How Digital Transformation Shapes Corporate Greenwashing: The Mediating Effect of Executives' Sustainability Cognition

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Abstract. The paper will examine the association between digital transformation and corporate greenwashing based on the sample of Chinese A-share-listed companies between 2014 and 2024. It is an empirical study incorporating the mediating variable as the green awareness of executives to investigate the effect of digital transformation on corporate greenwashing and the process behind it. The outcomes indicate that digital transformation can greatly prevent corporate greenwashing, with part of it being sustained by increasing the green consciousness of the executives. The analysis of heterogeneity also shows that the inhibitory action of digital transformation on the greenwashing, as well as the mediating effect of the green consciousness of executives, is stronger in the state-owned enterprises and the firms that undergo significant media attention. All in all, this paper explains how digital transformation can alleviate corporate greenwashing and provides theoretical background and practical advice that should be adopted by the companies looking to implement green development and enhance the environmental consciousness of the management.

Keywords: Digital Transformation, Corporate Greenwashing, Executive Green Awareness, Mediating Effect, Corporate Governance.

1. Introduction

With the increasing rate of global industrialization, awareness of environmental governance has been raised among global issues. To this, China has been seriously working towards development principles of green development by incorporating the duo carbon targets in its ecological civilization planning thus positively endorsing the shifting of businesses to green and environment-friendly enterprise activities. In this respect, digital transformation becomes one of the essential directions, which can help businesses to enhance the efficiency of their operations and the quality of development through the utilization of different technologies including big data, artificial intelligence, and blockchain. However, some businesses have turned to greenwashing whereby they make false or misleading environmental statements in exaggerating their environmental performance. This not only deceives the investor and consumer but also creates a distortion to the market order and harsher development of the green finance.

There is some general agreement within the existing literature that the digital transformation can reduce greenwashing. Essentially, mechanism tests have centered on these traditional perspectives of governance that include internal controls, financing constraint, and media oversight, and demonstrated systematically that digital transformation can restrain the corporate greenwashing through enhancing the quality of internal controls, reducing information asymmetry, establishing financing constraint, and enhancing the external supervision [1][2]. Simultaneously, other researches, based on neo-institutionalism, also develop a more specific role of regulatory pressure, as well as imitative pressure in the process of reducing greenwashing together [3].

Whereas the past researches have also investigated the interplay linking digital transformation and corporate greenwashing, with several studies finding that digital transformation could substantially increase the green awareness among executives and that the green awareness of the latter could be instrumental in deterring the greenwash practice [4][5], the majority of the past researchers have evaluated these three factors simultaneously without accounting the green awareness of the former as an intervening factor in a complete physiology of transmission. In this paper, green awareness will

be viewed as a fundamental mediator by showing how digital transformation does not only limit greenwashing on a technical level but also diminishes the incentive behind greenwashing by transforming the perception of the executives and modifying the strategy level. The finding provides a pathway of internal transmission through which digital transformation affects greenwashing, which is a weakness of the literature at the moment as it does not emphasize the role of decision-makers.

2. Theoretical Analysis

2.1. The Impact of Digital Transformation on Corporate Greenwashing

According to the theory of fraud risk factors, digital transformation can diminish corporate greenwashing in three ways, namely, faltering incentives, diluting opportunities, and augmenting exposure [6]. To begin with, the digital transformation streamlines the management decision-making and therefore restrains the management to promote greenwashing [7]. Second, onboards of directors and supervisory boards are empowered to effectively oversee the fulfillment of the corporate strategies with digital transformation, making all avenues in the corporate management process data-driven, which builds more checks on the management. Lastly, the digital transformation brings standardization and standardization of processes: disclosing information about the environment and making investment decisions; this leads to the enhancement of the structure of obligations and liabilities. Moreover, the essence of the greenwashing is the information division between the companies and external stakeholders that the companies use to only release and over state the environmental performance. Digital transformation allows real time incorporation of environmental data hence more standardized and objective disclosures are generated and the chances of edition or even hiding information are greatly minimized. Digital medium creates direct channels of communication between a company and the external stakeholders, establishing a kind of public control and lessening information asymmetry and therefore limits the extent of greenwashing. Consequently, the following hypothesis is put forward in this study:

H1: Digital transformation can significantly curb corporate greenwashing

2.2. The Mediating Role of Executives' Green Awareness

The digital transformation is a suitable approach that can increase the knowledge of sustainability acquired by the executives. Due to digital technologies, the flow of information is destroyed, and the executives will be more aware of the environmental policies and the green practices that an industry implements, therefore, establishing a holistic view of sustainable development. Introduction of internal environmental performance assessment systems can also help in persuading the executives to incorporate sustainable development in their long term strategies. More so, the pressure exerted by the external factors boom of the green consumption, tighter digital control and heightened scrutiny of the market are forcing executives to drop their greenwashing strategies and focus on real investments in the environment.

According to the hierarchical theory, corporate strategic decisions are based on the perceptions of the executives and the green awareness of executives directly mitigates corporate greenwashing practices [8]. On the one hand, high green-aware executives seem more concerned with green responsibility, and focus more on substantive environmental investments, as opposed to short-term greenwashing, thus removing the subjective motive behind greenwashing at the base. Conversely, highly green executives will promote the creation of a green culture in the organization by the top to bottom, enhance internal controls and performance reviews, and actively welcome audit attention, which will make the organization switch adherence to passively green change and roll further to diminish the possibility of greenwashing. Therefore, the following hypotheses are formulated:

H2: Executives' green awareness serves as an intermediary in the link between digital transformation and greenwashing.

3. Model Specification

3.1. Data Sources and Processing

The sample consists of A-share listed firms on the Shanghai and Shenzhen stock exchanges over the period 2014–2024. Sample selection proceeds according to the following criteria: (1) exclusion of firms with abnormal financial conditions or those subject to delisting risk warnings (i.e., ST, *ST, and PT); (2) companies operating in the financial, insurance, and real estate industries are removed; (3) observations with a listing duration shorter than one year are dropped; (4) deletion of observations characterized by severe missing values or outliers in core variables; and (5) all continuous variables are winsorized at the 1st and 99th percentiles to mitigate the impact of outliers on regression estimates.Data on greenwashing are drawn from Bloomberg and Huazheng, whereas other variables are sourced from the CSMAR and CNRDS databases.

3.2. Variable Definitions

3.2.1. Corporate Greenwashing.

Following the approach of relevant scholars, this study defines greenwashing (GW) as the difference between a firm's ESG disclosure score and its ESG performance score, calculated as follows:

$$GW_{i,t} = \left(\frac{ER_{i,t} - ER_{dis}}{\sigma_{dis}}\right) - \left(\frac{ER_{i,t} - ER_{per}}{\sigma_{per}}\right) \quad (1)$$

ER_{dia} and ER_{per} indicate the average values of environmental disclosure and environmental performance scores, with σ_{dis} and σ_{per} denoting their corresponding standard deviations. When $GW_{i,t}$ exceeds zero, the firm's disclosed ESG level surpasses its actual performance. In contrast, a negative value of $GW_{i,t}$ implies that actual performance outpaces disclosed levels, suggesting a possible underestimation of environmental conduct [9].

3.2.2. Corporate Digital Transformation.

Based on existing methods from previous studies, this paper creates a digital transformation indicator through counting how often 99 digital-related words appear in four areas: digital tech use, internet businesses, smart making, and modern info systems. Aggregate count is adjusted by adding one, then natural logarithm is taken to create the explanatory variable, called DT in the model [10].

3.2.3. Executives' Green Awareness.

Drawing upon measurement approaches previously employed with respect to executives' environmental awareness, this study performs a textual examination of annual reports by publicly traded corporations. Keywords are identified across three dimensions: recognition of green competitive advantages, commitment to corporate social responsibility, and sensitivity to external environmental pressures. The resulting measure for executives' environmental awareness – which is treated as equivalent to green awareness according to existing studies – comes from how often those words appear in the yearly report, showing how much green things affect company choices. Specifically speaking, it would be raw frequency plus one, then take its natural log so that we can get our final variable [11].

3.2.4. Control Variables.

Guided by prior studies, this study introduces a range of control variables, with their definitions detailed in Table 1.

Table 1. Table of Variable Definitions.

Type	Name	Symbol	Definition and Description
Dependent Variable	Greenwashing	GW	Difference between the industry-standardized ESG disclosure score and the ESG performance score
Explanatory Variables	Digital transformation	DT	Logarithm of the frequency of digital technology-related keywords in corporate annual reports
Intermediary variable	Senior management's green awareness	EGP	Logarithm of the total keyword frequency for executive green awareness in corporate annual reports
Control variables	Firm Size	Size	Natural logarithm of total assets at year-end
	Debt-to-Equity Ratio	Lev	Total Liabilities / Total Assets at Year-End
	Profitability	ROA	Net Income / Total Assets at Year-End
	Growth	Growth	Revenue Growth Rate
	Cash Flow Ratios	Flow	Net Cash Flow from Operating Activities / Current Liabilities at End of Period
	Board Size	Broad	Logarithm of the total number of board members
	Shareholding Concentration	Top 1	Shareholding percentage of the largest shareholder
	Management ownership ratio	Share	Number of shares held by management / Total number of shares
	Dual Role	Dual	Set to 1 if the company's chairman also serves as general manager; otherwise, set to 0

3.3. Model Specification

Building on the theoretical analysis outlined above, this study employs baseline model (1) to assess the impact of digital transformation on corporate greenwashing. The model incorporates Ind and year as industry and year fixed effects, respectively, with controls representing the control variables and ε denoting the error term.

$$GW_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \beta_2 controls + ind + year + \varepsilon \quad (2)$$

To test the mediating role of executives' green awareness, this study specifies mediation models (2) and (3).

$$EGP_{i,t} = \alpha_0 + \alpha_1 DT_{i,t} + \alpha_2 controls + ind + year + \varepsilon \quad (3)$$

$$GW_{i,t} = \gamma_0 + \gamma_1 DT_{i,t} + \gamma_2 EGP_{i,t} + \gamma_3 controls + ind + year + \varepsilon \quad (4)$$

4. Empirical Results and Analysis

4.1. Descriptive Statistics

In table2 it gives some summaries for the main variables. Mean GW is -0.0100, median GW is -0. 0300 and sd GW is 1. 140; range GW: -2. 600–3.090. So we can say even though most of them have been greenwashed but there's still a lot variation across different firms. While DT has an average value at 3.200 and median value at 3. 220.

Table 2. Descriptive Statistics

Variable	N	Mean	SD	Min	p50	Max
DT	40,777	3,200	1,270	0	3.220	5.970
GW	8,351	-0.0100	1.140	-2.600	-0.0300	3.090
Size	40,777	22.23	1.310	19.78	22.04	26.34
EGP	39,047	1.080	0.890	0	1.100	3.140
Lev	40777	0.410	0.210	0.0600	0.400	0.940
ROA	40,777	0.0300	0.0700	-0.320	0.0400	0.200
Growth	38,404	0.150	0.620	-0.880	0.0700	4.230
Flow	40,777	0.240	0.400	-0.630	0.150	2
Broad	40,774	2.100	0.200	1.610	2.200	2.560
Top 1	40,777	0.190	0.190	0	0.180	0.670
Share	40,777	0.0900	0.150	0	0	0.610
Dual	40777	0.970	0.160	0	1	1

4.2. Regression Analysis

Estimation result about how digital transformation influence greenwashing is shown in column (1) of Table 3. It has a coefficient -0.0752 which shows it's significant at 1% level and thus there will be strong negative effect from digital change on corporate greenwashing. The above results show together that digital transformation cuts down greenwashing, giving some initial backing for Hypothesis H1.

Table 3. Baseline Regression

	(1)	(2)	(3)	(4)
	GW	GW	EGP	GW
DT	-0.0752***		0.0257***	-0.0671***
	(0.0167)		(0.00501)	(0.0169)
DT2		-0.0206*		
		(0.0114)		
EGP				-0.134***
				(0.0187)
Size	0.143***	0.133***	0.0972***	0.155***
	(0.0149)	(0.0148)	(0.00477)	(0.0152)
Lev	-0.393***	-0.398***	0.129***	-0.380***
	(0.108)	(0.108)	(0.0315)	(0.111)
ROA	0.451	0.384	0.314***	0.498*
	(0.275)	(0.275)	(0.0786)	(0.293)
Growth	0.0898***	0.0880***	-0.0188**	0.0772***
	(0.0292)	(0.0292)	(0.00744)	(0.0299)
Flow	-0.0301	-0.0152	-0.0480***	-0.0293
	(0.0512)	(0.0511)	(0.0138)	(0.0518)
Broad	0.000673	-0.00113	0.0842***	0.0162
	(0.0768)	(0.0769)	(0.0250)	(0.0772)
Top 1	0.0976	0.0950	-0.188***	0.0740
	(0.0713)	(0.0714)	(0.0246)	(0.0716)
Share	0.848***	0.829***	-0.366***	0.793***
	(0.156)	(0.156)	(0.0338)	(0.156)
Dual	-0.220***	-0.224***	-0.0427	-0.235***
	(0.0713)	(0.0714)	(0.0278)	(0.0721)
year / ind	Yes	Yes	Yes	Yes
_cons	-2.699***	-2.606***	-2.026***	-2.944***
	(0.384)	(0.385)	(0.126)	(0.388)
N	6822	6822	27,264	6698
R^2	0.026	0.023	0.328	0.034
adj. R^2	0.013	0.011	0.326	0.021

4.3. Robustness Tests

Robustness testing: Replace DT with another indicator, DT2; re-estimate model. Based on previous methods, we build DT2 by taking out digital technology words such as AI, big data, cloud computing, and blockchain from the annual report and count how often they appear. And then those frequencies are normalized and added up to make an enterprise's digital transformation index [12]. The corresponding regression results can be found in column (2) of Table 3. Coefficient of DT2 is -0.0206 which reaches statistical significance at 10%, having same sign as DT in original model. Therefore, it shows that the negative effect of digital transformation on greenwashing is also robust under different ways of measuring.

4.4. Testing for Mediating Effects

Table 3, Columns (3) and (4) display the outcomes of the mediation analysis involving executives' green perception (EGP). In Column (3), where EGP serves as the outcome variable, digital transformation exhibits a coefficient of 0.0257, significant at the 1% level, pointing to a favorable effect on executives' green perception. In Column (4), with greenwashing (GW) as the dependent variable and both digital transformation and executives' green awareness included, the coefficient for digital transformation is -0.0671 (significant at 1%), showing a modest decrease from the baseline estimate, while the coefficient for executives' green awareness is -0.134 (also significant at 1%). Collectively, these findings indicate that executives' green awareness serves as a partial mediator in the digital transformation–greenwashing nexus, implying that digital transformation indirectly mitigates greenwashing by enhancing executives' green awareness. Hypothesis H2 is thereby validated.

4.5. Heterogeneity Analysis

4.5.1. Nature of Ownership.

To explore heterogeneity in how digital transformation affects greenwashing, the sample is partitioned according to ownership structure, with regression outcomes reported in Table 5. Column (1) displays results for state-owned enterprises (SOEs), revealing a coefficient of -0.111 for digital transformation, significant at the 1% level. Column (2) shows estimates for non-state-owned enterprises (non-SOEs), where the coefficient is -0.0514, significant at the 5% level. These results reveal that digital transformation significantly curbs greenwashing in both subsamples, though the magnitude is substantially larger among SOEs. This difference may stem from the stricter regulatory oversight faced by SOEs, where digitalization tends to amplify information transparency more markedly.

4.5.2. Media Attention.

The level of media attention is quantified by taking the natural logarithm of one plus the frequency of online media mentions for each firm, after which firms are categorized into low- and high-attention groups based on the median value. The corresponding results are presented in Columns (3) and (4) of Table 4. For the low-attention group, the coefficient for digital transformation is -0.0402 and is not statistically significant. In contrast, for the high-attention group, the coefficient is -0.0904, significant at the 1% level. These findings indicate that the constraining effect of digital transformation on greenwashing is concentrated among firms with high media attention, whereas no such effect is observed for firms with low media attention. This heterogeneity can be justified by the fact that firms under strong media attention are more subject to external public control, and thus the digital transformation, by its effectiveness in increasing transparency of information, has the ability to supplement media monitoring and hence more effectively bring greenwashing activity to bear.

Table 4. Heterogeneity Analysis

	GW			
	(1)	(2)	(3)	(4)
DT	-0.111***	-0.0514**	-0.0402	-0.0904***
	(0.0249)	(0.0235)	(0.0297)	(0.0212)
controls /Year/ ind	Yes	Yes	Yes	Yes
_cons	-3.715***	-1.822***	-2.297***	-2.453***
	(0.546)	(0.577)	(0.779)	(0.531)
N	3555	3267	2002	4820
R^2	0.050	0.043	0.062	0.029
Adj. R^2	0.029	0.020	0.021	0.011

5. Conclusion

Using data from A-share listed firms on the Shanghai and Shenzhen stock exchanges spanning 2014–2024, this study empirically investigates the relationships among digital transformation, executives' green awareness, and corporate greenwashing. The empirical results yield the following conclusions: (1) Digital transformation serves as a significant deterrent to corporate greenwashing, with higher levels of digitalization associated with fewer instances of such behavior; (2) The inhibitory effect of digital transformation on greenwashing is stronger in state-owned enterprises and firms subject to high media attention. Building on these results, this study proposes actionable implications for government regulatory authorities and corporate entities.

First off, the regulatory scene has got to get a boost from our government and the controls have to be made stronger. They need to raise differentiated regulation according to differences between enterprises, strengthen digital control for state-owned enterprises and those companies which attract lots of media attention, provide more media guidance and financial support for other enterprises so that it will help improve governance.

Second, firms should deepen their own transformation towards digitization; they must prioritize cultivating green consciousness amongst senior executives. Through recruitment of people and provision of green training, they could foster proactive decision making and use management as an intermediary in digital administration and stopping fake greenness.

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