

Research on the Impact of Enterprise Digital Transformation on Enterprise Greenwashing Behavior

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Abstract. Considering how deeply integrated is our dual-carbon objective with a digital economy now, what kind of corporate greenwashing would there be during that whole transition period into something called green development and maybe digital changes could give us some sorta tech route towards resolving this dilemma. A-Share companies from 2014 till 2023 as sample to explore what will happen after Digital Transformation of Corporate in Greenwashing through ESG information Disclosure along with ESG rating's mediating effect. It analyses the heterogeneous nature from three points: Region and industry technological characteristics, Pollution of industry. And also we have the following result here which indicates to me it's quite clear right away, if an organization does digital transformation they might actually reduce chances for it to just not look like there even existed this practice at all; furthermore those ratings given out concerning environmental standards can go from low up till really good when comparing everything about making money while trying one last chance instead than going over each others heads regarding doing more environmentally friendly things around here – because then nobody feels compelled anymore! From heterogeneity point-of-view view its inhibition of Digital change towards Green-washing shows strong signs within Companies found mainly inside areas where East exists alongside Tech Industry plus Pollutants Industries. And I passed robustness checks on my study. In this investigation is about showing digital transformations' environmental governance values for empirical support as well as references to both corporations for improving their disclosure practices and regulatory powers overseeing such actions called greenwashing and so forth helping our nation's growth towards becoming greener.

Keywords: Enterprise digital transformation, greenwashing, ESG rating, corporate governance

1. Introduction

In recent years, climate change, green transformation, and sustainable development have always been hot topics in political, business, and academic circles. The popularity of related expressions has also given rise to compound concepts such as "greenwashing" and "bluwashing." These concepts all originate from the English word "whitewashing," and are essentially false packaging by enterprises and institutions on social responsibility issues. Among them, "greenwashing" is the most

representative, referring to enterprises or financial institutions exaggerating their investment and achievements in the field of environmental protection, making exaggerated commitments and disclosures on environmental protection and resource utilization in ESG reports and sustainable development reports, and using a superficial green image to cover up actual environmental problems. The essence of these "greenwashing" behaviors is to use rhetoric to replace substantive corporate actions. This kind of false behavior that does not fulfill social responsibility undermines the market's trust in enterprises.

The Fourth Plenary Session of the 20th CPC Central Committee placed comprehensive green transformation in a strategic position, taking the "dual carbon" goal as the guide, and coordinating the promotion of "carbon reduction, pollution reduction, green expansion, and growth." Green development is not only an inherent requirement for high-quality development, but also an important direction for enterprises to participate in market competition. As the green capital market matures, ESG information disclosure has become a crucial window for companies to access green resources and demonstrate their environmental responsibility. However, the standards and regulatory system are still under development, creating opportunities for some companies to exploit loopholes. In 2023, the Supreme People's Court issued policies to strengthen corporate environmental responsibility, requiring stricter supervision of publicly disclosed environmental information, directly targeting false practices in ESG information disclosure. Yet, in reality, "greenwashing" persists, disrupting the efficient allocation of green resources and undermining investors' and the public's confidence in companies' sustainable development commitments. Traditional regulatory methods often fall short in addressing these subtle "word games," making the search for more effective governance pathways a pressing need.

The digital economy is also deeply integrated into all sectors of my country's economy and society. Enterprise digital transformation is reconstructing the entire process of production, operation and governance by leveraging big data [1], artificial intelligence, supply chain and other technologies [2]. From internal data collection and internal control process optimization to external information disclosure and regulatory traceability, digitalization is bringing new governance possibilities. So, can this technological revolution constrain enterprises' "greenwashing" behavior? If so, through which paths does it play a role? These questions are related to the environmental governance value of digital transformation [3] and also affect the actual effectiveness of my country's green transformation.

This article explores the impact of corporate digital transformation on "greenwashing" behavior from the perspective of ESG report and sustainable development report disclosure, dissects the path of action, and sorts out the manifestations, internal and external motivations and governance strategies of "greenwashing". It can provide practical reference for enterprises to embed ESG governance in digital layout and improve the quality of information disclosure, and also provide decision-making ideas for regulatory authorities to use digital technology to accurately identify and curb "greenwashing" behavior, and help my country's comprehensive green transformation to go deeper and more solid.

2. Theoretical analysis and research hypotheses

2.1. Enterprise digital transformation and enterprise "greenwashing" behavior

Enterprise digital transformation can improve the business environment while improving operational efficiency and significantly reduce information asymmetry between enterprises and various sectors of the economy and society. First, enterprise digital transformation optimizes the innovation

capabilities of enterprises and improves the level of green development of enterprises by using technologies such as big data, blockchain, and the Internet of Things, thereby reducing the occurrence of "greenwashing" behavior from the source. The higher the degree of green development of enterprises, the weaker their motivation to carry out "greenwashing" behavior [4]. Second, through real-time collection, automatic recording and tamper-proof storage of core environmental indicators, enterprise digital transformation makes ESG information disclosure shift from "greenwashing" ex-post packaging to a digital full-process traceability model. This transformation not only compresses the operational space for enterprises to conceal environmental problems, but also allows investors, regulatory agencies and the public to more accurately grasp the true environmental performance of enterprises, thereby significantly reducing the degree of information asymmetry between enterprises and external stakeholders. In addition, digital transformation can also strengthen the effectiveness of external supervision and market supervision, forming a constraint on enterprises' "greenwashing" behavior from the external level [5]. Digital technology can help build a cross-departmental environmental information sharing platform, thereby making the internal environmental information of enterprises "transparent", making it convenient for regulatory agencies to accurately trace the ESG disclosure data of enterprises, and effectively improving the response speed and deterrent effect of regulation. At the same time, digital tools such as ESG information retrieval platforms and intelligent analysis have effectively reduced the cost for investors and the public to obtain and interpret corporate environmental information, making "greenwashing" behavior easier to identify and expose, and thus forming a market-based constraint effect through rational investor choices, forcing enterprises to fulfill their environmental responsibilities and eliminate false disclosure behavior. Based on this, we propose Hypothesis 1 in this paper.

H1: Corporate digital transformation can significantly inhibit corporate greenwashing behavior.

2.2. Mediating role of ESG rating

On the basis of inhibiting corporate "greenwashing" behavior and improving the authenticity of environmental information, digital transformation can also have a positive effect on corporate ESG rating from multiple dimensions of environment, society and corporate governance [6]. In the environmental dimension, digital monitoring technology enables dynamic control of core indicators such as corporate pollutant emissions and energy consumption. This effectively improves environmental governance efficiency and, through traceable and verifiable data records, avoids the "greenwashing" of environmental information, ensuring the authenticity and traceability of environmental data and providing reliable support for ESG environmental assessments. In terms of social responsibility, digital transformation helps optimize internal management processes, standardize decision-making and oversight mechanisms, alleviate agency-related governance issues, improve the standardization and authenticity of information disclosure, effectively reduce information bias, and thus enhance social dimension evaluation performance. In the governance dimension, digital transformation helps optimize internal management processes, standardize decision-making and oversight mechanisms, alleviate agency-related governance issues, improve the standardization and authenticity of information disclosure, and significantly reduce information barriers between companies and rating agencies and capital markets. This allows rating agencies to more comprehensively capture a company's sustainable development capabilities and reduce underestimation due to insufficient information. As a core signal carrier of corporate sustainable development performance, ESG ratings directly convey the true level of a company's environmental governance, social responsibility fulfillment, and corporate governance to capital markets,

regulatory agencies, and the public, profoundly influencing companies' information disclosure strategies and behavioral choices. A higher ESG rating indicates that a company's true performance in green operations and social responsibility has been recognized by the market and rating agencies. This gives the company a more significant competitive advantage in terms of financing costs, market reputation, and access to policy resources, eliminating the need for "greenwashing" tactics such as false disclosures and data manipulation to appease external evaluations. Conversely, if a company's ESG rating is low, it is more likely to engage in strategic disclosure behaviors such as selective disclosure and exaggerating environmental achievements to alleviate financing constraints and avoid reputational damage, thus "greenwashing" its superficial image to improve its rating. Based on this, we propose the following hypothesis.

H2: ESG rating plays a mediating role between digital transformation and corporate "greenwashing" behavior.

3. Model construction

3.1. Sample selection and data sources

The sample used includes all a-share listed companies from 2014 until 2023 except money related businesses such as insurance and financials. The way in which we got rid of this stuff: If something had the st or *st name designation on it for more than two years straight we would get rid of these; Also if any thing was missing data for over three years running also deleted too. Continuous variable shorten at 1%,99%. We ended up with 33, 013 observations, among whom there are 31,967 associated with ESG evaluation scores across different industries in terms of the list corporations. Data is obtained by CSMAR database and listed company annual report. Greenwashed dat is obtained frm bloomberdbase &hz e sratingindex. ESG rating d atasrhm frmh z eg rtingidx.

3.2. Variable measurement

Core explanatory variable: corporate digital transformation (DT). The text analysis method is used to mine keywords related to digital technology in the annual reports of listed companies through computer programming language, and the level of corporate digital transformation is measured by statistical word frequency. This indicator can effectively reflect the strategic layout and implementation degree of corporate digital transformation [7].

Explained variable: Corporate "greenwashing" behavior (GW), GW equals the difference between ESG difference and ESG performance (ESG difference minus ESG performance). If $GW > 0$, the company's disclosed ESG level is higher than its actual performance, and the larger the difference, the stronger the suspicion of greenwashing. If $GW < 0$, the company's actual performance is better than the disclosed level, and there may be "underestimation of green behavior" [8].

Mediating variable: ESG rating, selected from listed A-shares using the Huazheng ESG rating.

Control variables. Corporate green innovation is affected by many factors. With the help of authoritative literature on green innovation, the following control variables were selected: debt-to-equity ratio (LEV), return on total assets (ROA), company size, number of directors (DirNum), number of independent directors (IndDirNum), proportion of independent directors (Indep), management shareholding ratio (ManS), and company age (ListAge).

4. Empirical results

4.1. Descriptive statistics

Table 1 presents the descriptive statistical results of the variables in this paper. This paper selects enterprise data from 2014 to 2023. Due to missing data for some enterprises, the mediating variable ESG rating has 31,967 valid observations. The explained variable, greenwashing (GW), has a minimum value of 0, a maximum value of 1, a mean of 0.200, and a median of 0. This result indicates a significant divergence in the quality of corporate environmental information disclosure in the capital market. Not all enterprises engage in greenwashing; most enterprises in the sample exhibit varying degrees of greenwashing, with only a few achieving a high degree of match between environmental information disclosure and actual environmental performance. Greenwashing is a relatively common phenomenon among A-share listed companies. The core explanatory variable, corporate digital transformation (DT), has a minimum value of 0, a maximum value of 6.380, a mean of 1.700, and a median of 1.610. This indicates a significant difference in the degree of digital transformation among different enterprises. Some enterprises have completed deep digitalization, while others are still in the initial stages of transformation. The overall digitalization level of the sample is relatively evenly distributed.

Table 1. Descriptive statistics

Variable	N	Mean	SD	Min	p50	Max
GW	33013	0.200	0.400	0	0	1
DT	33013	1.700	1.440	0	1.610	6.380
ESG	31967	73.43	4.920	41.19	73.58	92.93
LEV	33013	0.410	0.200	0.0600	0.400	0.900
ROA	33013	0.0400	0.0600	-0.260	0.0400	0.200
Size	33013	22.27	1.270	20.02	22.06	26.30
DirNum	33013	8.350	1.590	5	9	14
IndDirNum	33013	3.110	0.510	2	3	5
Indep	33011	0.380	0.0500	0.330	0.360	0.570
ManS	33013	15.25	19.92	0	2.790	68.83
ListAge	33013	3.150	0.0500	3.050	3.140	3.310

4.2. Benchmark regression

By incorporating control variables related to corporate financial characteristics and corporate governance, and controlling for a two-way fixed effect between industry and year, the model's R^2 increased to 0.188, and the adjusted R^2 was 0.186, indicating that the model has good explanatory power overall. The regression coefficient of the core explanatory variable, corporate digital transformation (DT), is 0.00587, and is significantly positive at the 1% statistical level ($p < 0.01$). This indicates that as the degree of digital transformation of enterprises increases, the "greenwashing" behavior of enterprises will be significantly suppressed, and the authenticity and compliance of environmental information disclosure will be significantly improved. The hypothesis H1 proposed in this paper is valid.

4.3. Robustness testing

4.3.1. Replace core explanatory variable measures

Robustness tests by replacing the key explanatory variables measurement indices. In the basic regressions it uses the entire digital characteristic word frequency in annual statements for companies, plus one more then takes logarithms to represent levels of how much change is happening around numbers among corporations. Here we have replaced DIGI_text [9], which stands for degree-of-digital-transformation-indicator-for-enterprise with our model that gets re-estimated again and the regression coefficients show: After changing the main cause variable in its expression into Enterprise's Digital Transformation (DIGI_text) after this replacement now we got it was equalized as: Coefficient became: +0.410, with significance level =1 %, completely agreeing what happened before! To put another way the higher degree to what an enterprise has transformed itself digitally will result on inhibiting their tendency towards greenwashing behaviors as well as improving correspondence among disclosed environment info against actual environment results. Control variables are looking at asset-liability ratio(lev)= still a big number when taking the one percent significant value as for size(s)=there isn't a single significant difference here, but if I check Listage I find there's definitely no major drop below one percent either; Other controls do not yield meaningful figures, aligning perfectly with base regression. Model Sample 33, 011 Total R² 0.188 Adjusted R² 0.186 Which agrees exactly with BaseRegression The outcomes imply that fundamental discoveries obtained through research still stand true following alterations made to ways these central explanation elements get calculated while maintaining reliability via benchmarks displayed from standard analyses.

4.3.2. Add control variable

As regards making it possible to lessen endogeneity problems brought about by not covering enough variables for benchmarking regression result accuracy, add two variables concerning how firms govern themselves: top 1 holder shareholding size(Top) and dual role(Dual); then redo my test on the model. After we introduce other controls variable into model as above in results show that now with respect of those core explaining factors like company's DT it's regressive coefficient is 0.00561 which remains quite positive statistically significant level 1%. And this also aligns very closely with coefficient sizes and sig. directions from bkgd regression suggesting that the strong negative effect of E-TD on Greenwashing behavior cannot be changed just because some control variables at the firm-level have been incorporated. Main research conclusion still stands.

Table 2. Analysis results

Variables	Benchmark Regression Results	Changing Explanatory Variables	Adding Control Variables
	(1) GW	(2) GW	(3) GW
DIGI_text		0.410*** -0.0998	
DT	0.00587*** -0.00187		0.00561*** -0.00187
LEV	0.123***	0.122***	0.122***

Table 2. (continued)

	-0.0134	-0.0134	-0.0134
ROA	-0.0309	-0.0304	-0.00285
	-0.0351	-0.0351	-0.0354
Size	0.595***	0.597***	0.617***
	-0.0446	-0.0446	-0.0448
DirNum	0.00135	0.00128	-0.0000239
	-0.00921	-0.00921	-0.0092
IndDirNum	-0.0123	-0.012	-0.0105
	-0.0241	-0.0241	-0.0241
Indep	-0.0514	-0.0529	-0.0582
	-0.19	-0.19	-0.19
ManS	-0.0000463	-0.0000484	-0.0000104
	-0.000114	-0.000114	-0.000115
ListAge	-11.89***	-11.93***	-12.39***
	-1.058	-1.058	-1.06
Top1			-0.000824***
			-0.000145
Dual			-0.00950**
			-0.00456
_cons	24.21***	24.30***	25.33***
	-2.337	-2.337	-2.343
ind	Yes	Yes	Yes
year	Yes	Yes	Yes
N	33011	33011	33011
R2	0.188	0.188	0.189
adj.R2	0.186	0.186	0.187

4.4. Heterogeneity analysis

4.4.1. Grouping by the region where the enterprise is located

Further, enterprises were grouped according to eastern and non-eastern regions for further investigation [10]. Among them, the DT was significantly positive at the 1% statistical level; the sample size of enterprises in non-eastern regions was 8973, and the regression coefficient of DT was 0.00577, which did not pass the conventional statistical significance test. This result indicates that, compared with non-eastern regions, the digital transformation of enterprises in eastern regions has a more significant inhibitory effect on "greenwashing" behavior, and the governance role of digitalization has obvious regional heterogeneity.

4.4.2. Grouping by industry technical attributes

And also we will have two kind of industries with a non- high tech companies and the company that does belong under hi-tech, for our group exploration [11]. There were 20,506 non-high-tech companies in the sample; the coefficient for digitalisation was .0555 which is significant positive on 5%level. And there were 12505 high tech enterprises and coefficient for dt would be like .0678 but still it is significantly higher than 0.000 at level less 5 percent. This indicates clearly the impact of Digital transformation to prevent Greenwashing from High Tech and Non- High Technology Companies as well and also shows us more effectiveness if compared towards these technologies used for governance purpose by way of high technology sector rather then others.

4.4.3. Group according to industry pollution attributes

Additionally the corporations where classified according to whether they are highly pollution creating or not: more work needed there. The number of heavily-polluting enterprises included 7,088 samples; while DT's coefficient equaled 0.00646 with respect thereof, however this does still fail under our standards for regular significant testing ($p < 0.05$). The other is Non-heavy polluting enterprise's sample is large quantity, it reaches up two five thousand and four hundreds and fifty-two numbers so their respective regression coefficients about dt would become like point six-five-fives but also quite clearly very high positive results can only appear here as well at just one percentile. And now that we've compared these, non-heavy-polluters do have a bigger impact by transforming digitally on "greenwashing", it's an even clearer sign what digitalization brings for industry's pollution differences being evident in different ways when you look at how things get green washed out from your side too.

Table 3. Heterogeneity analysis

Variable	eastern region	Non Eastern Regions	high-tech industry	Non high-tech industries	heavily polluting enterprises	Non heavy polluting enterprises
s	(1)	(2)	(3)	(4)	(5)	(6)
	GW	GW	GW	GW	GW	GW
DT	0.00558** *	0.00577	0.00555**	0.00680**	0.00646	0.00655***
	-0.00212	-0.00397	-0.00223	-0.00336	-0.00549	-0.00193
LEV	0.146***	0.0880***	0.146***	0.0898***	0.231***	0.0990***
	-0.0156	-0.0271	-0.0164	-0.023	-0.0349	-0.0142
ROA	-0.0266	-0.0488	-0.0341	-0.0162	0.200**	-0.0941**
	-0.0402	-0.0721	-0.0414	-0.0647	-0.0981	-0.0367
Size	0.597***	0.552***	0.613***	0.527***	0.299***	0.654***
	-0.0506	-0.0989	-0.061	-0.0706	-0.107	-0.0486
DirNum	-0.000883	-0.000513	0.0237**	-0.0307**	0.0481**	-0.0174*
	-0.0121	-0.0146	-0.0116	-0.0152	-0.0214	-0.0101
IndDirNum	-0.00387	-0.0144	-0.0581*	0.0526	-0.124**	0.0335
	-0.0314	-0.0388	-0.0305	-0.0395	-0.0565	-0.0263
Indep	-0.157	0.0863	0.329	-0.595*	0.842*	-0.414**

Table 3. (continued)

	-0.249	-0.301	-0.237	-0.318	-0.445	-0.207
ManS	-0.000128	0.000214	0.000181	-0.000561***	0.000175	-0.000128
	-0.000129	-0.000251	-0.000133	-0.000217	-0.000302	-0.00012
ListAge	-12.02***	-10.73***	-12.40***	-10.13***	-4.375*	-13.43***
	-1.201	-2.333	-1.432	-1.691	-2.55	-1.15
_cons	24.63***	21.46***	25.06***	20.46***	6.677	27.93***
	-2.656	-5.143	-3.173	-3.754	-5.641	-2.539
ind	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
N	24038	8973	20506	12505	7088	25923
R2	0.186	0.214	0.175	0.201	0.192	0.163
adj.R2	0.183	0.206	0.172	0.195	0.185	0.16

5. Conclusion

Using the company from 2014–2023 (A-shares), this paper explores how corporate digitalization influences greenwashing based on the view of ESG public information. Robustness testing finds that digital transition will greatly weaken firms' greenwashing activities, whereas compared with basic aspects such as scale or debts/stock, it's mainly an engine for influencing environmental details disclosure by corp'. In between corporation digital change and company go-green intent we find that esg grades serve some of a mediator position; when companies do become digitally upgraded they get better ratings in things like environment stuff which cuts into how much or well you're allowed to act as though you are going towards some greener ground and actually making any difference at all about being eco-friendly around here. As well as finding out there's also some great different results showing up too: it was really quite clear in the bigger ones who happen over in the far eastern parts or just those big tech firms themselves or perhaps very polluted ones where everything starts becoming more evident but less so everywhere else if not done properly nor paid sufficient respect due toward these changes occurring. Non-east region and non-high-technology industry, non-heavy -polluting industries lack strong digital facilities, sufficient use technology, lack enough regulation care thus don't make full effect of governance for digitalization. This study enriches the relevant research on the governance of corporate greenwashing behavior from the perspective of digital transformation, clarifies the mechanism and applicable boundaries of both, and provides experience and reference for companies to regulate ESG information disclosure using digital technology and for regulatory authorities to accurately govern greenwashing behavior using digital means. In practice, enterprises need to integrate digital technologies into the entire process of environmental management and ESG disclosure, taking into account their own regional and industry characteristics. Regulatory authorities should establish environmental information sharing platforms, address the shortcomings in digital infrastructure in non-eastern regions, implement differentiated industry guidance and regulatory policies, and fully unleash the environmental governance value of digital transformation to support my country's comprehensive green transformation. This study has limitations, such as the measurement of the level of digital transformation failing to accurately reflect its depth and quality, and the lack of consideration for influencing factors such as transformation models and ownership structures. Future research could construct comprehensive

evaluation indicators, incorporate more moderating variables, and explore the interaction between digital transformation and corporate environmental behavior from a combined macro and micro perspective, providing more comprehensive support for enterprises' green transformation and the achievement of "dual carbon" goals.

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