. Neglecting these macro-level factors may therefore introduce omitted-variable bias.

To address this concern, we augment the baseline model by incorporating several regional macroeconomic indicators. Specifically, we control for regional GDP growth rate (GDP), per capita GDP (PerGDP), credit supply (Loan), and the proportions of secondary and tertiary industries (I2 and I3) to capture heterogeneity in external environments across regions.

Table 8 reports the results. After including macro-level controls, the estimated effect of DIGI remains positive and statistically precise ($p < 0.01$); the point estimates lie in the 0.002–0.003 interval, closely aligning with the baseline results. Taken together, results suggest that regional macro differences are not the proximate drivers of the positive association between digitalization and CSR outcomes, further bolstering the robustness of the central conclusion.

Table 8. Regression results with macro-level control variables

Variables	(1)	(2)	(3)	(4)
	CSR	CSR	CSR	CSR
DIGI	0.002*** (3.14)	0.002*** (3.17)	0.002*** (3.26)	0.003*** (5.07)
Constant	0.952	4.270*	6.590***	2.794

	(0.50)	(1.92)	(2.92)	(1.14)
Firm FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
City FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	16,254	16,253	16,253	16,290
R-squared	0.65	0.65	0.66	0.30

5 Further Analysis

5.1 Mechanism test

5.1.1 R&D investment mechanism. Innovation functions as a core mechanism linking digital transformation to improvements in firms' CSR performance. Deploying digital technologies streamlines the use of R&D resources, reduces innovation's marginal costs, and bolsters corporate capacity in CSR-related fields, including environmental technologies, cleaner-production practices, and workforce training. If digital transformation indeed improves CSR through increased R&D investment, then it should be positively associated with R&D intensity, innovation output, and R&D efficiency.

Table 9 summarizes the empirical estimates for the R&D pathway. First, the estimated effect of DIGI in the RD equation is 0.003 and reaches 1% significance; thus, higher levels of digitalization are associated with greater R&D investment. Second, the estimated effect of DIGI on patenting (Patent) equals 0.001 and attains 1% significance; thus, digital transformation is linked to increases in innovation output. This finding reflects not only increased R&D investment but also improved innovation efficiency. Furthermore, we find significant positive effects of digitalization on both the capitalization rate of R&D and the R&D expenditure ratio, with p-values below 0.01 and 0.05, respectively. This implies that digital transformation facilitates the capitalization process of innovation outcomes and encourages higher R&D spending, thereby improving the quality and sustainability of innovation activities. Turning to R&D-investment growth, the DIGI coefficient is positive and significant at the 10% threshold, implying that digitalization contributes to the dynamic scaling of firms' R&D efforts.

Overall, evidence in Table 9 suggests that corporate digitalization is associated with statistically significant increases in R&D spending, greater innovation output, and higher R&D efficiency. Such innovation efforts enhance technological capacity and, in parallel, supply additional resource backing and governance assurances for CSR initiatives spanning the environment, workforce welfare, and public services. This evidence validates Hypothesis 2, namely that digital transformation promotes CSR by increasing R&D investment.

Table 9. Regression results for the R&D investment mechanism

Variables	(1) RD	(2) Patent	(3) RD_CAP	(4) RD_GROWTH	(5) RD_INT
DIGI	0.003*** (8.81)	0.001*** (3.99)	0.014*** (3.28)	0.001* (1.81)	0.003*** (4.76)
Constant	4.175*** (6.98)	-8.403*** (-15.31)	-65.416*** (-5.01)	-4.809*** (-4.50)	8.840*** (3.81)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	20,249	20,249	11,156	16,121	10,113
R-squared	0.83	0.79	0.75	0.17	0.93

5.1.2 Information transparency mechanism. Information transparency is a fundamental prerequisite for effective CSR engagement. Traditional disclosure practices are often constrained by delays and asymmetries, which limit investors' and the public's ability to monitor firms' CSR behavior. Digital transformation, underpinned by big data, cloud computing, and intelligent information systems, substantially improves disclosure quality and communication efficiency, thereby facilitating the implementation of CSR strategies. If digital transformation indeed enhances CSR through improved transparency, it should be linked to higher internal-control quality, better disclosure quality, broader analyst coverage, and improvements in the overall information environment.

Table 10 displays results for models evaluating the information-transparency mechanism. To begin, DIGI is positively linked to internal-control quality (IC), with an estimated coefficient of 0.001 that reaches 5% significance. This indicates that digitalization strengthens firms' internal control systems, reduces information asymmetry, and enhances compliance and credibility in CSR fulfillment. Second, with respect to disclosure quality, the estimate on DIGI in the KV regression is -0.012 ($p < 0.05$), indicating an inverse association. Since a lower KV denotes reduced opacity to investors, the evidence indicates that corporate digitalization effectively reduces information opacity.

Furthermore, digital transformation significantly increases analyst coverage (Attention), with an estimated coefficient of 0.001 that is statistically significant at the 1 percent level. This pattern indicates that digitalization improves information availability and strengthens transparency, thereby attracting greater analyst attention and exerting stronger external monitoring pressure, which in turn encourages firms to engage more actively in CSR. Moreover, for analyst forecast dispersion (FERR), the DIGI coefficient is -0.001 and statistically significant at the 10% threshold, indicating that digital transformation reduces uncertainty and disagreement in market expectations regarding firms' future performance, thereby further improving the information environment.

Taken together, the results in Table 10 clearly demonstrate that digital transformation improves information transparency by strengthening internal control quality,

enhancing disclosure integrity and timeliness, and attracting greater external monitoring. Such enhancements strengthen stakeholder trust and spur firms to take on greater responsibility spanning environmental protection, labor rights, and community welfare. This evidence supports Hypothesis 3, namely that digital transformation promotes CSR through enhanced information transparency.

Table 10. Regression results for the information transparency mechanism

Variables	(1) IC	(2) KV	(3) Attention	(4) FERR
DIGI	0.001** (2.34)	-0.012** (-2.05)	0.001*** (3.70)	-0.001* (-1.95)
Constant	4.625*** (9.42)	-148.730*** (-13.82)	-10.384*** (-22.78)	-0.758 (-0.69)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	20,239	20,128	14,616	14,464
R-squared	0.42	0.46	0.71	0.29

5.1.3 Governance structure mechanism. The effectiveness of corporate governance largely determines whether firms can incorporate CSR into their long-term strategic objectives. Under traditional governance structures, firms are often plagued by insider control and agency problems, leading to short-termism and insufficient CSR investment. Digital transformation, by improving transparency, strengthening external monitoring, and reducing information asymmetry, has the potential to improve governance effectiveness and enhance firms' incentives to fulfill CSR. If this channel operates, digitalization should materially lower stock price crash risk and price synchronicity; both are standard proxies for governance quality.

Following Hutton et al. (2009^[26]), crash risk is measured using NCSKEW, constructed under two approaches: NCSKEW_Cmdos, based on the circulation market capitalization method, and NCSKEW_Cmdtl, based on the total market capitalization method. Stock price synchronicity is measured following Durnev et al. (2003^[27]), with SYN_Cmdos and SYN_Cmdtl constructed analogously.

Table 11 displays the regression results for models evaluating the governance pathway. First, with respect to crash risk, digital transformation (DIGI) is negatively associated with both NCSKEW_Cmdos and NCSKEW_Cmdtl, with estimates significant at the 5% threshold ($p < 0.05$). These results imply that digitalization mitigates the risk of severe negative return events in equity prices, reflecting improvements in transparency and governance that limit opportunistic behavior and insider control. Second, regarding synchronicity, DIGI is significantly negatively associated with both SYN_Cmdos and SYN_Cmdtl, with coefficients around -0.002 , all significant at the 1% level. The results imply that digitalization deepens the incorporation of idiosyncratic firm information into equity prices, reduces the extent of homogenous market interpretations, and thereby enhances governance transparency.

Overall, these findings demonstrate that digital transformation mitigates internal governance risks and improves the external information environment, significantly

strengthening corporate governance structures. Improved governance constrains managerial short-termism and provides institutional safeguards for the long-term implementation of CSR. In other words, digital transformation optimizes governance mechanisms and fundamentally promotes CSR engagement. This evidence supports Hypothesis 4, namely that digital transformation enhances CSR by improving governance effectiveness.

Table 11. Regression results for the governance structure mechanism

Variables	(1) NCSKEW_Cmdos	(2) NCSKEW_Cmdtl	(3) SYN_Cmdos	(4) SYN_Cmdtl
DIGI	-0.001** (-2.14)	-0.001** (-2.00)	-0.002*** (-4.09)	-0.002*** (-4.07)
Constant	-0.367 (-0.78)	-0.407 (-0.85)	-7.413*** (-7.36)	-6.658*** (-6.63)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	20,086	20,086	20,086	20,086
R-squared	0.17	0.17	0.54	0.53

5.2 Heterogeneity analysis

To explore whether digitalization's CSR consequences vary across firms and contexts, we conduct subsample regressions based on four dimensions: regional development, financing constraints, firm life cycle, and industry technology intensity. The results, reported in Table 12, reveal significant cross-sample differences, suggesting that external context and company characteristics shape the relationship between digital transformation and CSR.

Regionally, for companies located in eastern China, digital transformation raises CSR (coefficient = 0.002; $p < 0.01$). By contrast, among firms in the west, the impact is smaller and only reaches 10% significance. This suggests that firms in the east, benefiting from more advanced digital infrastructure, stronger policy support, and more developed capital markets, are better able to convert digital strategies into CSR improvements, while firms in the west face greater constraints from external conditions and resources.

Regarding financing frictions, digital transformation raises CSR among firms facing lighter constraints (coefficient = 0.002; $p < 0.05$), but insignificant among highly constrained firms. This indicates that firms with greater access to resources are more capable of leveraging digital tools to improve CSR, whereas financially constrained firms prioritize operational and investment needs over CSR commitments.

By life-cycle stage, digitalization raises CSR for firms in the growth phase (coefficient = 0.002; $p < 0.01$), while the effect for mature firms is insignificant. Taken together, the evidence suggests that growth-stage enterprises are likelier to harness digital

technologies to build reputation, secure outside resources, and deepen CSR engagement; by contrast, mature firms show stronger strategic inertia and weaker incremental CSR effects from digitalization.

Stratifying industries by technological intensity, we find a significant DT–CSR association in high-tech sectors ($\beta = 0.002$, $p < 0.05$), whereas estimates for less-tech-intensive sectors are statistically indistinguishable from zero. This implies that in innovation-driven sectors, digital tools not only enhance production and R&D efficiency but also extend more readily into CSR-related activities such as green innovation and responsibility management. In contrast, in labor-intensive or low-tech sectors, the spillover effect of digitalization on CSR is relatively limited.

Overall, these heterogeneity tests suggest that digital transformation’s positive influence on CSR varies with external conditions and firm-specific characteristics, rather than being uniform. This finding highlights the need for policymakers to adopt differentiated strategies when promoting the integration of digitalization and CSR, tailoring support and regulatory policies to regional conditions, financing environments, firm stages of development, and industry attributes.

Table 12. Heterogeneity analysis results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CSR	CSR	CSR	CSR	CSR	CSR	CSR	CSR
	West	East	High FC	Low FC	Growth	Mature	High TechInd	Low TechInd
DIGI	0.002* (1.68)	0.002*** (3.24)	0.001 (1.04)	0.002** (2.41)	0.002*** (2.81)	0.001 (1.51)	0.002** (2.23)	0.001 (0.47)
Constant	-9.584*** (-4.63)	-2.196 (-1.60)	-14.488*** (-7.96)	-5.770 (-1.55)	-10.047*** (-6.10)	-11.277*** (-3.40)	-7.504*** (-4.99)	7.911** (2.23)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,325	13,924	10,010	10,239	11,173	9,076	13,909	6,340
R-squared	0.64	0.64	0.71	0.69	0.65	0.66	0.66	0.75

6 Conclusions and Suggestions

Using a large panel of Chinese A-share firms from 2009 to 2023, this study systematically examines how digital transformation shapes corporate social responsibility (CSR) engagement and through which mechanisms this influence unfolds. The empirical evidence consistently shows that digital transformation significantly enhances CSR performance, and this relationship remains robust across multiple model specifications and sensitivity tests. Mechanism analyses reveal that digital transformation advances CSR through three complementary channels: (1) by stimulating R&D investment, which promotes green innovation and employee welfare; (2) by improving information transparency, which strengthens disclosure quality and external monitoring; and (3) by optimizing governance structures, which mitigates managerial opportunism and reduces

crash risk. Heterogeneity analyses further indicate that the CSR benefits of digitalization are more pronounced among firms located in eastern regions, with lower financing constraints, at the growth stage, and operating in technology-intensive industries.

From a policy perspective, governments should continue to improve digital infrastructure, standardize CSR reporting frameworks, and design regionally differentiated industrial policies that link digital transformation to sustainability goals. Firms are advised to embed CSR objectives into their digital strategies, using technologies such as AI, big data, and blockchain to enhance environmental performance, workforce development, and supply-chain transparency. Investors and external monitors should also integrate firms' digital progress into their sustainability evaluations and leverage digital tools to strengthen CSR oversight.

Future research could expand in several directions. First, cross-country comparative studies could examine whether the digitalization–CSR nexus observed in China holds under different institutional and cultural settings. Second, micro-level analyses based on textual, behavioral, or ESG-related data could uncover how specific digital technologies (e.g., AI, blockchain, IoT) affect distinct dimensions of CSR. Third, future work may explore potential nonlinear or threshold effects of digital transformation, as well as its interaction with green finance, policy incentives, and corporate innovation ecosystems.

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References

1. Li F. The digital transformation of business models in the creative industries: A holistic framework and emerging trends[J]. *Technovation*, 2020, 92: 102012. <https://doi.org/10.1016/j.technovation.2017.12.004>
2. Brynjolfsson E, Rock D, Syverson C. The productivity J-curve: How intangibles complement general purpose technologies[J]. *American Economic Journal: Macroeconomics*, 2021, 13(1): 333-372. <https://doi.org/10.1257/mac.20180386>
3. Pan W, Xie T, Wang Z, et al. Digital economy: An innovation driver for total factor productivity[J]. *Journal of Business Research*, 2022, 139: 303-311. <https://doi.org/10.1016/j.jbusres.2021.09.061>
4. Zhou Y, Lyu J, Li L. Can digital transformation enhance labor productivity in enterprises: An analysis from the perspective of business process reengineering[J]. *PloS One*, 2025, 20(6): e0325484. <https://doi.org/10.1371/journal.pone.0325484>
5. Lindberg M, Ranner M, Månsson-Lexell E, et al. Work and everyday life in a digitalized time: Experiences of people with subjective cognitive difficulties related to neurological disorders [J]. *PLoS One*, 2021, 16(11): e0260013. <https://doi.org/10.1371/journal.pone.0260013>

6. Liu Y, He Q. Digital transformation, external financing, and enterprise resource allocation efficiency[J]. *Managerial and Decision Economics*, 2024, 45(4): 2321-2335. <https://doi.org/10.1002/mde.4136>
7. ElMassah S, Mohieldin M. Digital transformation and localizing the sustainable development goals (SDGs)[J]. *Ecological Economics*, 2020, 169: 106490. <https://doi.org/10.1016/j.ecolecon.2019.106490>
8. Zhao T, Xiao X. The impact of corporate social responsibility on financial constraints: Does the life cycle stage of a firm matter?[J]. *International Review of Economics & Finance*, 2019, 63: 76-93. <https://doi.org/10.1016/j.iref.2018.08.010>
9. Le T T. How do corporate social responsibility and green innovation transform corporate green strategy into sustainable firm performance?[J]. *Journal of Cleaner Production*, 2022, 362: 132228. <https://doi.org/10.1016/j.jclepro.2022.132228>
10. Chen W. Digital economy development, corporate social responsibility and low-carbon innovation[J]. *Corporate Social Responsibility and Environmental Management*, 2023, 30(4): 1664-1679. <https://doi.org/10.1002/csr.2443>
11. Fu S, Tian M, Ge Y, et al. Influencing factors and mechanisms of corporate social responsibility reputation under green and low-carbon transition: evidence from Chinese listed companies[J]. *Energies*, 2024, 17(9): 2044. <https://doi.org/10.3390/en17092044>
12. Sun Z, Wang W, Wang W, et al. How does digital transformation affect corporate social responsibility performance? From the dual perspective of internal drive and external governance[J]. *Corporate Social Responsibility and Environmental Management*, 2024, 31(2): 1156-1176. <https://doi.org/10.1002/csr.2615>
13. Zheng Y, Zhang Q. Digital transformation, corporate social responsibility and green technology innovation-based on empirical evidence of listed companies in China[J]. *Journal of Cleaner Production*, 2023, 424: 138805. <https://doi.org/10.1016/j.jclepro.2023.138805>
14. Kelley K J, Hemphill T A, Thams Y. Corporate social responsibility, country reputation and corporate reputation: A perspective on the creation of shared value in emerging markets[J]. *Multinational Business Review*, 2019, 27(2): 178-197. <https://doi.org/10.1108/mbr-07-2017-0047>
15. Vitolla F, Salvi A, Raimo N, et al. The impact on the cost of equity capital in the effects of integrated reporting quality[J]. *Business Strategy and the Environment*, 2020, 29(2): 519-529. <https://doi.org/10.1002/bse.2384>
16. Liu M, Lu W. Corporate social responsibility, firm performance, and firm risk: the role of firm reputation[J]. *Asia-Pacific Journal of Accounting & Economics*, 2021, 28(5): 525-545. <https://doi.org/10.1080/16081625.2019.1601022>
17. Xue Y, Jiang C, Guo Y, et al. Corporate social responsibility and high-quality development: Do green innovation, environmental investment and corporate governance matter?[J]. *Emerging Markets Finance and Trade*, 2022, 58(11): 3191-3214. <https://doi.org/10.1080/1540496x.2022.2034616>
18. Wu L, Jin S. Corporate social responsibility and sustainability: From a corporate governance perspective[J]. *Sustainability*, 2022, 14(22): 15457. <https://doi.org/10.3390/su142215457>
19. Yuan L, Zheng L, Xu Y. Corporate social responsibility and corporate innovation efficiency: evidence from China[J]. *International Journal of Emerging Markets*, 2023, 18(12): 6125-6142. <https://doi.org/10.1108/ijoem-09-2021-1364>
20. Sahasranamam S, Arya B, Sud M. Ownership structure and corporate social responsibility in an emerging market[J]. *Asia Pacific Journal of Management*, 2020, 37(4): 1165-1192. <https://doi.org/10.1007/s10490-019-09649-1>

21. Long W, Li S, Wu H, et al. Corporate social responsibility and financial performance: The roles of government intervention and market competition[J]. *Corporate Social Responsibility and Environmental Management*, 2020, 27(2): 525-541. <https://doi.org/10.1002/csr.1817>
22. Wu Y. Do political incentives promote or inhibit corporate social responsibility? The role of local officials' tenure[J]. *PloS One*, 2023, 18(3): e0283183. <https://doi.org/10.1371/journal.pone.0283183>
23. Yuan T, Wu J G, Qin N, et al. Being nice to stakeholders: The effect of economic policy uncertainty on corporate social responsibility[J]. *Economic Modelling*, 2022, 108: 105737. <https://doi.org/10.1016/j.econmod.2021.105737>
24. Brown S V, Hinson L A, Tucker J W. Financial statement adequacy and firms' MD&A disclosures[J]. *Contemporary Accounting Research*, 2024, 41(1): 126-162. <https://doi.org/10.1111/1911-3846.12919>
25. Yang L, Zhang Z, Wang L, et al. Encourage or inhibit: A study on the impact of corporate digital transformation on management's tone manipulation of information disclosure[J]. *PloS One*, 2025, 20(2): e0317503. <https://doi.org/10.1371/journal.pone.0317503>
26. Hutton A P, Marcus A J, Tehranian H. Opaque financial reports, R2, and crash risk[J]. *Journal of financial Economics*, 2009, 94(1): 67-86. <https://doi.org/10.1016/j.jfineco.2008.10.003>
27. Durnev A, Morck R, Yeung B, et al. Does greater firm-specific return variation mean more or less informed stock pricing?[J]. *Journal of Accounting research*, 2003, 41(5): 797-836. <https://doi.org/10.1046/j.1475-679x.2003.00124.x>

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