

Can Digital Transformation Curb Corporate Greenwashing? Empirical Evidence from the Perspectives of Financing Constraints and Media Supervision

Qiyue Zhu

*Beijing Institute of Technology, Beijing, China
rn811010@student.reading.ac.uk*

Abstract. As China advances its dual-carbon goals and refines environmental disclosure requirements, corporate greenwashing increasingly distorts capital allocation and impedes green transformation. Using panel data on A-share listed firms from 2014 to 2023, this paper examines how digital transformation affects corporate greenwashing. Empirical results indicate that digital transformation significantly reduces instances of greenwashing, with stronger effects observed in non-state-owned firms and firms outside heavily polluting industries. Additional analyses show that high financing constraints attenuate the mitigating influence of digital transformation, whereas more intensive media scrutiny amplifies it. By illuminating the environmental governance role of digitalization and the moderating effects of financing pressure and media oversight, the study offers policy implications: governments and regulators should bolster digital adoption among small and medium enterprises, develop robust digital platforms for environmental information disclosure, and incentivize media oversight to strengthen corporate environmental accountability and support sustainable development.

Keywords: digital transformation, corporate greenwashing, financing constraints, media supervision

1. Introduction

At the 20th Third Plenary Session, the Communist Party of China explicitly called for “deepening the reform of the environmental information disclosure system in accordance with the law” and positioned the establishment of robust green and low-carbon development mechanisms as a central task of ecological civilization construction. In parallel, the pursuit of the national “dual carbon” goals has elevated green development to a core dimension of high-quality corporate growth. Nevertheless, some firms seek to evade environmental responsibilities and secure market legitimacy to continue to engage in greenwashing, employing tactics such as selective disclosure and symbolic compliance to obscure their actual environmental performance. These practices not only distort the allocation of resources within capital markets but also undermine the broader transition toward sustainable development. Consequently, identifying effective mechanisms to curb greenwashing has become a priority for both policymakers and corporate decision-makers.

Digital transformation is emerging as a potentially decisive lever in addressing this challenge. The integration of advanced digital technologies has fundamentally reshaped how firms collect, process, and disclose environmental information. By enabling accurate, transparent, and verifiable disclosures, digital transformation can enhance the credibility of environmental reporting, create market-based constraints aligned with genuinely green practices, and encourage firms to abandon symbolic compliance in favor of substantive environmental responsibility.

The extant literature on corporate digital transformation has predominantly focused on its economic consequences, with a broad consensus that digitalization improves business operations. Empirical studies demonstrate that the adoption of technologies such as the Internet of Things (IoT) and big data can reconfigure organizational and business models, thereby improving operational efficiency [1], enhancing financial performance, reducing the cost of capital, and curbing aggressive tax avoidance [2]. Additional research links digital transformation to greater innovation output, improved export performance, and enhanced supply chain resilience [3]. More recently, scholars have begun to explore its non-economic implications, particularly in environmental governance. Evidence suggests that digital transformation can strengthen corporate social responsibility [4], improve ESG performance [5], and suppress greenwashing through mechanisms such as improving accounting information quality, enhancing internal control systems, and alleviating financing constraints [6].

Research on the drivers of greenwashing identifies both external and internal motivations. Externally, institutional conditions and societal pressures shape corporate behavior: weak regulatory enforcement and insufficient policy pressure encourage symbolic rather than substantive compliance [7], while societal expectations for environmental responsibility may prompt firms to overstate their performance [8]. Internally, firm-level characteristics also matter. Larger firms often engage in greenwashing to meet stakeholder expectations, while financial constraints and operational difficulties can incentivize symbolic environmental actions to protect reputation and attract resources [9]. At the managerial level, information asymmetry provides fertile ground for greenwashing: the complexity and ambiguity of environmental information enable selective disclosure and narrative manipulation, fostering a “more talk, less action” disclosure pattern that misleads stakeholders [10].

Despite these insights, two important gaps remain. First, the moderating roles of financing constraints and media supervision in the relationship between digital transformation and greenwashing remain underexplored, and the underlying mechanisms through which these factors shape environmental governance outcomes are not well understood. Second, the heterogeneity of this relationship across different ownership structures, particularly between state-owned and non-state-owned enterprises, has yet to be systematically examined.

This study makes two primary contributions. First, it deepens theoretical understanding of the environmental governance effects of digital transformation by explicitly modeling the moderating roles of financing constraints and media supervision. Second, it extends heterogeneity analysis by comparing the impact of digital transformation on greenwashing across ownership types, thereby broadening the scope of inquiry into the conditions under which digital transformation can most effectively promote genuine corporate environmental responsibility.

2. Theoretical background and hypothesis development

2.1. Digital transformation and corporate greenwashing

Greenwashing essentially reflects an opportunistic use of environmental information by corporate managers in pursuit of short-term interests [11]. Digital transformation can help curb such behavior through both external and internal mechanisms.

Externally, regulatory bodies can leverage digital technologies to detect greenwashing more efficiently, shifting environmental disclosure from “textual narratives” to “data mirroring.” For example, technologies such as the Internet of Things (IoT) can capture real-time data, translating corporate statements into granular, verifiable indicators of energy consumption, emissions, and other metrics. By integrating multidimensional datasets with algorithm-based detection, regulatory oversight can evolve from “disproving narratives” to “calibrating data networks,” enabling precise identification of greenwashing practices [12].

Internally, digital transformation allows firms to adopt data-driven processes that facilitate faster and more accurate collection and organization of environmental information. This enhances the utilization of information, improves internal communication efficiency, and expands the transparency of internal information systems [13]. Accordingly, we propose the following hypothesis:

H1: Digital transformation reduces the likelihood of corporate greenwashing.

2.2. The moderating role of financing constraints

Firms facing high levels of financing constraints operate under persistent cash flow pressures, making the continuity of cash flows generated by operating activities critical for survival [14]. Under such constraints, limited resources are typically prioritized for activities directly related to day-to-day operations and for areas where costs can be closely controlled. Digital transformation, encompassing technologies such as the Internet of Things (IoT) and big data, does not fall within the scope of routine operational expenditure. To preserve cash flow stability, highly constrained firms are more inclined to allocate resources toward operational necessities rather than committing substantial investment to digital transformation initiatives. As a result, higher financing constraints are likely to dampen the extent of digital transformation, thereby weakening its effectiveness in curbing greenwashing. Accordingly, we propose the following hypothesis:

H2: The inhibitory effect of digital transformation on corporate greenwashing weakens as financing constraints increase.

2.3. The moderating role of media supervision

By analyzing, integrating, and disseminating environmental information, media outlets enable stakeholders to better understand and monitor firms’ environmental governance, thereby exerting pressure to reduce greenwashing. For example, Southern Weekly’s publication of a “Greenwashing List” illustrates the media’s role as an external watchdog [15]. When media supervision is weak, genuine environmental achievements may go largely unnoticed, and firms may perceive lower legitimacy pressures from public scrutiny. In such contexts, management may be more inclined to engage in greenwashing to secure development resources, enhance market performance, and project a “false” green image.

The adoption of digital technologies enhances corporate information transparency, thereby raising the potential reputational and legitimacy costs of engaging in greenwashing. In this sense, digital transformation can partially substitute for media oversight by making opportunistic behavior easier to detect. However, when media supervision is strong, firms face heightened scrutiny from both capital markets and regulatory agencies. Under such conditions, firms are more likely to standardize environmental practices, disclose more valuable environmental information, and avoid symbolic compliance, thereby reinforcing the deterrent effect of digital transformation on greenwashing. Accordingly, we propose the following hypothesis:

H3: The inhibitory effect of digital transformation on corporate greenwashing strengthens as media supervision increases.

3. Model specification

3.1. Data and sample selection

This study examines A-share listed firms over the period 2014–2023, with data obtained from the CSMAR database. The sample was refined using the following criteria: (1) firms designated as ST or *ST during the study period were excluded; (2) companies that were delisted, suspended, or exited the market were removed; (3) financial firms were omitted due to their distinct industry characteristics; and (4) to reduce the impact of outliers, all continuous variables were winsorized at the 1% and 99% levels.

3.2. Variable definitions and measurement

3.2.1. Independent variable: digital transformation (DCG)

Following prior research [16], this study constructs a corporate digital transformation index (DCG) through a text-mining method. Specifically, the “Management Discussion and Analysis” sections of listed firms’ annual reports were collected. Successful transformation cases were then manually identified, from which high-frequency terms were extracted and validated using Jieba segmentation. A specialized dictionary was created across four dimensions including digital technology application, internet-based business models, smart manufacturing, and modern information systems. This dictionary was subsequently applied to all sample firms to calculate keyword frequencies in each dimension. After standardization and entropy-based weighting, the results were aggregated to generate the DCG index.

3.2.2. Dependent variable: corporate greenwashing (GWL)

Building on prior studies, this paper develops a relative greenwashing index to assess the degree of greenwashing. The index reflects the difference between a firm’s ESG disclosure score and its actual ESG performance score. For consistency across firms and years, both scores are standardized by subtracting the corresponding annual industry mean and dividing by the standard deviation ($ESG_{disclosure}$ represents the ESG disclosure score, and ESG_{rating} represents the ESG performance score). The difference between the standardized disclosure score ($ESG_disclosure$) and the standardized performance score (ESG_rating) represents the firm’s greenwashing level, with higher values indicating more severe greenwashing.

$$GreenwashScore_{i,t} = \left(\frac{ESG_{disclosure_{i,t}} - \overline{ESG_{disclosure_{i,t}}}}{\sigma ESG_{disclosure}} \right) - \left(\frac{ESGrating_{i,t} - \overline{ESGrating_{i,t}}}{\sigma ESG_{rating}} \right)$$

3.2.3. Moderating variables: financing constraints (KZ) and media supervision (Me)

Following prior research, Media supervision was measured by the natural logarithm of the number of newspaper reports, serving as a proxy for the intensity of media monitoring. Financing constraints were proxied by the KZ index, consistent with prior studies.

3.2.4. Control variables

Following prior research, Several control variables were included to account for factors potentially affecting corporate greenwashing: firm size (Size), firm age (Age), leverage (Lev), profitability (Roa), board size (Board), proportion of independent directors (Indep), ownership concentration (Most), ownership type (Ownership), pollution level (PL), financing constraints (KZ), and media supervision (Me). Year fixed effects (Yr) and industry fixed effects (Ind) were also included to control for temporal and sectoral heterogeneity.

Table 1. Variable definitions

Variable Type	Variable Name	Variable Symbol	Definition
Dependent Variable	Corporate Greenwashing	GWL	The gap between disclosed environmental behavior and actual environmental performance
Independent Variable	Digital Transformation	DCG	Logarithm of keyword frequency in annual reports related to digital transformation
Moderating Variable	Financing Constraints	KZ	KZ index
	Media Supervision	Me	Natural logarithm of the number of newspaper reports
Control Variables	Firm Size	Size	Natural logarithm of total assets at year-end
	Firm Age	Age	Natural logarithm of years since listing
	Leverage	Lev	Total liabilities / total assets at year-end
	Profitability	Roa	Net profit / total assets at year-end
	Board Size	Board	Number of board members
	Proportion of Independent Directors	Indep	Number of independent directors / total board size
	Ownership Concentration	Most	Shareholding ratio of the largest shareholder
	Ownership Type	Ownership	Type of corporate ownership
	Pollution Level	PL	Classification of firm pollution level according to “Notice on the Classification of Environmental Inspection for Listed Companies”
	Year	Yr	Year dummy variable
	Industry	Indus	Industry dummy variable

4. Empirical analysis

4.1. Descriptive statistics

Before conducting the formal regression analysis, descriptive statistics were performed for all variables, and the results are presented in Table 2. For the dependent variable, the maximum value of corporate greenwashing behavior is 3.09, indicating the existence of firms with severe greenwashing practices. The minimum value is -2.43 , suggesting that some firms, concerned that an excessively strong green reputation may impose additional pressure, have reduced their environmental disclosure. This implies that there is substantial variation in the extent of greenwashing behavior among firms in the sample. For the independent variable, the maximum value of corporate digital transformation is 0.12, while the minimum is 0. This shows that some enterprises have successfully undergone digital transformation, whereas others have yet to initiate such efforts.

Table 2. Descriptive statistics of variables

Variable	Obs	Mean	Std.Dev	Min	Max	Median
GWL	5774	0.02	1.10	-2.43	3.09	0
DCG	5774	0.01	0.02	0	0.12	0
Size	5774	21.62	1.78	18.08	25.97	21.66
Lev	5774	0.42	0.21	0.05	0.90	0.40
Board	5774	1.60	0.93	0	2.89	2.08
Roa	5774	0.05	0.08	-0.25	0.29	0.04
Indep	5774	0.04	0.11	0	0.57	0
Most	5774	0.25	0.19	0	0.72	0.24
Ownership	5774	0.63	0.48	0	2	1
PL	5774	0.19	0.39	0	1	0
Age	5774	11.26	11.17	0	32	3
FC	5774	0.30	0.33	0	0.98	0.15
Me	5774	0.33	0.38	-1	1	0.27

4.2. Baseline regression

As presented in Table 3, the coefficient of corporate digital transformation is -1.317 and significant at the 1% level, suggesting that digital transformation strongly suppresses greenwashing behavior. In line with Hypothesis 1, digitalization reduces greenwashing through both internal and external mechanisms. Thus, a higher level of digital transformation corresponds to a lower degree of greenwashing, offering empirical confirmation for Hypothesis 1.

Table 3. Baseline regression and robustness tests

	(1)	(2)
	GWL	GWL
DCG	-1.317*** (0.471)	-3.656*** (0.920)
Size	0.129*** (0.00738)	0.0895*** (0.0104)
Lev	-0.343*** (0.0447)	-0.226*** (0.0614)

Table 3. (continued)

Roa	-0.698*** (0.104)	-0.471*** (0.144)
Indep	-0.355*** (0.0793)	0.222 (0.300)
Most	-0.431*** (0.0575)	-0.221** (0.0897)
Board	0.348*** (0.0161)	0.434*** (0.0252)
Age	0.0440*** (0.00121)	0.0381*** (0.00192)
PL	0.0289 (0.0197)	0.00641 (0.0335)
Ownership	0.0307** (0.0153)	-0.0196 (0.0210)
year	Yes	Yes
ind	Yes	Yes
_cons	-3.276*** (0.169)	-2.563*** (0.231)
Observations	5774	3489
R ²	0.806	0.819
adj. R ²	0.799	0.809

*p<0.1, **p<0.05, ***p<0.01

4.3. Robustness checks

To ensure the robustness of the estimation results, this study re-estimated the model using subsample regressions, with results presented in Table 3. Considering the potential impact of the COVID-19 pandemic and policy changes after 2020, the subsample excluded observations from 2020–2023, and the regression was re-run. The results indicate that the conclusions from the baseline regression remain robust after this adjustment.

4.4. Moderating effect test

Table 4 shows that the interaction between financing constraints and digital transformation carries a statistically significant negative coefficient. Hypothesis 2 contends that stronger financing constraints weaken the restraining impact of digital transformation on greenwashing. Because the KZ index is used to proxy financing constraints with higher KZ values indicating tighter constraints, the negative interaction coefficient is consistent with and supports Hypothesis 2.

Likewise, the interaction between media supervision and digital transformation is significantly positive. Hypothesis 3 predicts that more intensive media oversight enhances the suppressing effect of digital transformation on greenwashing. Media supervision is measured as the natural log of the number of firm-related newspaper articles, so larger values reflect stronger external scrutiny; the positive coefficient therefore provides empirical support for Hypothesis 3.

Table 4. Moderating effect tests

	(1)	(2)
	GWL	GWL
DCG	-2.784*** (0.666)	-0.757 (0.535)
Me	-0.0809*** (0.0237)	0.0112** (0.00497)
KZ	0.0319** (0.0153)	0.0315** (0.0153)
Ownership	0.0309 (0.0197)	0.0292 (0.0197)
PL	0.131*** (0.00742)	0.133*** (0.00752)
Size	0.0440*** (0.00121)	0.0436*** (0.00125)
Age	-0.345*** (0.0447)	-0.371*** (0.0496)
Lev	-0.687*** (0.104)	-0.657*** (0.109)
Roa	0.353*** (0.0161)	0.344*** (0.0162)
Board	-0.355*** (0.0793)	-0.351*** (0.0796)
Indep	-0.434*** (0.0574)	-0.429*** (0.0575)
Most	-2.784*** (0.666)	-0.757 (0.535)
year	Yes	Yes
ind	Yes	Yes
Me_DCG	4.081*** (1.313)	
KZ_DCG		-0.583** (0.247)
_cons	-3.301*** (0.170)	-3.319*** (0.170)
Observations	5774	5774
R ²	0.806	0.806
adj. R ²	0.800	0.799

*p<0.1, **p<0.05, ***p<0.01

4.5. Heterogeneity analysis

4.5.1. Heterogeneity analysis: pollution intensity

Firms differ in their pollution profiles, which may influence their propensity to engage in greenwashing. In accordance with the Catalogue for Classified Administration of Environmental

Verification of Listed Companies by Industry, this study classifies firms into heavily polluting and non-heavily polluting categories, assigning a value of 1 to the former and 0 to the latter.

Regression results in columns (1) and (2) of Table 5 indicate that the effect of digital transformation is statistically significant only for non-heavily polluting firms. A plausible explanation is that heavily polluting enterprises already operate under intense scrutiny from media, institutional investors, and regulatory authorities. Under such environmental and institutional constraints, heavily polluting firms have limited latitude to engage in greenwashing and are already close to “genuinely green” practices. Consequently, the incremental inhibitory effect of digital transformation is minimal for these firms.

4.5.2. Heterogeneity analysis: ownership structure

Ownership structure can also influence the link between digital transformation and greenwashing. Firms are classified as state-owned (SOE = 1) or non-state-owned (non-SOE = 0).

Regression results in columns (3) and (4) of Table 5 reveal that significance is observed only for non-SOEs. One possible reason is that SOEs generally benefit from preferential access to resources and operate under relatively stringent supervision mechanisms, reducing both the incentives and marginal benefits of adopting digital transformation for the purpose of mitigating greenwashing. In contrast, non-SOEs face more market-driven constraints and thus exhibit greater responsiveness to the governance effects of digital transformation.

Table 5. Heterogeneity tests

	(1)	(2)	(3)	(4)
	GWL	GWL	GWL	GWL
DCG	1.027 (0.747)	-1.848*** (0.584)	-0.283 (0.582)	-1.609** (0.707)
Controls	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
ind	Yes	Yes	Yes	Yes
_cons	-3.965*** (0.391)	-3.160*** (0.192)	-3.581*** (0.240)	-3.243*** (0.225)
Observations	1083	4691	3652	2118
R ²	0.827	0.811	0.814	0.855
adj. R ²	0.806	0.803	0.806	0.845

*p<0.1, **p<0.05, ***p<0.01

5. Conclusion and policy implications

Mitigating corporate greenwashing is essential to building an ecological civilization and plays a crucial role in achieving green, sustainable development. Firms are indispensable actors in advancing China’s ecological civilization, meeting the dual-carbon targets, and pushing forward a broad-based green transformation of economic and social activity. In the era of digitalization, identifying ways to restrain corporate greenwashing to support sustainable development has become an urgent research priority.

Using panel data on A-share listed companies in China from 2014 to 2023, this paper investigates whether digital transformation can restrain corporate greenwashing and examines the mechanisms at

work. The empirical results are: (1) Digital transformation significantly reduces greenwashing, and this finding remains robust across numerous checks, including subsample regressions. (2) Moderation tests reveal that tighter financing constraints weaken the restraining effect of digital transformation, while stronger media oversight strengthens it. (3) Firms under greater financing pressure and facing fiercer market competition are more likely to engage in greenwashing, yet the mitigating influence of digital transformation is stronger in those circumstances. (4) Compared with state-owned enterprises and heavily polluting firms, the dampening effect of digital transformation on greenwashing is more pronounced among non-SOEs and firms not classified as heavily polluting.

These findings carry important policy implications: accelerating corporate digital transformation is imperative. Beyond its numerous economic benefits, this study demonstrates that digital transformation also generates non-economic effects by curbing corporate greenwashing. Given that digital transformation entails substantial upfront investments, particularly for non-SOEs with relatively limited access to resources, strong policy support is necessary. Such support should include facilitating the upgrading of digital equipment, providing training in digital technologies, and cultivating digital talent, thereby ensuring that no enterprise is left behind in the wave of digital transformation.

References

- [1] Maganioti, A.E., Chrissanthi, H.D., Charalabos, P.C., Andreas, R.D., George, P.N. and Christos, C.N. (2010) Cointegration of Event-Related Potential (ERP) Signals in Experiments with Different Electromagnetic Field (EMF) Conditions. *Health*, 2, 400-406.
- [2] Xiao Jing, Zeng Ping, Ren Ge, 2023a. Digital Transformation, Absorptive Capacity and Dual Performance of Manufacturing Enterprises: The Moderating Role of Regional Digital Level [J]. *R&D Management* (2): 129-143.
- [3] Tao Feng, Wang Xinran, Xu Yang, et al. Digital Transformation, Industrial Chain and Supply Chain Resilience and Enterprise Productivity [J]. *China Industrial Economics*, 2023, (05): 118-136.
- [4] Zhao Chenyu, Wang Wenchun, Li Xuesong. How Does Digital Transformation Affect Total Factor Productivity of Enterprises [J]. *Finance & Trade Economics*, 2021, 42(07): 114-129.
- [5] Hu Jie, Han Yiming, Zhong Yong. How Does Enterprise Digital Transformation Affect Enterprise ESG Performance—Evidence from Chinese Listed Companies [J]. *Review of Industrial Economics*, 2023, (01): 105-123.
- [6] Wang Jianxin, Cao Zhiming. Can Digital Transformation Curb Corporate "Greenwashing" Behavior [J]. *Journal of Hunan University (Social Sciences)*, 2024, 38(02): 58-67.
- [7] Testa F, Miroshnychenko I, Barontini R, et al. Does it pay to be a greenwasher or a brownwasher? [J]. *Business Strategy and the Environment*, 2018, 27(7): 1104-1116.
- [8] Delmas A M, Burbano C V. The Drivers of Greenwashing [J]. *California Management Review*, 2011, 54(1): 64-87.
- [9] Huang Rongbing, Zhao Qian. Research on Corporate Greenwashing from an Evolutionary Perspective: A Case Study Based on China's Greenwashing List [J]. *Accounting Research*, 2018, (04): 11-19.
- [10] Wang Yunchen, Yang Ruoyi, He Kang, et al., 2023. Can Digital Transformation Improve Corporate ESG Performance?—A Study Based on Legitimacy Theory and Information Asymmetry Theory [J]. *Securities Market Herald* (7): 14-25.
- [11] Qi Huaijin, Cao Xiuqin, Liu Yanxia. The Impact of Digital Economy on Corporate Governance: Based on the Perspective of Information Asymmetry and Managerial Irrational Behavior [J]. *Reform*, 2020(4): 50-64.
- [12] Wu Fei, Hu Huizhi, Lin Huiyan, et al., 2021. Corporate Digital Transformation and Capital Market Performance: Empirical Evidence from Stock Liquidity [J]. *Management World* (7): 130-144, 10.
- [13] Charitou A, Clubb C, Andreou A. The Effect of Earnings Permanence, Growth, and Firm Size on the Usefulness of Cash Flows and Earnings in Explaining Security Returns: Empirical Evidence for the UK [J]. *Journal of Business Finance & Accounting*, 2001, 28(5-6): 563-594.
- [14] Chen Kai, Yang Yaping. Why Does Enterprise Digital Transformation Increase Tax Difficulty—Evidence from Tax Avoidance Activities of Chinese Listed Companies [J]. *Journal of Shanxi University of Finance and Economics*, 2023(12): 111-122.

- [15] Dong yang Z. Green financial system regulation shock and greenwashing behaviors: Evidence from Chinese firms [J]. Energy Economics, 2022, 111
- [16] Yao Haidong, Li Wei. Does Digital Transformation Curb Corporate Greenwashing Behavior? [J]. Journal of Huaqiao University (Philosophy & Social Sciences Edition), 2024, (06): 52-69.