

# Does Digital Transformation Enhance Corporate ESG Performance? Evidence from China

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**Abstract.** Digital transformation has endowed enterprises with new growth momentum, but can it further improve their Environmental (E), Social (S), and Governance (G) performance? Based on data from Chinese A-share listed companies from 2011 to 2021, this paper empirically examines the impact of digital transformation on corporate ESG performance and its underlying mechanisms. The study finds that digital transformation significantly enhances corporate ESG performance. Mechanism analysis reveals that the increase in digitalization levels not only strengthens enterprises' capabilities for green technological innovation but also reduces internal information asymmetry, both of which contribute to the improvement of corporate ESG practices. Moreover, the paper finds that the positive impact of digital transformation on ESG performance diminishes over time. Therefore, to sustain and enhance ESG performance, companies should consider continuous investment in digital technologies. This study enriches and extends research on the applications of digital transformation, providing valuable insights for driving corporate digital transformation and improving ESG performance.

**Keywords:** Digital transformation; ESG; green technological innovation; information transparency.

## 1. Introduction

With the rapid development of the global economy, it has become increasingly apparent that many companies are prioritizing profit maximization at the expense of societal interests. Governments and social organizations around the world are calling for companies to enhance their sense of social responsibility by not only pursuing shareholder value but also actively considering public interests, community well-being, and environmental protection. This approach aims to provide a favorable market environment for sustainable development. As a cutting-edge method that evaluates a company's sustainability from the three dimensions of Environmental (E), Social (S), and Governance (G), ESG has become a key standard for measuring corporate green and sustainable development at the international level, gaining increasing attention from all sectors (Larcker and Watts, 2020; Baker et al., 2021; Asante-Appiah and Lambert, 2022; Tsang et al., 2023). According to KPMG, the ESG disclosure rate of the top 250 companies in the Fortune 500 reached 96% in 2022. At the same time, data from the United Nations Principles for Responsible Investment (UN PRI) shows that, as of May 2023, 5,368 institutions worldwide have signed up for PRI, including 135 institutions from the Chinese market. Although ESG practices in China started relatively late, they have garnered increasing attention from both investors and policymakers. Based on this, improving their ESG responsibility performance has become an important issue that companies cannot afford to ignore.

Meanwhile, digitalization is driving a new wave of strategic transformation in enterprises. By deeply integrating digital technologies and concepts with corporate operations and management, companies are continuously enhancing their dynamic capabilities. The deep integration of digital technology with the real economy has also become a crucial driving force for improving ESG practices and promoting ESG development in enterprises. Specifically, the application of digital technology, on the one hand, allows for the tracking and management of internal information through big data analysis while recording business activities, significantly reducing costs and increasing efficiency in



information collection, decision-making support, and operations management. On the other hand, it also meets the needs of ESG information disclosure, information management, and capital market regulation, enhancing the accuracy, comprehensiveness, and timeliness of ESG disclosures while improving the efficiency and convenience of ESG information management and operations. This, in turn, helps strengthen corporate ESG practices and improve ESG performance. Notably, according to the latest data from Accenture, nearly 59% of surveyed corporate executives plan to increase digital investment in the next one to two years, indicating that digital transformation has become a “must-have” for an increasing number of Chinese companies. However, while digital transformation is gaining increasing favor within the corporate world, can it truly enhance a company’s sustainability and provide effective support for its ESG practices? Existing research primarily focuses on the impact of digitalization on a company’s economic value, such as financial performance and market value, while exploration into its effects on non-economic values, such as environmental responsibility, remains limited. Furthermore, there is a scarcity of literature directly establishing the link between digitalization and corporate ESG performance. Therefore, this paper aims to explore the impact of digital transformation on ESG performance and its underlying mechanisms to uncover the internal drivers and pathways for improving corporate ESG performance. Specifically, using a sample of Chinese A-share listed companies in Shanghai and Shenzhen from 2011 to 2021, this study empirically examines the effects of digital transformation on ESG performance and the channels through which these effects occur. The findings are expected to provide insights for companies seeking to build dual competitive advantages in both digitalization and ESG performance.

## **2. Hypothesis Development**

### **2.1. Digital Transformation and ESG Performance**

Stakeholder theory posits that the survival and development of a company depend on the quality of its responses to the demands of stakeholders, including shareholders, employees, consumers, and the natural environment (Freeman, 2010; Asante-Appiah and Lambert, 2022). However, there has long been an issue of insufficient investment in corporate ESG practices. On the one hand, corporate investment in environmental and social responsibilities increases additional expenses, reduces profits, and may weaken competitiveness, thus harming shareholder interests (Garcia and Orsato, 2020; Huang et al., 2022). On the other hand, many companies face significant challenges in improving their ESG capabilities due to resource constraints, outdated technology, and information asymmetry with stakeholders, which makes it difficult to achieve substantial results. Consequently, these factors lead to insufficient incentives for companies to engage in ESG practices (Welch and Yoon, 2022). By undergoing digital transformation, companies integrate advanced digital technologies such as big data, blockchain, artificial intelligence, and cloud computing into their existing operational models. The use of digital technologies to mine and analyze vast amounts of information can drive fundamental changes in corporate management models, information structures, operational mechanisms, and production processes (Hanelt et al., 2020). At the same time, digital transformation can further help companies improve their ESG performance. On the one hand, digital transformation plays a crucial role in promoting green technological innovation, thereby enhancing a company’s contribution to environmental sustainability. On the other hand, the deployment of digital technologies helps reduce information asymmetry and transaction costs, while increasing corporate transparency, thus better enabling companies to fulfill social responsibilities and improve corporate governance. Therefore, digital transformation can largely remove obstacles to corporate ESG practices, leading to enhanced ESG capabilities. Based on this, the following hypothesis is proposed:

*H1: Digital transformation enhances corporate’s ESG performance.*

## **2.2. The Mechanism of Corporate Digital Transformation on ESG Performance**

### **2.2.1. Green Technological Innovation**

Externality theory suggests that corporate production activities have certain externalities, and green production can help companies reduce the negative externalities generated during their production processes. Specifically, the innovation and application of green technologies further enable companies to conduct green production with greater efficiency and lower costs. Numerous studies have shown that digital transformation empowers companies to achieve breakthroughs in green technology innovation. On the one hand, in the digital economy era, companies achieve data-driven production automation, data-driven organizational networking, and data-driven operational and decision-making intelligence, which helps accurately identify environmental issues and enables companies to respond quickly with targeted R&D and innovation. On the other hand, the application of digital technology helps companies integrate internal and external information, breaking down information silos and achieving interconnection between internal and external entities, thereby providing strong support for collaborative innovation between companies. It also creates an efficient incubator for green technology innovation (Subramaniam and Youndt, 2005). Based on the above analysis, it is clear that corporate green technology innovation relies on well-established data infrastructure, which further facilitates green production and ultimately helps companies better fulfill environmental responsibilities and improve their ESG performance. Therefore, the following hypothesis is proposed:

*H2*: The digital transformation of companies improves their ESG performance by increasing their ability to innovate with green technologies.

### **2.2.2. Information Transparency**

Corporate governance theory suggests that there is significant information asymmetry between companies and stakeholders, which can lead to problems such as adverse selection and moral hazard. These issues increase corporate governance costs and exacerbate the risk of stakeholder interest losses, ultimately resulting in poor ESG performance. Some companies deliberately reduce the quality of information disclosure (Luo et al., 2017), selectively disclose information, or engage in decoupling behaviors, such as “greenwashing” or “brownwashing” (Wu et al., 2020; Huang et al., 2022). However, the application of digital technologies enhances the immediacy, transparency, and verifiability of data elements, increasing external pressure on companies and making it more difficult for them to selectively disclose information through manipulative practices. For instance, blockchain technology allows for efficient recording and reliable tracing of corporate activities, significantly curbing decoupling behaviors in information disclosure. Additionally, digital transformation provides a solid foundation for companies to disclose environmental information, enabling them to capture data quickly and accurately, process large volumes of fragmented and unstructured data efficiently, and ensure the reliability and traceability of generated information throughout the process. This helps companies escape the predicament of being overwhelmed by data and provides critical support for improving internal governance and better fulfilling social responsibilities. Based on this, the following hypothesis is proposed:

*H3*: Enterprise digital transformation improves ESG performance by increasing transparency of information within the organization.

## **3. Research Design**

### **3.1. Sample**

This paper uses data from Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2011 to 2021 as a sample to conduct an empirical analysis by establishing an econometric model. The data were filtered as follows: (1) companies with ST, PT status and those listed for less than three years were excluded; (2) to ensure data comparability, companies in the

financial sector were excluded; (3) to eliminate the influence of outliers, all continuous variables were winsorized at the 1% and 99% levels. Additionally, to avoid issues of autocorrelation and heteroscedasticity, the standard errors were adjusted using firm-level clustering.

## **3.2. Empirical Measures**

### **3.2.1. Explained Variable**

Corporate ESG Performance (*ESG*): Currently, indicators used to measure corporate ESG performance are largely sourced from market rating agencies, such as MSCI, FTSE Russell, and Bloomberg internationally, and Huazheng, SynTao Green Finance, and Wind domestically. In this paper, the composite score from the Huazheng ESG rating system is used as a proxy variable for corporate ESG performance. For robustness checks, this paper further selects ESG performance scores provided by Bloomberg as an alternative dependent variable to test whether the conclusions of this paper hold robustly.

### **3.2.2. Explanatory Variable**

Corporate Digital Transformation (*Digital*): Currently, some scholars measure corporate digital transformation by the ratio of the amount of digital-related intangible assets reflected in the details of the intangible assets account at year-end to the total amount of intangible assets of the company. However, more scholars adopt text analysis methods to count the frequency of terms related to digital transformation in annual reports to construct this indicator. This paper follows the mainstream approach, using the corporate digital transformation index, which reflects the frequency of relevant terms in annual reports from the CSMAR database, as a proxy variable for measuring corporate digital transformation.

### **3.2.3. Mediators**

Based on the aforementioned theoretical analysis, the mechanism variables selected are green technology innovation and internal information transparency. Green Technology Innovation (*Innovation*) is sourced from the China Research Data Service Platform (CNRDS) and is defined as the sum of the number of independently applied green inventions and the number of jointly applied green inventions in a given year, plus one, and then log-transformed to form the proxy variable for green technology innovation. For internal information transparency (InfoTrans), this paper measures it using the internal control information disclosure index from the Dibo database.

### **3.2.4. Control Variables**

Considering other factors that may have an impact on the mechanism variables and the explanatory variables, 10 control variables are selected in this paper, and the data are obtained from the CSMAR database.

The specific variables and definitions are shown in Table 1.

**Table 1.** Variables and their definitions.

Type	Name	Notation	Calculation
Explained variable	ESG performance	<i>ESG</i>	The composite score from the Huazheng ESG rating system
Explanatory variable	Corporate digital transformation	<i>Digital</i>	Digital Transformation Index from CSMAR database
Mediators	Green technology innovation	<i>Innovation</i>	Ln (number of green inventions filed independently in the year + number of green inventions filed jointly in the year + 1)
	Information transparency	<i>InfoTrans</i>	Internal control information disclosure index from the Dibo database
	Size	<i>Size</i>	Ln (total of asset)
Control variables	Age	<i>Listage</i>	Ln(Difference between the fiscal year and the year the firm went public + 1)
	profitability	<i>Roe</i>	Net profit/average balance of shareholders' equity
	solvency	<i>Lev</i>	Total liabilities/total assets of the enterprise at the end of the year
	Development Capability	<i>Growth</i>	Gross operating income growth rate
	Executive team size	<i>TMT</i>	Ln (total number of executives + 1)
	shareholding concentration	<i>Top10</i>	Sum of shareholdings of the top ten shareholders
	duality	<i>Duality</i>	Whether the chairman of the board and the general manager are the same person: 0: No; 1: Yes
Board size	<i>Board</i>	Ln (number of board members + 1)	
Proportion of independent directors	<i>Indirect</i>	Number of independent directors/size of directors	

### 3.3. Regression Models

#### 3.3.1. Baseline regression model

$$ESG_{i,t} = \alpha_0 + \alpha_1 Digital_{i,t} + \sum_{j=2} \alpha_j Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

Based on H1, we construct the baseline regression model (1) to explore whether corporate digital transformation can enhance its ESG performance. If  $\alpha_1$  is significantly positive, then Hypothesis 1 is supported, indicating that corporate digital transformation does indeed promote an improvement in ESG performance.

#### 3.3.2. Mechanism verification model

$$Mediator_{i,t} = \beta_0 + \beta_1 Digital_{i,t} + \sum_{j=2} \beta_j Controls_{i,t} + \partial_{i,t} \quad (2)$$

$$ESG_{i,t} = \gamma_0 + \gamma_1 Mediator_{i,t} + \gamma_2 Digital_{i,t} + \sum_{j=3} \gamma_j Controls_{i,t} + \mu_{i,t} \quad (3)$$

Model (2) tests the relationship between digital transformation and the mechanism variables. The baseline regression model (1) and Model (2) represent the first and second steps of the mediating effect test, respectively, while Model (3) constitutes the third step. Together, these three models are used to examine the mediating effects. If  $\alpha_1$  and  $\beta_1$  are both significant, and  $\gamma_1$  is also significant, then a mediating effect exists. Furthermore, if  $\gamma_2$  is significant, it indicates a partial mediating effect, with the magnitude of the mediating effect calculated as  $\beta_1\gamma_1/\alpha_1$ . If  $\gamma_2$  is not significant, it indicates a full mediating effect. If either  $\alpha_1$  or  $\beta_1$  is not significant, it suggests that no mediating effect exists. The term “Controls” in the three models represents the control variables.

## 4. Empirical Analyses

### 4.1. Descriptive statistics

From the descriptive statistics results in Table 2, it can be observed that for the dependent variable, corporate ESG performance, the standard deviation is 5.67, indicating a certain degree of variation among different companies. However, compared to the minimum value (55.45), the median (73.09), and the mean (72.72) are closer to the maximum value (84.46), suggesting that most companies in the sample exhibit ESG performance leaning towards the upper-middle level. Regarding the core explanatory variable, digital transformation, there is also a noticeable variation among companies (with a standard deviation of 10.54), indicating a significant gap between “high achievers” and “low performers” (with a range of over 40). Notably, the data for board size (*Board*) shows anomalies, as both the maximum and minimum values are integers, which do not align with the characteristics of natural logarithms. Upon checking the data downloaded directly from the CSMAR database, it is found that the logarithmic results have been pre-rounded. Considering that this data structure does not significantly affect the results, no further processing has been conducted in this study.

**Table 2.** Descriptive statistics.

Name	N	mean	p50	sd	min	max
<i>ESG</i>	24569	72.72	73.09	5.667	55.45	84.46
<i>Digital</i>	24569	36.42	33.84	10.54	23.28	65.04
<i>Size</i>	24569	22.38	22.22	1.305	19.67	26.37
<i>TMT</i>	24569	1.949	1.946	0.311	1.099	2.708
<i>Listage</i>	24569	2.425	2.485	0.580	1.386	3.332
<i>Duality</i>	24569	0.247	0	0.432	0	1
<i>Board</i>	24569	2.024	2	0.154	2	3
<i>Indirect</i>	24569	37.56	36.36	5.350	33.33	57.14
<i>Lev</i>	24569	0.451	0.447	0.205	0.064	0.943
<i>Roe</i>	24569	0.056	0.066	0.143	-0.728	0.378
<i>Growth</i>	24569	0.179	0.100	0.484	-0.594	3.317
<i>Top10</i>	24569	56.07	56.32	14.96	22.59	89.67

### 4.2. Correlations

From Table 3, it can be observed that the positive correlation between the core explanatory variable, digital transformation, and corporate ESG performance is significant at the 1% confidence level, providing initial support for Hypothesis 1. Meanwhile, all selected control variables are significantly correlated with the explanatory variable, and the absolute values of the reported correlation coefficients are all less than 0.5, indicating that there is no serious multicollinearity issue. Therefore, the variables selected in this study are considered reasonable.

**Table 3.** Correlation analysis (Pearson).

	<i>ESG</i>	<i>Digital</i>	<i>Size</i>	<i>TMT</i>	<i>Listage</i>	<i>Duality</i>	<i>Board</i>	<i>Indirect</i>	<i>Lev</i>	<i>Roe</i>	<i>Growth</i>	<i>Top 10</i>
<i>ESG</i>	1											
<i>Digital</i>	0.09 ***	1										
<i>Size</i>	0.29 ***	0.03 ***	1									
<i>TMT</i>	0.17 ***	0.04 ***	0.30 ***	1								
<i>Listage</i>	-0.03 ***	-0.12* **	0.30 ***	0.01 *	1							
<i>Duality</i>	-0.05 ***	0.12 ***	-0.14* **	-0.05* **	-0.21 ***	1						
<i>Board</i>	0.05 ***	-0.03* **	0.18 ***	0.13 ***	0.06 ***	-0.06* **	1					
<i>Indirect</i>	0.06 ***	0.08 ***	0.00 3	-0.08* **	-0.04 ***	0.12* **	-0.04* **	1				
<i>Lev</i>	-0.04* **	-0.11* **	0.45 ***	0.13 ***	0.28 ***	-0.096 ***	0.09 ***	-0.01	1			
<i>Roe</i>	0.22 ***	-0.01	0.15 ***	0.08 ***	-0.04 ***	-0.01* 4	0.00 4	-0.015 **	-0.19* **	1		
<i>Growth</i>	-0.03* **	0.01	0.04 ***	-0.02 **	-0.03 ***	0.02* **	-0.02* **	0.00 1	0.03 ***	0.22 ***	1	
<i>Top 10</i>	0.13 ***	-0.08* **	0.27 ***	0.04 ***	-0.21 ***	-0.03* **	0.05 ***	0.02 ***	-0.00 4	0.17 ***	0.09 ***	1

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively.

### 4.3. Main Empirical Results

#### 4.3.1. Baseline Regression Results

Table 4 presents the results of the baseline regression. The left side of the table supplements the predicted signs of the regression coefficients based on the hypotheses and previous research findings. Subsequently, four tests were conducted depending on whether industry and year fixed effects were controlled. The results show that regardless of whether industry and year fixed effects are controlled, digital transformation consistently enhances corporate ESG performance, with statistical significance at the 1% level. This suggests that digital transformation helps firms better manage relationships with stakeholders, assume social responsibilities, and ultimately improve their ESG performance, thus confirming H1.

However, some results do not align with expectations. For instance, in the fourth column, which controls for both industry and year fixed effects, it is evident that stronger growth capacity does not lead to better ESG performance. This may be because companies in the growth phase focus more on

maximizing profits and less on activities such as environmental responsibility, which in the short term only consume resources without generating immediate returns.

**Table 4.** Baseline regression results.

	Expected Sign	(1) <i>ESG</i>	(2) <i>ESG</i>	(3) <i>ESG</i>	(4) <i>ESG</i>
<i>Digital</i>	+	0.025*** (2.862)	0.026*** (3.096)	0.030*** (3.328)	0.032*** (3.589)
<i>Size</i>	+	1.368*** (12.321)	1.373*** (12.328)	1.495*** (13.224)	1.500*** (13.260)
<i>TMT</i>	+	0.226 (1.185)	0.247 (1.294)	0.166 (0.865)	0.188 (0.983)
<i>Listage</i>	–	-1.940*** (-8.868)	-1.908*** (-8.803)	-1.434*** (-3.884)	-1.422*** (-3.874)
<i>Duality</i>	–	-0.206 (-1.579)	-0.209 (-1.621)	-0.178 (-1.374)	-0.183 (-1.422)
<i>Board</i>	+	0.230 (0.582)	0.197 (0.501)	0.133 (0.338)	0.102 (0.258)
<i>Indirect</i>	+	0.074*** (7.011)	0.072*** (6.938)	0.075*** (7.121)	0.073*** (7.047)
<i>Lev</i>	–	-3.481*** (-8.488)	-3.583*** (-8.859)	-4.020*** (-9.516)	-4.124*** (-9.913)
<i>Roe</i>	+	1.541*** (5.077)	1.504*** (5.050)	1.408*** (4.639)	1.367*** (4.584)
<i>Growth</i>	+	-0.315*** (-5.044)	-0.323*** (-5.211)	-0.293*** (-4.647)	-0.303*** (-4.825)
<i>Top10</i>	–	-0.000 (-0.042)	0.001 (0.104)	0.002 (0.333)	0.003 (0.470)
<i>Constant</i>	?	43.855*** (19.911)	44.541*** (18.734)	39.830*** (15.595)	40.587*** (14.895)
<i>Industry</i>		No	Yes	No	Yes
<i>Year</i>		No	No	Yes	Yes
<i>Observations</i>		24569	24569	24569	24569
<i>Adjusted R<sup>2</sup></i>		0.042	0.046	0.050	0.055

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. t statistics in parentheses.

### 4.3.2. Mechanisms of Digital Transformation and ESG Performance

#### (1) Green technological innovation

Table 5 reports the results of the mechanism test between corporate digital transformation, green technological innovation, and ESG performance. Columns (1), (2), and (3) represent the test models (1), (2), and (3) for the mechanism effect, respectively. It is worth noting that for Column (2), which corresponds to the mechanism effect test model (2), green technological innovation is measured by the number of green invention patent applications. Due to the presence of zero-inflation, a zero-inflated Poisson regression model is used for better testing. According to the results in Column (2), digital transformation significantly enhances corporate green technological innovation capabilities. Additionally, by combining the results of Columns (2) and (3), it can be observed that green technological innovation indeed partially mediates the effect of digital transformation on corporate ESG performance. All the positive correlations mentioned above are significant at the 1% level, confirming the validity of H2.

**Table 5.** The role of green technological innovation.

	Expected Sign	(1) <i>ESG</i>	(2) <i>Innovation</i>	(3) <i>ESG</i>
<i>Innovation</i>	NA/NA/+			0.219*** (3.816)
<i>Digital</i>	+	0.032*** (3.589)	0.030*** (37.435)	0.024*** (2.664)
<i>Size</i>		-1.422*** (-3.874)	-0.118*** (-7.022)	-1.591*** (-4.037)
<i>TMT</i>		1.500*** (13.260)	0.407*** (50.582)	1.241*** (9.968)
<i>Listage</i>		0.102 (0.258)	0.083** (1.997)	-0.015 (-0.039)
<i>Duality</i>		0.073*** (7.047)	-0.002 (-1.170)	0.072*** (6.650)
<i>Board</i>		0.188 (0.983)	0.096*** (3.779)	0.128 (0.641)
<i>Indirect</i>		-4.124*** (-9.913)	0.227*** (4.048)	-3.659*** (-8.224)
<i>Lev</i>		1.367*** (4.584)	0.254*** (3.632)	1.629*** (4.754)
<i>Roe</i>		-0.303*** (-4.825)	-0.014 (-0.694)	-0.365*** (-5.282)
<i>Growth</i>		0.003 (0.470)	-0.002*** (-3.882)	-0.002 (-0.314)
<i>Top10</i>		-0.183 (-1.422)		-0.115 (-0.857)
<i>Constant</i>	?	40.587*** (14.895)	-10.512*** (-56.081)	47.987*** (16.180)
<i>Industry</i>		Yes	Yes	Yes
<i>Year</i>		Yes	Yes	Yes
<i>Observations</i>		24569	21131	20833
<i>Log_likelihood/Adjusted R<sup>2</sup></i>		-/0.055	-21235.7/-	-/0.048

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. z statistics in parentheses of column (1) and t statistics in parentheses of columns (2) and (3).

## (2) Information Transparency

Table 6 reports the results of the mechanism test between corporate digital transformation, internal information transparency, and ESG performance. Columns (1), (2), and (3) represent the test models (1), (2), and (3) for the mechanism effect, respectively. According to the results in Column (2), digital transformation helps reduce corporate internal information asymmetry and increases transparency, though the results are not significant. Meanwhile, combining the regression results of Column (3) with all variables, it can be seen that both digital transformation and internal information transparency significantly promote the improvement of corporate ESG performance. Notably, compared to the results in Column (1), the impact coefficient of digital transformation slightly decreases after considering internal information transparency. Therefore, the insignificant result in Column (2) might be due to the limited power of the stepwise regression method in testing the mediation effect.

**Table 6.** The role of information transparency

	Expected Sign	(1) <i>ESG</i>	(2) <i>InfoTrans</i>	(3) <i>ESG</i>
<i>InfoTrans</i>	NA/NA/+			0.068*** (11.852)
<i>Digital</i>	+	0.032*** (3.589)	0.007 (0.600)	0.031*** (3.532)
<i>Size</i>		1.500*** (13.260)	0.649*** (4.671)	1.459*** (12.965)
<i>TMT</i>		0.188 (0.983)	0.537** (2.348)	0.154 (0.814)
<i>Listage</i>		-1.422*** (-3.874)	-2.167*** (-5.127)	-1.290*** (-3.558)
<i>Duality</i>		-0.183 (-1.422)	-0.635*** (-4.358)	-0.138 (-1.080)
<i>Board</i>		0.102 (0.258)	0.306 (0.782)	0.081 (0.207)
<i>Indirect</i>		0.073*** (7.047)	0.039*** (3.044)	0.070*** (6.789)
<i>Lev</i>		-4.124*** (-9.913)	-2.106*** (-4.086)	-3.971*** (-9.625)
<i>Roe</i>		1.367*** (4.584)	1.317*** (3.885)	1.277*** (4.337)
<i>Growth</i>		-0.303*** (-4.825)	-0.375*** (-4.139)	-0.278*** (-4.470)
<i>Top10</i>		0.003 (0.470)	0.027*** (3.660)	0.001 (0.129)
<i>Constant</i>	?	40.587*** (14.895)	26.939*** (7.745)	38.798*** (14.461)
<i>Industry</i>		Yes	Yes	Yes
<i>Year</i>		Yes	Yes	Yes
<i>Observations</i>		24569	24564	24564
<i>Adjusted R<sup>2</sup></i>		0.055	0.290	0.064

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. t statistics in parentheses.

### (3) Bootstrap

Considering that there are three main methods for testing mediation effects—stepwise regression (used previously), the Sobel test, and the Bootstrap method—this study chooses to re-examine the mediation effect using the bias-corrected percentile Bootstrap method. The Bootstrap method does not require the sample to follow a normal distribution, making it superior to the Sobel test. Furthermore, the bias-corrected percentile Bootstrap method provides the most accurate confidence interval estimates, has the highest statistical power, and compensates for the limitation of the stepwise regression method, which can only provide parameter estimates. The main results of this re-examination are presented in Table 4.6. Both the confidence intervals for the indirect and direct effects do not include zero, indicating that the mediation effect significantly differs from zero statistically. This confirms the presence of a significant mediation effect, which is partial mediation. The result is consistent with the stepwise regression test results for green technology innovation, demonstrating the robustness of the previous findings regarding the partial mediation effect.

Moreover, for internal information transparency, the Bootstrap method also detects partial mediation. However, the indirect effect accounts for only 10.90%, which offers a possible explanation for the insignificant result in Column (2) of Table 6. Overall, Hypothesis 3 (H3) is also supported.

**Table 7.** The results of testing the mediation effect using the bias-corrected percentile Bootstrap.

Mediator	Aggregate effect	Direct effect	Indirect effect	Share of indirect effects	95% Conf. Interval (BC)	Conclusion
<i>Innovation</i>	0.030	0.018	0.011	38.41%	(0.009, 0.013)	Partial mediation
<i>InfoTrans</i>	0.036	0.032	0.004	10.90%	(0.003, 0.005)	Partial mediation

### 4.3.3. Robustness Check

#### (1) Replacement of explanatory variables

The digital transformation index provided by the CSMAR database is composed of six detailed components, which include strategic leadership, technology-driven initiatives, organizational empowerment, environmental support, digital outcomes, and digital applications. To verify the robustness of the regression results in the main analysis using the digital transformation index as the core explanatory variable, the next step involves regressing the six subcomponents of the digital transformation index as explanatory variables, following model (1), and the results are presented in Table 8. From the results in the table, it can be seen that, among the six subcomponents, all except environmental support can enhance the ESG performance of enterprises. However, only strategic leadership, technology-driven initiatives, and digital applications show significance levels above 10%, while the other two components are not significant. The reason for this could be attributed to the different emphases of each subcomponent on reflecting the extent of digital transformation in enterprises. For instance, the calculation basis for the environmental support score focuses on the environment in which the company operates, including the digital investment of the relevant regulatory body, industry, and city. However, this evaluation criterion may be far removed from the actual level of digital transformation within the company itself, resulting in negative correlations and insignificant conclusions.

**Table 8.** Replacement of explanatory variables.

	(1)	(2)	(3)	(4)	(5)	(6)
	<i>ESG</i>	<i>ESG</i>	<i>ESG</i>	<i>ESG</i>	<i>ESG</i>	<i>ESG</i>
<i>Strategy_driven</i>	0.013*** (3.228)					
<i>Tech_enabling</i>		0.007* (1.678)				
<i>Org_enabling</i>			0.006 (0.962)			
<i>Env_enabling</i>				-0.005 (-0.878)		
<i>Digital_achievement</i>					0.004 (0.616)	
<i>Digital_application</i>						0.007** (2.143)
<i>Size</i>	1.520*** (13.465)	1.533*** (13.610)	1.545*** (13.685)	1.552*** (13.810)	1.550*** (13.802)	1.530*** (13.603)
<i>TMT</i>	0.195 (1.016)	0.204 (1.064)	0.209 (1.092)	0.207 (1.081)	0.208 (1.084)	0.203 (1.057)
<i>Listage</i>	-1.411*** (-3.841)	-1.425*** (-3.882)	-1.417*** (-3.858)	-1.407*** (-3.829)	-1.408*** (-3.834)	-1.430*** (-3.900)
<i>Duality</i>	-0.181 (-1.405)	-0.186 (-1.446)	-0.185 (-1.434)	-0.184 (-1.430)	-0.184 (-1.428)	-0.183 (-1.424)
<i>Board</i>	0.110 (0.280)	0.113 (0.285)	0.118 (0.297)	0.121 (0.307)	0.118 (0.298)	0.118 (0.299)
<i>Indirect</i>	0.073*** (7.028)	0.072*** (6.972)	0.072*** (6.960)	0.072*** (6.945)	0.072*** (6.959)	0.073*** (6.986)
<i>Lev</i>	-4.142*** (-9.953)	-4.153*** (-9.971)	-4.152*** (-9.934)	-4.164*** (-10.002)	-4.165*** (-9.998)	-4.153*** (-9.982)
<i>Roe</i>	1.362*** (4.569)	1.368*** (4.591)	1.368*** (4.592)	1.362*** (4.573)	1.364*** (4.577)	1.366*** (4.585)
<i>Growth</i>	-0.299*** (-4.769)	-0.303*** (-4.829)	-0.304*** (-4.849)	-0.301*** (-4.808)	-0.303*** (-4.834)	-0.305*** (-4.871)
<i>Top10</i>	0.002 (0.407)	0.003 (0.448)	0.002 (0.387)	0.002 (0.389)	0.002 (0.389)	0.003 (0.440)
<i>Constant</i>	40.588*** (14.902)	40.786*** (14.974)	40.575*** (14.900)	40.737*** (14.934)	40.492*** (14.848)	40.835*** (15.008)
<i>Industry</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	24569.000	24569.000	24569.000	24569.000	24569.000	24569.000
<i>Adjusted R<sup>2</sup></i>	0.055	0.054	0.054	0.054	0.054	0.054

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. t statistics in parentheses.

## (2) Replacement of explained variables

In this section, Bloomberg's ESG ratings are used to replace the Huazheng ESG ratings employed in the main analysis, and the baseline model is re-estimated. Bloomberg's ESG ratings range from 0 to 100 points and are divided into three dimensions: E (environmental), S (social responsibility), and G (corporate governance). The regression results are shown in Table 9. From the table, it can be

observed that corporate digital transformation can enhance overall ESG performance, environmental performance, and corporate governance capabilities. However, only the impact of digital transformation on environmental performance is statistically significant at the 1% level. Notably, the regression results for corporate digital transformation and social responsibility are contrary to expectations, as digital transformation does not incentivize firms to take on more social responsibility or fulfill their social responsibilities more efficiently. Nevertheless, this result lacks statistical significance.

**Table 9.** Replacement of explained variables.

	Expected Sign	(1) <i>ESG</i>	(2) <i>ESG</i>	(3) <i>ESG</i>	(4) <i>ESG</i>
<i>Digital</i>	+	0.016 (1.001)	0.077*** (2.729)	-0.003 (-0.120)	0.008 (0.686)
<i>Size</i>		1.650*** (8.023)	2.034*** (5.323)	2.456*** (8.643)	0.654*** (4.969)
<i>TMT</i>		-0.120 (-0.391)	-0.638 (-1.057)	0.313 (0.751)	-0.294 (-1.355)
<i>Listage</i>		0.233 (0.307)	1.662 (1.165)	-0.094 (-0.094)	-2.446*** (-4.632)
<i>Duality</i>		-0.231 (-1.037)	0.113 (0.281)	-0.384 (-1.317)	-0.010 (-0.075)
<i>Board</i>		-1.047* (-1.818)	-1.549 (-1.634)	-0.733 (-1.084)	0.458 (0.803)
<i>Indirect</i>		0.029 (1.644)	0.025 (0.812)	0.034 (1.346)	0.006 (0.455)
<i>Lev</i>		-1.806** (-2.534)	-1.956 (-1.531)	-3.273*** (-3.312)	-1.638*** (-3.345)
<i>Roe</i>		0.748 (1.560)	1.619* (1.927)	0.653 (1.072)	-0.554 (-1.538)
<i>Growth</i>		-0.359*** (-3.278)	-0.101 (-0.514)	-0.472*** (-2.748)	-0.196** (-2.148)
<i>Top10</i>		0.003 (0.324)	0.018 (1.159)	-0.002 (-0.153)	0.010 (1.444)
<i>Constant</i>		0.280 (0.053)	-29.890*** (-3.103)	-38.093*** (-5.358)	67.933*** (18.244)
<i>Industry</i>		Yes	Yes	Yes	Yes
<i>Year</i>		Yes	Yes	Yes	Yes
<i>Observations</i>		10275.000	9020.000	10127.000	10275.000
<i>Adjusted R<sup>2</sup></i>		0.690	0.289	0.215	0.913

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. t statistics in parentheses.

#### 4.3.4. Endogeneity Test - Mutual Causation Problems

Considering that the results of the main analysis may be influenced by endogeneity issues—whereby digital transformation enhances ESG performance while companies with strong ESG performance are also more inclined to undergo digital transformation—this paper lags the core explanatory variable by one to three periods and conducting the regression again. The regression results are presented in Table 10. From the table, it can be seen that lagging digital transformation by one period still leads to an enhancement in ESG performance, and this positive effect is significant at the 5%

level. However, when digital transformation is lagged by two or three periods, a suppressive effect emerges. This indicates that if a company deploys digital technology in the current period, the value of digital transformation can be reflected in the current and next period's ESG performance. Yet, as time extends further, this positive impact weakens and may even turn into a suppressive effect.

The reasons for this could be as follows: digital technology evolves rapidly, and its effects tend to diminish over time. The benefits are often short-term, and once the time span is extended, outdated technologies may hinder the company's ESG practices. Therefore, to maintain or continuously pursue improvements in ESG performance, companies need to consistently track new technologies and significantly increase their investment in innovation.

**Table 10.** Endogeneity test: mutual causation problems.

	Expected Sign	(1) <i>ESG</i>	(2) <i>ESG</i>	(3) <i>ESG</i>
<i>Digital (-1)</i>	+	0.023** (2.369)		
<i>Digital (-2)</i>	+		-0.012 (-1.169)	
<i>Digital (-3)</i>	+			-0.039*** (-3.310)
<i>Size</i>		1.539*** (12.557)	1.660*** (11.961)	1.837*** (11.924)
<i>TMT</i>		0.175 (0.843)	0.165 (0.740)	0.095 (0.394)
<i>Listage</i>		-1.324*** (-2.689)	-1.139* (-1.773)	-0.665 (-0.792)
<i>Duality</i>		-0.191 (-1.400)	-0.137 (-0.922)	-0.148 (-0.933)
<i>Board</i>		0.125 (0.320)	0.173 (0.406)	0.198 (0.445)
<i>Indirect</i>		0.073*** (6.594)	0.076*** (6.395)	0.071*** (5.457)
<i>Lev</i>		-4.264*** (-9.590)	-4.609*** (-9.360)	-5.046*** (-9.315)
<i>Roe</i>		1.342*** (4.293)	0.975*** (2.979)	0.732** (2.119)
<i>Growth</i>		-0.231*** (-3.440)	-0.222*** (-3.005)	-0.216*** (-2.727)
<i>Top10</i>		0.005 (0.768)	0.004 (0.520)	0.005 (0.632)
<i>Constant</i>		38.467*** (11.882)	36.290*** (9.347)	32.544*** (7.191)
<i>Industry</i>		Yes	Yes	Yes
<i>Year</i>		Yes	Yes	Yes
<i>Observations</i>		21333.000	18203.000	15493.000
<i>Adjusted R<sup>2</sup></i>		0.055	0.054	0.058

\*\*\*, \*\*, \* denote statistical significance at the two-tailed 1%, 5%, and 10% levels, respectively. t statistics in parentheses.

## 5. Summary

Today, ESG plays a crucial role in promoting sustainable development for enterprises and ensuring that countries fulfill their corresponding environmental commitments. With the continuous development of the digital economy, digital transformation has become an important means for companies to shape core advantages. While scholars have focused on the economic value brought by digital transformation, its potential to generate non-economic value, particularly in enhancing corporate ESG performance, has not been explored in depth.

Based on this, this paper uses data from Chinese A-share listed companies from 2011 to 2021 as the research sample to investigate the impact of digital transformation on corporate ESG performance and its underlying mechanisms. The empirical results indicate that digital transformation injects new momentum into improving corporate ESG performance, and this promoting effect can be transmitted through the companies' green technology innovation capabilities and internal information transparency.

Furthermore, this paper conducts a series of robustness tests; however, the results only partially support the main conclusion, which may be attributed to inappropriate variable substitution. Additionally, a heterogeneity analysis regarding property rights is performed, revealing that digital transformation can equally assist both state-owned and non-state-owned enterprises in better implementing ESG practices. Nevertheless, whether there are significant differences in the promoting intensity of digital transformation between the two types of enterprises requires further analysis combined with inter-group difference testing results for clarification.

Moreover, considering the endogeneity issues arising from mutual causality, this study lags the explanatory variable and finds that the core conclusion only holds when digital transformation is lagged by one period, leading to another conclusion that the effects of digital transformation are short-term in nature.

Based on the findings above, the following recommendations are proposed:

Firstly, at the macro-government level, there should be more encouragement for the integration of the digital economy with the real economy to create a positive market environment that drives enterprises to undergo digital transformation. This will contribute to enhancing the ESG performance of micro-level enterprises and provide assurance for fulfilling environmental commitments and maintaining the stability of society as a whole.

Secondly, at the micro-enterprise level, companies should seize the development opportunities of the digital economy era by engaging in digital transformation to enhance their green technology innovation capabilities and improve internal information transparency. This, in turn, will reflect as an improvement in ESG performance, ultimately building a dual advantage of digitalization and ESG performance. Particularly considering the short-term nature of the effects of digital transformation, continuously tracking new technologies and increasing investment will be an important strategy for enterprises to maintain and even pursue progress in ESG performance.

Given that this paper is merely a preliminary exploration of the impact of digital transformation on corporate ESG performance, there are still significant limitations. First, regarding the mechanisms of action, this study only considers green technology innovation and internal information transparency, but there may be other potential channels and mechanisms involved. Second, to ensure the reliability of the results, broader searches are needed to verify the robustness of the findings. Additionally, further investigations are required for endogeneity issues beyond reverse causality, such as omitted variable problems. Finally, concerning the richness of content, the heterogeneity analysis has so far only considered property rights. Future research will also analyze other grouping criteria, such as the level of corporate carbon emissions, business models, and lifecycle stages.

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