

# Can digital transformation curb corporate greenwashing

Jiaheng Li

Yunnan University, Kunming, Yunnan 650504 China

**Abstract.** Enterprise greenwash behavior can have serious negative impacts, so governance of greenwash behavior is crucial. Digital transformation can effectively inhibit corporate greenwash behavior. Based on the data of China's A-share listed companies from 2012 to 2022, this paper explores the effect of digital transformation on corporate greenwash behavior. The study shows that corporate digital transformation can effectively inhibit and improve corporate greenwash behavior, and the conclusion still holds after a series of robustness tests. Further analysis shows that digital transformation improves corporate greenwash behavior by facilitating corporate green transformation. Heterogeneity analysis shows that the inhibitory effect of digital transformation on corporate greenwash behavior is more significant in state-owned enterprises and non-heavily polluted enterprises compared to non-state-owned enterprises and heavily polluted enterprises.

**Keywords:** digital transformation; corporate bleaching green; green transformation; ESG.

## 1. Preface

In this day and age, with global environmental problems becoming increasingly serious, green development and sustainable development have become the consensus of all countries. The report of the twentieth Party Congress clearly put forward the concept of "green mountains are golden mountains", which advocates focusing on the protection of the ecological environment in the development process and realizing a win-win situation for both economic growth and environmental quality. The core of this concept is to promote green development, that is, in the economic development at the same time, to protect and improve the ecological environment, to achieve sustainable development, and at the same time, China has put forward the "dual-carbon" goal, these initiatives reflect the country's determination to adhere to green development. As the concept of sustainable development takes hold in people's hearts, enterprises and investors are paying more and more attention to environmental, social and corporate governance (ESG) standards. However, for enterprises, these requirements will undoubtedly subject them to more social scrutiny as well as legitimacy pressures. The idea that companies want to fulfill the country's environmental goals at the lowest possible cost directly leads to greenwash behavior[1].

Greenwashing is a concept that describes false publicity or misleading statements made by enterprises in respect of environmental protection. The term was first coined in 1986 by Jay Westerveld, an American environmentalist, to describe companies that appear to care about the environment, but are actually motivated by financial gain. Nowadays, greenwashing refers to enterprises taking advantage of their own information to consciously disclose only those environmental information that is favorable to them, thus misleading the public and constructing a false green image. This behavior is a strategic move aimed at concealing their true environmental impacts through selective or symbolic disclosure[2].

China's enterprises have a late start in the construction of environmental information disclosure system, and the current imperfect institutional framework provides an opportunity for enterprises to take advantage of the greenwashing behavior. In the face of increasing environmental protection requirements, driven by the goal of profit maximization, many enterprises have begun to adopt greenwashing measures to shape their environmental image, in an attempt to obtain the greatest economic returns with the smallest environmental protection investment. Therefore, solving the problem of greenwashing and promoting the real fulfillment of environmental responsibility has become an urgent concern in promoting green development[3]. The problem of greenwashing has become an urgent concern and solution in the promotion of green development.

Digital transformation plays a crucial role in the process of enterprise green transformation. On the one hand, digital transformation can improve the green innovation ability of enterprises, which is conducive to the green development of enterprises and has a significant positive effect on the development of green economy[4]. On the other hand, digital transformation not only enhances the enterprise's green innovation ability, but also contributes to the enterprise's green development, which has a significant positive effect on the development of green economy. On the other hand, digital transformation not only enhances the transparency of corporate information and operational efficiency, but also promotes the optimization of the internal control system[5-6]. On the other hand, digital transformation not only enhances corporate information transparency and operational efficiency, but also promotes the optimization of internal control systems. In terms of environmental, social and governance (ESG) disclosure, digital transformation improves the quality of corporate governance by reducing information asymmetry and strengthening internal regulation, and reduces the phenomenon of "profit manipulation" in the process of environmental information disclosure. The digital transformation has reduced the phenomenon of "profit manipulation" in the environmental disclosure process.

Taken together, the above analysis shows that digital transformation can promote green transformation of enterprises, which in turn inhibits enterprise greenwash behavior. However, there are few studies on digital transformation and corporate bleaching green behavior. Therefore, based on the digital empowerment theory and green transformation mechanism, this paper takes A-share listed companies in 2021-2022 as the research sample to explore the effect of digital transformation on corporate greenwashing behavior. The possible innovations of this paper are reflected in the following three aspects: firstly, this paper incorporates the digital transformation of enterprises into the factors affecting the enterprise bleaching green behavior, which makes the influencing factors more comprehensive and provides a new perspective for the study of the bleaching green behavior; secondly, the mechanism analysis is carried out with the green transformation of the enterprise as the mediator variable, which clarifies the role mechanism of how the digital transformation affects the enterprise's bleaching green behavior; lastly, from the perspective of the nature of the enterprise's property rights and industry pollution characteristics, the different impacts of digital transformation on enterprises' green-bleaching behavior are analyzed.

## **2. Literature review**

### **2.1 Green Drifting Behavior**

Greenwashing refers to an enterprise's attempt to enhance its public image by misleading consumers and investors into believing that its products, services, or the enterprise as a whole are more environmentally friendly through superficial environmental statements or minimal environmental efforts, without actually making substantial environmental improvements. Current research on greenwashing focuses on the identification and consequences of greenwashing and the governance of greenwashing. Greenwashing usually involves selective disclosure of information, misleading marketing campaigns and lack of transparency. Firms may exaggerate the environmental attributes of their products or deliberately ignore the negative impacts of their operations[7]. In recent years, as the topic of ESG investing continues to heat up, so does the environmental awareness of investors, and more and more investors are no longer confined to focusing only on the financial information of companies, but have begun to seek third-party certifications as a criterion for judging the reliability of a company's environmental information[8]. Greenwash behavior can lead to inappropriate resource allocation and negatively affect the effectiveness of capital markets[9]. Greenwash can lead to inappropriate resource allocation and negatively affect the effectiveness of capital markets. When greenwashing is uncovered, companies face a drop in share price, government fines, and increased market regulation[10]. The consequences of greenwashing can include a drop in share price, government fines and increased market regulation. At the same time, greenwash can also cause investors to make wrong judgments and harm their interests. Therefore, the identification and

management of greenwash behavior is of paramount importance. At present, the governance of greenwash behavior is mainly divided into three levels: government policy guidance, the active role of green investors and public supervision can effectively inhibit the phenomenon of greenwash and promote the truthfulness and transparency of their environmental behavior[11]. The government's policy guidance, the role of green investors and public supervision can all effectively curb the phenomenon of greenwashing and promote the authenticity and transparency of their environmental behavior.

## 2.2 Digital transformation

Current academic research on digital transformation focuses on analyzing how digital transformation can provide new impetus for high-quality economic growth, mainly focusing on enhancing internal economic effects and strengthening external market performance. From the perspective of internal economic effects, digital transformation has been proven to significantly improve the quality of corporate governance, enhance the quality of corporate information disclosure[12] and accelerates the development of new products[13] and enhancing the strategic value of cash reserves, ultimately leading to an increase in revenue from main business[14]. In terms of external market performance In terms of external market performance, digital transformation demonstrates superior performance in the capital market by reducing share price volatility[15]. In terms of external market performance, digital transformation demonstrates capital market excellence by reducing share price volatility. In addition, digital transformation can help reduce audit costs while improving audit quality[16].

From the above literature, it can be seen that the current research on digital transformation on corporate greenwash behavior is relatively small. Therefore, this paper will start from the perspective of digital transformation to explore the effect of digital transformation on corporate greenwashing behavior and deeply analyze its mechanism of action.

## 3. Theoretical analysis and research hypothesis

### 3.1 Theory of Digital Empowerment

The suppression of corporate greenwash by digital transformation can be divided into two parts: internal and external. Regarding internal enterprises, digital transformation can reduce management irregularities by improving the quality of internal control of enterprises. At the same time, digital transformation can influence corporate strategy and change corporate organizational structure, management strategy and business practices, making companies more stringent in internal control. This structured and standardized data significantly enhances the comparability of information, making it easier to identify the greenwash behavior of enterprises, thus compressing the space for corporate greenwash behavior[17]. The data can be used as a basis for the analysis of the enterprise's internal control.

With regard to the outside of the enterprise, through digital transformation, an enterprise can significantly expand its information communication channels with the outside world and increase the openness of information. This increased transparency allows external stakeholders to more accurately understand the internal operations of the enterprise and to more effectively regulate its production processes. This regulation significantly improves the truthfulness of companies in communicating environmentally relevant information, thus making it more difficult for companies to implement greenwashing behaviors. High-quality transparency not only provides a true picture of a company's production, but also clearly communicates to the outside world key production information, such as new technologies, patents, and investments in environmental protection. This information acts as a "spotlight" to increase external scrutiny of the company. The increased attention that companies receive during the digital transformation process can magnify inappropriate behaviors in their daily operations, increase internal and external pressures on companies, and reduce the likelihood that they will engage in greenwashing.

Digital transformation reduces the loss in the process of information transmission and reduces the degree of information asymmetry through the use of digital tools such as blockchain and big data. The application of these technologies not only improves the accuracy and reliability of information, but also enhances the comparability of information, making it easier to identify corporate greenwash. At the same time, digital transformation reduces the degree of information asymmetry so that external investors or regulators can understand the accounting information of enterprises in a more timely manner, further compressing the space for enterprises to carry out a series of behaviors such as selective disclosure and counterfeiting, and inhibiting the greenwashing behavior of enterprises. The digital transformation has also reduced the asymmetry of information, enabling external investors or regulators to understand accounting information in a more timely manner.

In addition, stakeholders are able to use sophisticated digital technology to analyze publicly available environmental information in depth and improve the accuracy of the results. This analytical ability constitutes a strict regulatory pressure on the outside of the enterprise, effectively reducing the possibility of management manipulation of environmental information. In this way, the opportunistic behavior of management in environmental information disclosure can be reduced, ultimately improving the transparency and integrity of enterprises in the fulfillment of their environmental responsibilities and suppressing the phenomenon of greenwashing[18].

Therefore, according to the above theoretical analysis, digital transformation can effectively inhibit corporate greenwash behavior, according to which this paper proposes the first hypothesis:

Hypothesis 1: Digital transformation can curb corporate greenwash behavior.

### **3.2 Green transformation mechanisms**

An important factor for enterprises to engage in green-bleaching behaviors is the green transformation dilemma. According to existing research, the process of promoting green transformation by enterprises involves the research and development of green technologies, the improvement of production processes and the upgrading of production equipment, all of which require huge capital investment. In the face of such cost pressure, enterprises may tend to choose less costly means of greenwashing, with a view to obtaining a rapid improvement in their green image in the short term, and thus may fall into the short-term speculative behavior of greenwashing[19]. The green transformation and greenwashing themselves are not the same thing. Green transformation and greenwashing themselves have an obvious antagonistic relationship, the ultimate goal of green transformation is to realize the enterprise's "real green" rather than greenwashing, the higher the degree of green transformation, the lower the possibility of enterprises to implement greenwashing behavior, greenwashing degree will also decline.

Secondly, digital transformation can improve the level of green innovation in enterprises, thus promoting their green transformation. The wide application of digital technology in enterprise production activities provides an effective way for enterprises to obtain external technology and promote the sharing of internal green technology. Through this way, enterprises can more effectively promote green technological innovation, continuously improve their own level of green transformation, and help realize the goal of sustainable development[20]. For example, in the area of pollution control, through the use of green technology, enterprises can achieve sustainable development goals. For example, in terms of pollution control, by adopting advanced intelligent environmental protection management systems such as intelligent online monitoring platforms, enterprises are able to carry out comprehensive, real-time pollution monitoring and early warning management of the elements and equipment status of the entire production area. This helps to realize ultra-low emissions of exhaust gas, zero discharge of wastewater and no solid waste leaving the factory, laying a solid foundation for the green and sustainable development of the enterprise[21]. In addition, studies have shown that the digital transformation of enterprises can significantly accelerate the speed of information circulation and improve the accessibility of information, thus enhancing the information integration ability of enterprises and bringing greater competitive advantages to enterprises[22]. While reducing the cost of searching for information about the external

environment[23] digital transformation also effectively breaks down the barriers of information flow between different technology fields[24]. It also facilitates the integration and reorganization of innovative knowledge resources[25].

When enterprises decide to implement green transformation fundamentally, digital technology will become a powerful tool for enterprises to help them complete green transformation faster and better, and improve the degree of green transformation, thus reducing the possibility of enterprises' implementation of green-bleaching behaviors and curbing their green-bleaching behaviors. In summary, this paper puts forward the second hypothesis:

Hypothesis 2: Digital transformation inhibits corporate greenwashing behavior by driving corporate green transformation.

## 4. Study design

### 4.1 Sample selection

In this paper, the listed companies in Shanghai and Shenzhen A-shares from 2012 to 2022 are selected as the research samples, and the research samples are processed as follows: (1) the samples of companies that are ST and \*ST are excluded; (2) the samples of listed companies in the financial industry are excluded; (3) the samples of companies with missing relevant data are excluded, and finally 4,950 sample observations are obtained. Given that outliers may interfere with the research results, this paper shrinks the continuous variables at the 1% and 99% quartiles. The data in this paper come from Bloomberg ESG database, CSI ESG rating data, annual reports of listed companies and Cathay Pacific CSMAR database.

### 4.2 Description of variables

#### 4.2.1 Explained variables

The explanatory variable in this paper is the degree of corporate greenwash (GWS). In recent years ESG and ESG rating performance disclosure have been widely used to measure corporate sustainable performance, so this paper refers to Zhang's (2022) research methodology to quantify the relative corporate bleaching score of the same industry as a proxy variable for the degree of corporate bleaching, which is calculated as follows:

$$WS_{i,t} = \left( \frac{ESG\ Disclosure_{i,t} - \overline{ESG\ Disclosure}_{i,t}}{\sigma ESG\ Disclosure_{i,t}} \right) - \left( \frac{ESG\ Performance_{i,t} - \overline{ESG\ Performance}_{i,t}}{\sigma ESG\ Performance_{i,t}} \right) \quad (1)$$

where  $i$  is the company,  $t$  is the year and  $ES\ Disclosure$  represents the ESG disclosure score, and  $ES\ Performance$  represents the ESG actual performance score. The degree of corporate greenwash, i.e., the difference between ESG disclosure score and ESG actual score, specifically transforms  $\overline{ESG\ Disclosure}_{i,t}$  and  $\overline{ES\ Performance}_{i,t}$  into Z-scores to make them comparable.  $\overline{ES\ Disclosure}_{i,t}$  and  $\overline{ES\ Performance}_{i,t}$  represent the mean of ESG disclosure score and ESG actual score, respectively.  $\sigma ESG\ Disclosure_{i,t}$  and  $\sigma ESG\ Performance_{i,t}$  represent the standard deviation of ESG disclosure score and ESG actual score, respectively. A positive value indicates that a firm intends to hide its true environmental performance by disclosing inaccurate information, and the larger the value is, the greater the degree of greenwashing the firm is[26].

Referring to Zhang's (2022) methodology, the Bloomberg ESG Disclosure Score is used to measure the ESG disclosure score, and the CSI ESG rating data to measure the actual ESG performance score[27].

#### 4.2.2 Explanatory variables

The explanatory variable of this paper is enterprise digital transformation (DT). This paper refers to the method of Yuan Chun et al. (2021), firstly, we screened 32 national policy documents about digital economy and extracted 238 enterprise digital transformation related words from the above documents to construct a dictionary of digital terminology; secondly, we analyzed the text of "Management Discussion and Analysis" part of the annual report of the enterprise to get the frequency

number of related words; finally, we divided the total number of related words by the length of the paragraph in the annual report to construct an indicator of the level of enterprise digital transformation. Secondly, we analyze the text of the "Management Discussion and Analysis" section of the annual report to get the frequency of the relevant words; finally, we divide the total number of relevant words by the paragraph length of the "Management Discussion and Analysis" section of the annual report to construct the digital transformation level indicator of the enterprise[28]. Finally, the total number of related words is divided by the length of the paragraph in the "Management Discussion and Analysis" section of the annual report to construct an indicator of the level of enterprise digital transformation.

In terms of robustness testing, another method is used to construct the enterprise digital transformation index (DT1): referring to the method of Chenyu Zhao et al. (2021), text analysis is used to construct the enterprise's digital transformation index. Separately, 99 digitization-related word frequencies were selected from the four dimensions of digital technology application, Internet business model, intelligent manufacturing and modern information system to be counted and used to calculate the degree of enterprises' digital transformation[29]. The digital transformation degree of enterprises is calculated by this method.

### 4.2.3 Control variables

In this paper, we refer to the study of Huang Solbing et al. (2020) and select the following control variables: (1) control variables at the operation level: firm size (Size), net asset margin (Roa), gearing ratio (Lev), growth (Growth), return on net assets (Return), fixed assets (Fixed), and the firm's listed years (ListAge); (2) control variables at the governance level: percentage of independent directors (Indep), shareholding of the first largest shareholder (Top1), and two positions in one (Dual); and (3) control variables at the governance level: percentage of independent directors (Indep), shareholding of the first largest shareholder (Top1), and two positions in one (Dual). ) control variables at the governance level: percentage of independent directors (Indep), shareholding of the first largest shareholder (Top1), and two positions (Dual); and (3) control variables at the firm nature level: the nature of the firm's property rights (Soe). In addition, this paper controls for year (Year) and industry (Indu) effects.

### 4.2.4 Intermediate variables

The mediating variable in this paper is corporate green transformation (GT). Referring to the study of Li Sumei et al. (2024), this paper chooses to use the number of green patents granted to listed companies in the current year as a proxy variable for corporate green transformation and takes the natural logarithm of this variable after adding 1 to solve the skewed distribution problem[30].

The symbols and definitions of the relevant variables in this paper are shown in Table 1.

Table 1 List of variable definitions

Variable type	variable name	variable symbol	Variable Definition
explanatory variable	bleaching degree	GWS	Calculated according to the formula
explanatory variable	Digital Transformation	DT DT1	See variable definitions for details
control variable	Enterprise size	Size	Natural logarithm of total assets for the year
	Net interest rate on assets	Roa	Net profit/average balance of total assets
	gearing	Lev	Total liabilities at year-end divided by total assets at year-end

growth	Growt h	(Total assets at the end of the current period - total assets at the end of the previous period)/total assets at the end of the previous period
return on net assets	Return	Net profit/shareholders' equity balance
fixed assets	Fixed	Net fixed assets/total assets
Nature of business	Soe	State-controlled enterprises take the value of 1, others 0
Years of listing	Listag e	Natural logarithm of the difference between the current year and the year of listing
Percentage of independent directors	Indep	Independent directors divided by number of directors
Shareholding of the largest shareholder	Top1	Number of shares held by the largest shareholder/total number of shares
two jobs in one	Dual	The chairman and general manager are the same person as 1, otherwise 0
vintages	Year	Annual dummy variables
sector	Indu	Industry dummy variables
intermediary variable	Green Transformation	GT Logarithm of the number of green patents of the firm in the year

### 4.3 Modeling

In order to study the impact of digital transformation on the enterprise bleaching green behavior, this paper constructs model (2) to investigate hypothesis 1 of this paper:

$$W S = \alpha_0 + \alpha_1 DT + \alpha_2 Controls + Industry + Year + \epsilon_{i,t} \quad (2)$$

Where GWS is the firm's degree of greenwash, DT is the explanatory variable, i.e., the firm's digital transformation,  $\alpha_1$  represents the effect of the firm's digital transformation on the firm's degree of greenwash,  $\alpha_0$  denotes the constant term, Controls denotes the control variables,  $i$  denotes the firm,  $t$  denotes the year, Industry denotes the industry fixed effect, Year denotes the year fixed effect, and  $\epsilon_{i,t}$  denotes the perturbation term.

According to hypothesis 2, this paper adds enterprise green transformation as a mediating variable to test the hypothesis on the basis of the model, and adopts the stepwise regression method to test whether digitization can inhibit the enterprise's green bleaching behavior by promoting the enterprise's green transformation, and the specific model is as follows:

$$W S = \alpha_0 + \alpha_1 DT + \alpha_2 Controls + Industry + Year + \epsilon_{i,t} \quad (3)$$

$$T = \beta_0 + \beta_1 DT + \beta_2 Controls + Industry + Year + \epsilon_{i,t} \quad (4)$$

$$W S = \gamma_0 + \gamma_1 DT + \gamma_2 T + \gamma_3 Controls + Industry + Year + \epsilon_{i,t} \quad (5)$$

## 5. Analysis of empirical results

### 5.1 Descriptive statistics

The descriptive statistics of the main variables are shown in Table 5.1. As shown in Table 2, the maximum value of the enterprise's degree of greenwash GWS is 2.55, and the minimum value is -3.46, which indicates that there is a large difference in the degree of greenwash between enterprises. The maximum value of DT, the degree of digital transformation of enterprises, is 4.72, the minimum value is 0.03, the mean is 0.79, and the standard deviation is 0.87, which indicates that most enterprises have carried out digital transformation, but there are also differences in the degree of

digital transformation among enterprises. The descriptive statistics of the remaining control variables are also within reasonable limits.

Table 2 Descriptive statistics for key variables

variable name	sample size	average value	(statistics) standard deviation	minimum value	upper quartile	maximum values
GWS	4950	-0.590	1.210	-3.460	-0.630	2.550
DT	4950	0.790	0.870	0.030	0.480	4.720
Size	4950	23.47	1.290	19.56	23.43	28.29
Roa	4950	0.040	0.060	-0.970	0.030	0.640
Lev	4950	0.510	0.190	0.020	0.530	1
Growth	4950	0.100	0.280	-0.710	0.070	10.89
Return	4950	0.030	0.970	-46.33	0.070	0.880
Fixed	4950	0.260	0.190	0	0.220	0.950
Soe	4950	0.690	0.460	0	1	1
Listage	4950	2.880	0.310	1.610	2.940	3.470
Indep	4950	0.370	0.060	0.230	0.360	0.800
Top1	4950	0.380	0.160	0.030	0.370	0.900
Dual	4950	0.140	0.350	0	0	1

## 5.2 Benchmark regression analysis

The results of the benchmark regression are shown in Table 3. As can be seen from column (1), with only the explanatory variable DT included, the regression coefficient of DT is -0.0919, which is significantly negative at the 1% confidence level, indicating that there is a significant negative relationship between corporate greenwashing behavior and digital transformation. Column (2) adds control variables and fixes the year and industry effects, and the regression coefficient of DT is -0.0778, which is significantly negative at the 1% level, again proving that there is a significant negative relationship between corporate greenwashing and digital transformation. The above analysis indicates that digital transformation can effectively inhibit the enterprise's green drifting behavior, and hypothesis 1 is verified.

Table 3 Regression results

variant	(1) GWS	(2) GWS
DT	-0.0919*** (0.0197)	-0.0778*** (0.0298)
cons	-0.514*** (0.0231)	-4.382*** (0.445)
Controls	No	Yes
Year	No	Yes
Indu	No	Yes
N	4950	4950
R2	0.004	0.085
adj. R2	0.004	0.069

Note: \*\*\*, \*\*, \* represent significance levels of 1%, 5%, and 10%, respectively; t-values are in parentheses and are the same as in the following table

## 5.3 Robustness Tests

### 5.3.1 Substitution of explanatory variables

Replacing the explanatory variables with DT1, the regression results are presented in Table 4. Column (1) considers only the explanatory variables, the industry and year dummy variables, and has

a regression coefficient of -1.213, which is significantly negative at the 5% level. Column (2) incorporates the control variables and the regression coefficient for DT1 is -1.499, which is significantly negative at the 1% level. This shows that digital transformation is indeed effective in improving firms' greenwash behavior. This robustness test provides further support and validation for the findings above.

Table 4 Regression results after replacing explanatory variables

variant	(1) GWS	(2) GWS
DT1	-1.213** (0.482)	-1.499*** (0.479)
cons	-0.975*** (0.225)	-4.234*** (0.446)
Controls	No	Yes
Year	Yes	Yes
Indu	Yes	Yes
N	4950	4950
R2	0.061	0.085
adj. R2	0.047	0.069

### 5.3.2 Propensity Score Matching

Given that the variability that exists among different firms in terms of firm characteristics and financial status may have an impact on the robustness of the empirical results, this paper adopts the propensity score matching (PSM) method to conduct further in-depth tests of the empirical results to ensure the accuracy and reliability of the research findings. First, this paper uses the median degree of enterprise digital transformation as a benchmark to divide the level of enterprise digital transformation into two groups of high and low. Second, this paper adopts the radius matching method to obtain 4944 valid samples, and utilizes the successfully matched samples to conduct regression, and the regression results are shown in Table 5. The samples in the two groups satisfy the common support hypothesis, the balance tests on all covariates have been passed, and the average treatment effect (ATT) of digitally transformed enterprises is significantly negative at the 1% level. All these results further validate the findings of this paper.

Table 5 Regression results of the propensity score matching method

variant	GWS
DT	-0.116*** (-2.82)
Controls	Yes
Year	Yes
Indu	Yes
N	4944
R <sup>2</sup>	0.082

## 5.4 Heterogeneity analysis

### 5.4.1 Heterogeneity analysis based on the nature of firms

Based on the special nature of the property rights of enterprises in China, the impact of digital transformation on the bleaching green behavior of enterprises with different property rights may be different. In this paper, the sample is divided into state-owned enterprises and non-state-owned enterprises, and regression is conducted on them, and the results are shown in Table 6. As can be seen from Table 5.5, the regression coefficient of digital transformation of state-owned enterprises is -0.146, which is significantly negative at the 1% level, while the regression coefficient of non-state-owned enterprises is not significantly correlated, although it is 0.0339. State-owned enterprises (SOEs)

usually bear more social responsibilities and are subject to stricter government regulation. As a result, SOEs pay more attention to transparency and public image in the process of digital transformation, thus reducing greenwash behavior. In addition, SOEs have more resources and policy support to promote true green innovation, rather than relying solely on greenwashing to enhance their image. For non-SOEs, operational objectives may be more oriented towards profit maximization, which leads them to adopt greenwashing behaviors to attract investors and consumers when facing cost pressures. The fact that non-SOEs have fewer resources at their disposal than SOEs can also lead to the digital transformation of non-SOEs being at an early stage and not effectively curbing greenwashing.

Table 6 Regression Results for Heterogeneity of Firm Nature

variant	nationalized business	non-state enterprise
	GWS	GWS
DT	-0.146*** (0.0383)	0.0339 (0.0504)
cons	-4.613*** (0.651)	-3.883*** (0.799)
Controls	Yes	Yes
Year	Yes	Yes
Indu	Yes	Yes
N	3411	1539
R <sup>2</sup>	0.096	0.147
adj. R <sup>2</sup>	0.077	0.104

#### 5.4.2 Heterogeneity analysis based on industry classification

There are significant differences in different industries in terms of causing environmental pollution, and such differences may also be reflected in their greenwash behavior. Based on the Guidelines for Industry Classification of Listed Companies (2012 Revision), this paper classifies 16 industries as heavy polluting industries and others as non-heavy polluting industries. This paper assigns the value of 1 to the heavily polluted industries and 0 to the non-heavily polluted industries, and the regression results are shown in Table 7. As shown in Table 5.6, the regression coefficient of digital transformation of enterprises in non-heavily polluted industries is -0.0913, which is significantly negative at 1% level, while the regression coefficient of enterprises in heavily polluted industries is 0.0264, and the result is not significant. This is because the heavy pollution enterprises will be subject to more supervision by the society and government departments, in this environment, the heavy pollution enterprises want to carry out the difficulty of bleaching green, bleaching green space is very limited, and the results have been close to achieving the real environmental protection, so the inhibiting effect of digital transformation on the heavy pollution industry bleaching green behavior is not obvious. In contrast, as enterprises in the digital transformation continues to deepen, the difficulty of greenwashing behavior gradually increased, for non-heavily polluting enterprises, its greenwashing problem is expected to be more obvious relief.

Table 7 Regression results for heterogeneity by industry classification

variant	Heavily polluting enterprises	Non-heavily polluting enterprises
	GWS	GWS
DT	0.0264 (0.0848)	-0.0913*** (0.0321)
cons	-3.631*** (0.703)	-4.463*** (0.544)
Controls	Yes	Yes
Year	Yes	Yes
Indu	Yes	Yes
N	1634	3316

$R^2$	0.079	0.084
adj. $R^2$	0.059	0.064

## 5.5 Mediated effects test

Based on the previous theoretical analysis, enterprise digital transformation can significantly promote enterprise green transformation and thus inhibit the enterprise's green-bleaching behavior, so this paper takes enterprise green transformation GT as a mediating variable to study its impact on green-bleaching behavior, and the regression results are shown in Table 8. Column (2) represents the relationship between digital transformation and enterprise green transformation, and the regression coefficient of digital transformation is 0.133, which is significantly positive at the 1% level, indicating that digital transformation effectively promotes enterprises to carry out green transformation. Column (3) The regression coefficient of green transformation is -0.0403, which is significantly negative at the 5% level, indicating that enterprise green transformation inhibits green bleaching behavior. At the same time, the absolute value of the regression coefficient of digital transformation is reduced compared with the baseline regression results, indicating that enterprise green transformation plays a part of the mediating effect in the inhibition of digital transformation on greenwashing behavior, so the hypothesis (2) of this paper has been verified.

Table 8 Green Transition Regression Results

variant	(1) GWS	(2) GT	(3) GWS
DT	-0.0778*** (0.0298)	0.133*** (0.0249)	-0.0725** (0.0299)
GT			-0.0403** (0.0172)
cons	-4.382*** (0.445)	-11.03*** (0.371)	-4.826*** (0.484)
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Indu	Yes	Yes	Yes
$N$	4950	4950	4950
$R^2$	0.085	0.531	0.086
adj. $R^2$	0.069	0.523	0.070

## 6. Conclusions and Implications of the Study

### 6.1 Conclusions of the study

This paper takes the A-share listed companies in Shanghai and Shenzhen as data samples from 2012 to 2022, and explores the influence effect of enterprise digital transformation on enterprise bleaching green behavior and its functioning mechanism through the method of theoretical analysis and empirical research, and this paper draws three conclusions:

First, digitization can significantly inhibit firms' greenwash behavior. The conclusion still holds after robustness tests such as replacing explanatory variables and considering endogeneity issues.

Second, digital transformation acts as a deterrent to corporate greenwashing by facilitating corporate green transformation. Green transformation plays a partial mediating effect in the impact of digital transformation on corporate greenwashing.

Third, digital transformation is more effective in curbing firms' greenwash behavior in SOEs and non-heavily polluting industries.

## 6.2 Research Implications

Against the backdrop of the current transformation of the global economy towards sustainable development, digital transformation not only brings unprecedented opportunities for enterprises, but also gives them new responsibilities. With technological advances, transparency and truthfulness of corporate information on environmental, social and governance (ESG) have become particularly important. Digital transformation provides effective tools and ways to curb greenwash by enhancing corporate internal controls, optimizing resource allocation, improving the quality of information disclosure and facilitating corporate green transformation.

Driven by the wave of digitization, enterprises should take the initiative to carry out digital transformation in order to achieve a more efficient, transparent and responsible mode of operation. This transformation is not only an inevitable choice for enterprises to adapt to the development of the times, but also a key measure for them to fulfill their social responsibility and curb greenwash. At the same time, enterprises should apply digital technology to combat greenwash and promote the synergistic development of digitalization and greening in their operations.

From the government's point of view, the government should also formulate clear policies and regulations to encourage enterprises to carry out digital technology transformation, deepen the application of digital technology in the production process, and actively expand the field of digital transformation. At the same time, the government should strengthen the standardization of environmental information disclosure, improve the relevant system, build a comprehensive and efficient environmental information disclosure system, and set stricter penalties for greenwash, as well as to ensure the effective implementation of corporate environmental responsibility.

## References

- [1] Yang Youde, Xu Guanghua, Fei Jinhua. Can Environmental Taxation Curb the "Greenwashing" Behavior of Enterprises? [J]. *China Soft Science*,2024,(05):132-141.
- [2] The Greenwashing and Anti-Greenwashing of ESG Reporting[J]. *Accounting Monthly*,2022,(01):3-11.
- [3] WANG Jianxin,CAO Zhiming. Can Digital Transformation Curb the "Greenwashing" Behavior of Enterprises[J]. *Journal of Hunan University (Social Science Edition)*,2024,38(02):58-67.
- [4] XIN Hao,TAN Weijie. Digitization and corporate green innovation performance - identifying dual effects based on incremental and qualitative improvement[J]. *Southern Economy*,2022(09):118-138.
- [5] XIAO Hongjun,YANG Zhen,LIU Meiyu. The social responsibility promotion effect of corporate digitalization: a test of internal and external dual paths[J]. *Economic Management*,2021,43(11):52-69.
- [6] Wang Xianbin,Chen He. Whether enterprise digital transformation can reduce labor cost stickiness - an examination based on internal control[J]. *Journal of Guangdong University of Finance and Economics*,2024,39(02):71-87.
- [7] Bowen F ,Aragon-Correa A J .Greenwashing in Corporate Environmentalism Research and Practice: the Importance of What We Say and Do[J].*Organization & environment*,2014,27(2):107-112.
- [8] Shen Yi,Qian Ming,Lv Minghan,et al. Small and medium-sized shareholders' monitoring and drifting green governance--A textual analysis based on word vector modeling[J]. *China Population-Resources and Environment*,2023,33(08):116-129.
- [9] Parguel B ,Benoît-Moreau F ,Larceneux F .How Sustainability Ratings Might Deter 'Greenwashing': a Closer Look at Ethical Corporate Communication[J]. *Journal of Business Ethics*,2011,102(1):15-28.
- [10] Li T. A review of research on corporate greenwashing[J]. *Service Science and Management*, 2024, 13(4): 399-408.
- [11] HUANG Solbing, XIE Xiaojun, ZHOU Huifen. The "isomorphic" behavior of corporate greenwashing[J]. *China Population-Resources and Environment*,2020,30(11):139-150.
- [12] LIU Beibei,CHEN Menglu,GUAN Wenna,LI Chuntao,. Information governance effects of digital transformation: evidence from disclosure quality of A-share listed companies[J]. *Journal of Central University of Finance and Economics*,2024,(04):52-65.

- [13] CHI Mao-Mao, YE Ding-Ling, WANG Jun-Jing, et al. How to Improve New Product Development Performance of Small and Medium-sized Manufacturing Enterprises in China - Based on the Perspective of Digital Empowerment[J]. *Nankai Management Review*, 2020, 23(03):63-75.
- [14] TAN Zhidong, ZHAO Xun, PAN Jun, et al. The value of digital transformation: a perspective based on corporate cash holdings[J]. *Financial Research*, 2022, 48(03):64-78.
- [15] WU Fei, HU Huizhi, LIN Huiyan, et al. Corporate digital transformation and capital market performance - Empirical evidence from stock liquidity[J]. *Management World*, 2021, 37(07):130-144.
- [16] ZHANG Yongshen, LI Xiaobo, XING Mingqiang. Enterprise digital transformation and audit pricing[J]. *Auditing Research*, 2021(03):62-71.
- [17] SIN Yi-ting, HE Wei-feng. Does corporate digital transformation affect the quality of earnings forecasts[J]. *Journal of Shanxi University of Finance and Economics*, 2022, 44(09):100-113.
- [18] Wang HF, Jiang DP, Xu Y. Can Digital Transformation Improve the Quality of Information Disclosure? - A study based on readability of annual reports[J]. *Management Modernization*, 2022, 42(02):58-65.
- [19] Su Ruixin, Du Jianguo, Jin Shuai. Green Transformation or Speculative Green Drifting: Strategic Choices of High-Carbon Enterprises under the Perspective of Financial Support[J]. *Enterprise Economy*, 2023, 42(12):139-149.
- [20] WANG Mingyue, LI Yingming, WANG Zitong. The U-shaped relationship between environmental performance and economic performance of corporate green technology innovation and the moderation of competition regulation[J]. *Science Management Research*, 2021, 39(05):107-116.
- [21] ZHOU Yihong, DONG Qian. Research on the Impact of Enterprise Digital Transformation on Environmental Performance--Based on Internal and External Dual Moderating Effects[J]. *Business Research*, 2023, 30(06):31-42.
- [22] Qi Yudong, Xiao Xu. Enterprise management change in the era of digital economy[J]. *Management World*, 2020, 36(06):135-152.
- [23] XING Xiaoqiang, ZHOU Pinglu, ZHANG Zhu, et al. Digital technology, BOP business model innovation and inclusive market construction[J]. *Management World*, 2019, 35(12):116-136.
- [24] Zhang Yao, Yang Linrui. Can Digital Transformation Improve Corporate Environmental Performance? [J]. *Modern Management Science*, 2023(01):115-126.
- [25] Chang Yingying, Zeng Quan. Environmental Information Transparency and Corporate Credit Ratings - Empirical Evidence Based on Bond Rating Market[J]. *Financial Research*, 2019(05):132-151.
- [26] Dongyang Z. Environmental regulation and firm product quality improvement: how does the greenwashing response?[J]. *International Review of Financial Analysis*, 2022, 80.
- [27] Marquis C, Toffel W M, Zhou Y. Scrutiny, Norms, and Selective Disclosure: A Global Study of Greenwashing[J]. *Organization Science*, 2016, 27(2):483-504.
- [28] YUAN Chun, XIAO Tusheng, GENG Chunxiao, et al. Digital transformation and corporate division of labor: specialization or vertical integration[J]. *China Industrial Economy*, 2021, (09):137-155.
- [29] ZHAO Chenyu, WANG Wenchun, LI Xuesong. How digital transformation affects enterprise total factor productivity[J]. *Finance and Trade Economics*, 2021, 42(07):114-129.
- [30] LI Su-Mei, TIAN Zhu-Zhu. Can Digital Transformation Improve Corporate Bleaching Green Behavior[J]. *Finance and Economy*, 2024, (04):39-50.