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A Study on the Impact of ESG Performance on Corporate Performance—Based on the Moderating Effect of Digital Transformation

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Abstract

Against the backdrop of the parallel development of the "dual-carbon" strategy and the digital economy, the impact of ESG performance on corporate performance and the moderating effect of digital transformation have become valuable research topics. This paper uses A-share listed companies from 2016 to 2024 as a sample to explore the impact of ESG performance on corporate performance (ROA) and the moderating effect of digital transformation. The study finds that ESG performance has a significant negative impact on current performance, exhibiting obvious "short-term pain" characteristics and potential long-term positive effects that have not yet been fully realized. The combined costs of digital transformation and ESG construction exert a negative moderating effect. Heterogeneity analysis shows that the pollution attributes of an industry weaken the promoting effect of ESG performance on corporate performance, with heavily polluting industries showing even lower marginal effects. Furthermore, factors such as company size and growth significantly positively impact corporate performance, while financial leverage and the short-term costs of digitalization have a negative impact. Based on this, this paper proposes countermeasures from the perspectives of government, enterprises, and investment, providing theoretical reference and practical guidance for ESG-enabled corporate performance transformation and upgrading.

Keywords

ESG performance, corporate performance, digital transformation, moderating effect, industry heterogeneity

1. Introduction

Green development is a new form of economic growth and social development with efficiency, harmony and sustainability as its goals [1]. In 2020, China clearly proposed the "dual carbon" goal of "striving to achieve carbon peak before 2030 and carbon neutrality before 2060", marking the entry of the country's ecological civilization construction into a new stage. Against this background, enterprises, as carriers of technological innovation and low-carbon practices, are particularly important for their green and sustainable development. The ESG (Environment, Society and Governance) concept has received much attention because it is highly compatible with the "dual carbon" goal. At the same time, the digital economy, as a new economic form with data resources as the key element, modern information networks as the main carrier, and the integration and application of information and communication technologies as the driving force, is providing enterprises with

a large number of innovation opportunities through big data, artificial intelligence and other technologies, and promoting enterprises to maintain competitiveness in the rapidly changing market environment [2]. Digital transformation not only provides enterprises with technical support for innovative development, but also plays an irreplaceable role in resource allocation, efficiency improvement and risk management. Against the backdrop of the coordinated advancement of the “dual-carbon” strategy and the digital economy, how ESG performance affects corporate performance, and whether digital transformation will alter this mechanism, have become important topics requiring in-depth exploration.

Corporate performance is a core indicator used to evaluate the effectiveness of corporate strategy execution and the efficiency of resource utilization. It reflects a company's capabilities in market competition and supports decision-making and improvement to achieve long-term sustainable development. Since the reform and opening up, the performance of Chinese enterprises has been steadily improving, but many problems remain, such as weak performance management awareness, outdated performance appraisal data management methods, and a lack of scientific rigor in content and indicator design. These problems continue to affect corporate resilience and its domestic and international competitiveness. At the academic research level, although existing literature has confirmed that good ESG performance can improve corporate performance, there are still disagreements and blind spots regarding the internal mechanisms by which ESG performance is transformed into financial performance. Some studies have found that ESG investments are difficult to translate into financial performance in the short term, and may even have an inhibitory effect on performance due to increased costs; other studies have pointed out that there are significant differences in the efficiency of ESG performance transformation among different companies, and the root causes of these differences have not yet been fully explained. Crucially, most existing research focuses on the independent impacts of ESG performance or digital transformation on corporate performance, neglecting their interaction. Whether digital transformation can act as a catalyst or obstacle to the conversion of ESG performance into corporate performance remains unclear, and its moderating mechanism has not been systematically revealed. This research gap provides a space for exploration in this paper.

Currently, the criticality of ESG performance in the field of corporate performance is widely recognized, but the following shortcomings still exist, urgently requiring further research: Firstly, the breadth of research is insufficient; most literature focuses on the direct impact of ESG on corporate performance, lacking attention to influencing factors and boundary conditions. Furthermore, there is a lack of research combining ESG performance with digital transformation to explore pathways through which “digital value transformation” acts as a moderating mechanism for corporate performance. In the current context of vigorously advocating green development and the digital economy, digital transformation, as a crucial technological variable in corporate operations, is highly likely to modulate the relationship between ESG performance and corporate performance by altering information transmission rates and enhancing resource integration capabilities. Therefore, in-depth exploration of the synergistic or competitive effects of ESG performance and digital transformation in the field of corporate performance has significant practical implications. On the other hand, research depth is lacking. Existing studies on the relationship between ESG and corporate performance fail to fully explain the contradiction that “some companies' ESG investments are efficiently converted into performance, while others see minimal results.” Digital transformation, as a key means for companies to improve operational efficiency and optimize governance structure, largely addresses this issue, but the inherent logic, direction, and intensity of its moderating effect still require empirical verification. Therefore, this paper aims to use digital transformation as a moderating variable, analyzing relevant statistical indicators to explore the moderating mechanism of corporate digital transformation in the process of ESG performance affecting corporate performance from both theoretical and empirical perspectives. This provides theoretical support and practical guidance for companies to achieve performance upgrades through the interaction between ESG and digital transformation.

This research is of significant importance. From a theoretical perspective, it enriches the research perspective on the relationship between ESG performance and corporate performance. This paper breaks through the existing research's singular focus on the direct relationship between the two, introducing digital transformation as a moderating variable to reveal the conditional factors that influence corporate performance through ESG, thus improving the theoretical system of ESG performance effects; it also deepens the research on the economic effects of digital transformation. Existing research largely focuses on the direct impact of digital transformation on corporate performance. This paper places it within the framework of the relationship

between ESG and corporate performance, exploring its moderating role and expanding the application scenarios and theoretical boundaries of digital transformation research; it also discovers the inherent logic of ESG performance transformation. By analyzing the moderating effect of digital transformation, it explains the root causes of differences in the efficiency of ESG investment performance transformation among different companies, providing a new analytical dimension for solving difficulties in academic research. From a practical perspective, it provides development direction for enterprises, guiding them to dynamically adjust their ESG investment strategies according to their own level of digital transformation during the ESG construction process. Simultaneously, it reveals the technology spillover effects driven by internal governance changes or compliance triggered by "mandatory disclosure," providing new ideas for sustainable corporate development; it provides reference for policymakers, offering empirical evidence for the government to formulate ESG-related policies and digital transformation support policies, helping to build a policy environment for the real-time linkage of "ESG + digitalization," and promoting high-quality corporate development; and it provides decision-making basis for investors, helping them to more comprehensively evaluate the value of corporate ESG investment, pay attention to the impact of digital transformation level on ESG performance effects, and improve the scientific nature of investment decisions.

In terms of research methodology, this paper adopts a combination of normative and empirical research methods. The normative research is reflected in the systematic review of domestic and international literature related to ESG performance, digital transformation, and corporate performance. Based on theories such as information asymmetry and resource-based theory, it constructs a theoretical framework for how digital transformation moderates the impact of ESG performance on corporate performance and proposes research hypotheses. The empirical research selects A-share listed companies from 2016 to 2024 as research samples. Through the construction of a multiple linear regression model, it empirically tests the direct impact of ESG performance on corporate performance and the moderating effect of digital transformation. Robustness tests and heterogeneity analysis ensure the reliability of the research conclusions.

2. Literature Review

2.1 The Impact of ESG Performance on Corporate Performance

The impact of ESG performance on corporate performance is an important topic in academia.

Some studies support that ESG has a positive driving effect on corporate performance. Hu and Qin found, based on data from Shanghai and Shenzhen A-shares from 2013 to 2023, that ESG performance can improve corporate performance by alleviating financing constraints and reducing agency costs [3]; Shi used A-share listed companies from 2018 to 2022 as a sample to confirm that innovation capability plays a mediating role in the positive relationship between ESG performance and corporate performance [4]; Zhou et al. also verified that ESG rating has a positive impact on corporate performance [5]; Tao et al. used data from A-share agricultural enterprises from 2013 to 2023 to study and found that green technology innovation plays a significant moderating role in the relationship between ESG performance and corporate performance, which helps to enhance the positive impact of ESG performance on corporate performance [6].

Another view is that ESG investment may have an inhibitory effect on performance in the short term due to increased corporate costs. The "trade-off hypothesis" proposed by Preston and O'Bannon laid the theoretical foundation for this view [7]. They believed that corporate resources are limited and that expenditures on social responsibility and environmental governance will directly squeeze profit margins, leading to a decline in short-term financial performance. Subsequently, Margolis et al. further confirmed through a large-scale meta-analysis that the positive correlation between corporate social responsibility and financial performance usually takes a long time to manifest [8]. In the early stage of investment, due to the cost first and the benefit lagging, negative short-term effects are often observed. In China, Zhang and Zhao found through analysis of Chinese A-share listed companies that ESG performance is negatively correlated with corporate financial performance (ROA, ROE) in the short term [9]. Gao et al. revealed that when there is a large divergence in the market's ESG rating of enterprises, it will increase the uncertainty of corporate information and financing costs, thereby having a negative impact on the total factor productivity of enterprises [10]. Xie and Lü also confirmed this rule, that enterprises will increase compliance costs in the short term when fulfilling ESG responsibilities, but in the long term it will help improve the performance of foreign investment [11]. These studies collectively

reveal the "short-term pain" characteristic of ESG investment, namely, the early investment of enterprises in environmental, social and governance aspects will significantly increase operating costs, while the corresponding long-term benefits such as cost reduction and efficiency improvement, risk management and competitiveness reconstruction will take a long time to realize.

2.2 The Moderating Role of Digital Transformation

The relationship between enterprise digital transformation and performance and value presents a "double-edged sword" situation. On the one hand, digital transformation can promote the improvement of enterprise performance and the reconstruction of value. Wu et al. proposed that digital technology can optimize production processes, reduce communication costs and improve resource allocation efficiency [12]; Bharadwaj showed that as the digital capabilities of enterprises mature, innovative models can be built to form competitive advantages, thereby achieving long-term value growth [13]. On the other hand, digital transformation is very likely to have a negative effect and inhibitory effect on performance in the short term due to the high cost investment. Brynjolfsson and McAfee pointed out that initial costs will squeeze profit margins and drag down productivity growth in the short term, forming a "digital paradox" [14]; Liu et al. empirically found that digital transformation and corporate performance have a U-shaped relationship [15]. The underlying mechanism is that high initial investment leads to reduced performance, and performance increases significantly after crossing the critical point. In summary, digital transformation has the characteristics of "accumulation and release". Xiao et al. found that digital transformation indirectly affects corporate performance by optimizing human capital structure, but its positive effect requires a long adjustment period to manifest [16].

This paper focuses on the moderating role of digital transformation in the relationship between ESG performance and corporate performance. Its internal logic chain lies in the bidirectional transformation from compliance-driven technology spillover to digital value [17]: First, in order to achieve ESG goals such as carbon emission monitoring and resource management, enterprises need to build digital infrastructure. Although this initial investment stems from the pressure of compliance disclosure, its effectiveness will spread to the entire process of enterprise operation and management, i.e. the entire business chain, through optimizing production processes, thereby realizing the transition from "external regulatory pressure" to "internal business motivation". Secondly, digital transformation utilizes big data and cloud computing technologies, which can affect the performance conversion efficiency of ESG investment in different situations. Highly digital enterprises can accelerate the realization of ESG value through information transmission, resource integration and risk control mechanisms, while lowly digital enterprises may fall into a short-term performance dilemma due to dual cost pressures [18].

3. Theoretical Analysis and Research Hypotheses

3.1 Theoretical Analysis of the Impact of ESG Performance on Corporate Performance

Based on the resource-based theory and the trade-off hypothesis [19-20], corporate investment in environmental, social, and governance (ESG) typically exhibits a "cost-first, benefit-later" characteristic. First, according to the trade-off hypothesis, corporate resources are limited in the short term. To improve ESG performance, companies need to invest heavily in green technology research and development, pollution control facilities, and employee welfare improvements. These expenditures are often included in current costs in financial accounting, directly squeezing corporate profit margins and causing a decline in performance indicators such as return on total assets (ROA) in the short term, resulting in obvious "short-term pain." Second, according to the information asymmetry theory [21-22], the non-financial benefits brought by ESG investment (such as enhanced brand reputation and reduced financing constraints) have strong positive externalities and uncertainties [23]. These benefits often need a long time window for the market and investors to gradually digest and reflect them in corporate performance. Therefore, in the initial stages of investment, high compliance and operational costs dominate, while long-term benefits have not yet materialized. Based on this, this paper proposes the following hypothesis:

H1: ESG performance has a lagged positive impact on corporate performance.

3.2 The Moderating Logic of Digital Transformation in the Relationship between ESG Performance and Corporate Performance

As a key technological variable in corporate operations, digital transformation and ESG construction exhibit a "double cost" logic in their interaction. On the one hand, digital transformation itself is a high-investment, high-risk project. According to the "digital paradox" theory, companies need to build expensive digital infrastructure and introduce technologies such as big data and artificial intelligence in the early stages of transformation, which will generate huge financial expenditures in the short term, squeezing current profits. On the other hand, when companies simultaneously promote ESG construction and digital transformation, resource competition and cost superposition effects will occur. Companies with high levels of digitalization often need to invest in more cutting-edge digital technologies to achieve ESG goals such as accurate carbon emission monitoring and transparent supply chain management, which further increases their financial burden. Companies with low levels of digitalization may lack effective resource integration capabilities and fall into a passive investment dilemma when dealing with ESG regulatory pressure, making the double cost pressure even more prominent. Therefore, the cost effects of digitalization may overshadow its enabling effects in the short term, but it possesses potential long-term benefits. Based on the above analysis, this paper proposes the following hypothesis:

H2: Digital transformation plays a significant moderating role in the relationship between ESG performance and corporate performance; that is, the level of digitalization alters the direction and intensity of the impact of ESG performance on corporate performance.

4. Research Design

4.1 Sample and Data Sources

This paper selects A-share listed companies data from 2016 to 2024 as the research sample, and performs the following screening on the initial data: (1) Excludes abnormal operating samples such as ST, *ST, and PT; (2) Excludes samples from the financial and insurance industries, as the characteristics and regulatory requirements of this type of industry differ greatly from other industries, making horizontal comparison difficult; (3) Excludes samples with missing variables to ensure data integrity; (4) Performs a 1% winsorize (tailing) on all continuous variables to eliminate the influence of extreme values. After screening, 26,121 sample observations were finally obtained. The corporate ESG performance data comes from Huazheng Index, a third-party authoritative rating agency published by Wind. The data related to digital transformation are constructed using Python text analysis technology, and other control data are all from the CSMAR database.

4.2 Variable Definitions

Explicit Variable: Corporate Performance (ROA). In existing studies, scholars mostly quantify corporate performance from a financial perspective. The indicators, including Return on Assets (ROA), Return on Equity (ROE), Tobin's Q, and Earnings Per Share (EPS), provide quantitative accordance from the perspectives of asset efficiency, capital return, market expectations, and shareholder interests. This paper aims to explore whether ESG performance can be transformed into a company's core competitive advantage and generate additional revenue, thereby improving performance. Based on Shi Yiling's methodology, this paper uses ROA as the performance evaluation standard. It not only directly reflects the profitability of assets but also embodies the company's comprehensive competence in resource utilization and value creation, demonstrating the company's operational development and resource value to a certain extent, making it highly representative.

Explanatory Variable: ESG Performance. This paper uses annual data from Huazheng ESG Ratings. Huazheng ESG Ratings, from highest to lowest, are AAA, AA, A, BBB, BB, B, CCC, CC, and C. This paper assigns scores from 1 to 9 based on these ratings, with higher scores indicating better ESG performance.

Mediating Variable: Digital Transformation. This paper draws on the research method of Wu et al. to construct enterprise digital transformation indicators through text recognition of listed companies' annual reports [24]. Compared with a single financial input indicator, text analysis can capture the management's emphasis on digitalization and actual application scenarios from the strategic perspective of the enterprise, and is more comprehensive and forward-looking. Moreover, the indicators cover keywords of underlying

technologies and practical applications, which can depict the degree of penetration of enterprises in digital transformation and effectively measure the substantial progress of enterprise digitalization. More convincingly, the thesaurus constructed by Wu et al. has been widely used in Chinese core journals, and its reliability and validity have been fully verified, which helps to improve the objectivity and comparability of the empirical analysis results in this paper. The specific method is as follows: using Python text analysis technology, keyword retrieval is performed on the "Management Discussion and Analysis" (MD&A) section of the annual reports of A-share listed companies. The retrieval scope covers five dimensions: artificial intelligence, big data, cloud computing, blockchain and digital technology applications. The frequency of occurrence of keywords in the above five dimensions is summed to obtain the original total word frequency of enterprise digital transformation. Considering the obvious right-skewed characteristic of word frequency data, this paper performs natural logarithmic transformation on the total word frequency after adding 1, i.e., Digital = ln(1 + Total_Keywords). A higher score indicates a deeper level of digital transformation for the enterprise.

Interaction Term: ESG Performance×Digital Transformation (ESG×Digital). To test the moderating effect of digital transformation, this paper constructs the interaction term ESG×Digital, which is the core variable for testing hypothesis H2. If the coefficient of the interaction term is significantly positive, it indicates that digital transformation strengthens the positive impact of ESG performance on corporate performance; conversely, if the coefficient is significantly negative, it indicates that digital transformation weakens this positive impact.

Control Variables: This paper selects the following control variables: firm size (Asset), financial leverage (Debt), cash flow ratio (Cashflow), revenue growth rate (Growth), number of directors (Boardsize), duality (Duality), and government subsidies (lnSubsidy). Additionally, a year dummy variable (Year) and a firm fixed-effects dummy variable (Firm) are included. The definitions of these variables are shown in Tab.1.

Table 1: Variable definition

Variable Type	Variable Name	Variable Symbol	Variable Description
Explanatory variable	Return on Total Assets	ROA	Year-end Net Profit / Total Assets
Explanatory variables	ESG performance	ESG	Huazheng ESG Rating Results
Mediator variables	Digital transformation level	Digital	The natural logarithm of the total frequency of words in the five dimensions of artificial intelligence, big data, cloud computing, blockchain, and digital technology applications plus 1.
control variables	Company Size	Asset	Natural logarithm of total annual assets
	Financial Leverage	Debt	Total liabilities / Total assets
	Cash Flow Ratio	Cashflow	Net cash flow from operating activities / Total assets
	Revenue Growth	Growth	Year-end revenue growth / Beginning-of-year total revenue
	Number of Directors	Boardsize	The natural logarithm of the number of board members
	Dual Roles (Both Director and Director)	Duality	If the chairman and the general manager are the same person, assign a value of 1; otherwise, assign a value of 0.
	Government Subsidies	lnSubsidy	External policy impact
	Company Year	Firm	Company fixed-effects dummy variable
	Company Size	Year	Annual dummy variable

Source: Author's survey

4.3 Model Construction

To study the impact of ESG performance on corporate performance, and to verify Hypothesis 1, a regression model (1) was constructed:

$$ROA_{i,t} = \alpha_0 + \beta_1 ESG_{i,t} + \sum Control_{i,t} + \sum Firm + \sum Year + \varepsilon_{i,t} \quad (1)$$

Where, the subscript i represents the individual, t represents the year, $\sum Control_{i,t}$ is the set of control variables, Year and Firm are the year fixed effect and company fixed effect, respectively (industry attributes

are inherent characteristics of enterprises that do not change over time, and the company fixed effect will completely absorb the industry fixed effect), and ε is the residual value.

Furthermore, to explore the moderating effect of digital transformation, and to verify Hypothesis 2, a moderating variable Digital and an interaction term ESG×Digital were added to model (1) to construct model (2):

$$ROA_{i,t} = \alpha_0 + \beta_2 ESG_{i,t} + \beta_3 Digital_{i,t} + \beta_4 (ESG_{i,t} \times Digital_{i,t}) + \sum Control_{i,t} + \sum Firm + \sum Year + \varepsilon_{i,t} (2)$$

5. Empirical Results and Analysis

5.1 Descriptive Statistics

To initially observe the overall characteristics of the sample, this paper conducted descriptive statistical analysis on the main variables. Statistical indicators included sample size, mean, standard deviation, median, minimum, and maximum values. The results are shown in Table 2. Fig.1 to Fig.3 visually illustrate the distribution density of the core variables ROA, ESG, and Digital, facilitating understanding of the sample characteristics. Overall, there are certain differences among the variables, which can well reflect the heterogeneity of the observed enterprises in terms of operating conditions and governance levels.

From the perspective of the explained variable, the mean of firm performance (ROA) is 0.0321, the standard deviation is 0.0680, the minimum is -0.2479, the maximum is 0.2145, and the median is 0.0337. It can be seen that there are significant differences in profitability among different enterprises, with some enterprises experiencing negative returns, indicating that the distribution of firm performance has a certain degree of dispersion.

From the core explanatory variables, the mean of ESG performance (ESG) is 4.116, the median is 4, the minimum is 1, the maximum is 7, and the standard deviation is 1.165. Overall, ESG performance is at a moderate level, but there are significant differences between companies, indicating uneven practices in environmental, social responsibility, and corporate governance.

From the control variables, the mean of firm size (Asset) is 22.413, the median is 22.24, the minimum is 20.2, the maximum is 26.21, and the standard deviation is 1.230, showing that while the overall size of firms is not significantly different, some differentiation exists. The mean of the debt-to-equity ratio (Debt) is 0.426, the median is 0.417, the minimum is 0.068, the maximum is 0.928, and the standard deviation is 0.200, indicating that the overall leverage level is within a moderate range, but there are significant differences in financial structures among different companies. The mean of the cash flow ratio is 0.0503, the minimum is -0.1365, the maximum is 0.2411, and the standard deviation is 0.0649, indicating that some companies have negative operating cash flow and that there are significant differences in operating capabilities among companies. The mean of growth is 0.2874, but the standard deviation reaches 0.7372, with a minimum of -0.6840 and a maximum of 4.8252, indicating high disparity in growth capabilities among companies.some companies are in a phase of rapid growth, while others are experiencing stagnant or even declining growth. The mean of dual roles (chairman and general manager) is 0.3088, indicating that approximately 30% of companies have the same person holding both the chairman and general manager positions. The mean of the government subsidy variable (lnSubsidy) is 15.9478, the minimum is 8.5174, the maximum is 20.1627, and the standard deviation is 2.0480, reflecting the varying degrees of government subsidies received by companies.

Furthermore, the mediating variable “Digital Transformation Level” has a mean of 1.331, a minimum of 0, a maximum of 4.727, and a standard deviation of 1.305, revealing a uneven progress in digitalization. Some companies have not yet significantly implemented digital transformation, while others have a high level of digitalization.

Overall, the descriptive statistical analysis results obtained in this paper generally reflect the actual situation of listed companies and possess a certain degree of reliability.

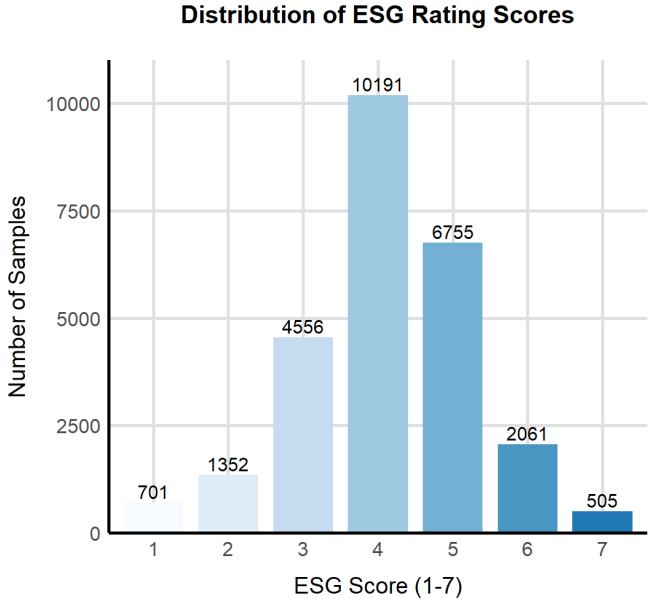
Table 2: Descriptive statistics

Variable	Obs	Mean	Sd	Min	Md	Max
ROA	26121	0.032	0.068	-0.248	0.034	0.214
ESG	26121	4.116	1.165	1	4	7

Variable	Obs	Mean	Sd	Min	Md	Max
Asset	26121	22.413	1.230	20.200	22.240	26.210
Debt	26121	0.426	0.200	0.068	0.417	0.928
Cashflow	26121	0.050	0.065	-0.136	0.048	0.241
Growth	26121	0.287	0.737	-0.684	0.110	4.825
Duality	26121	0.309	0.462	0	0	1
lnSubsidy	26121	15.948	2.048	8.517	16.214	20.163
Digital	26121	1.331	1.305	0	1.099	4.727

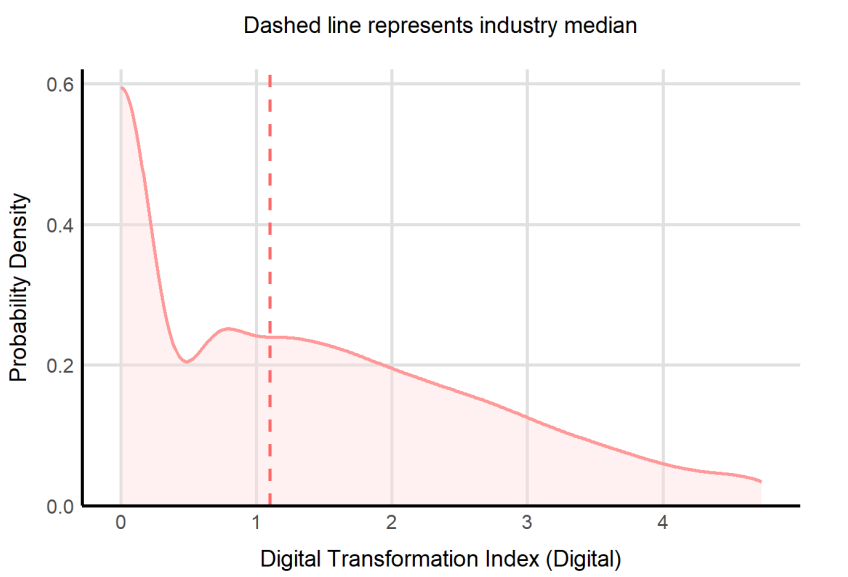
Note: Obs is the sample size, Mean is the sample mean, Sd is the sample standard deviation, Min is the sample minimum, Md is the sample median, and Max is the sample maximum.
Source: Author's survey

Figure 1: ESG distribution bar chart



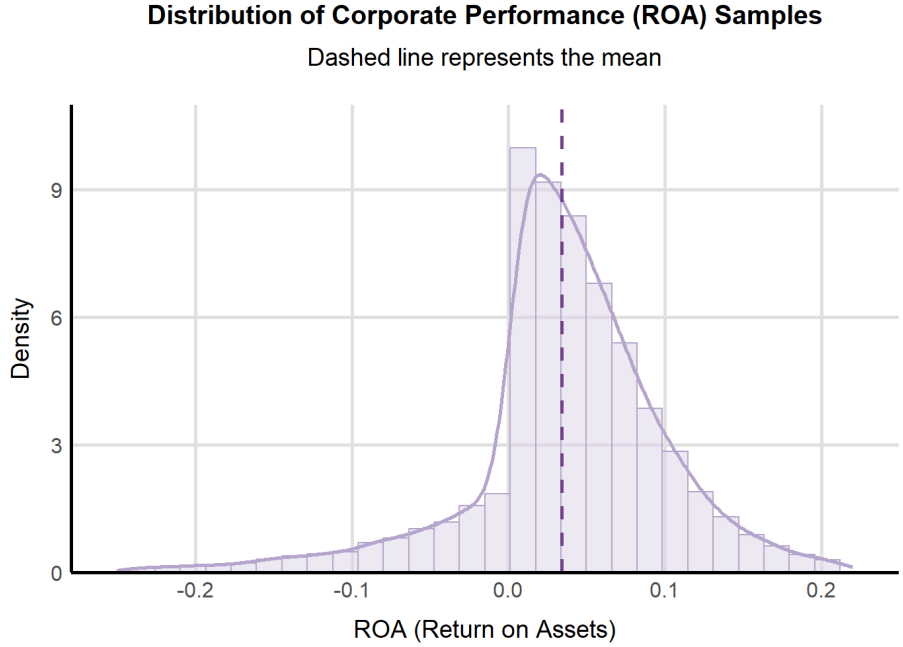
Source: Author's survey.

Figure 2: Digital Distribution Density Map



Source: Author's survey

Figure 3: ROA distribution histogram



Source: Author's survey.

5.2 Correlation Analysis

The results of the correlation analysis are shown in Table 3. The correlation coefficients among different variables were generally below 0.500. The correlation coefficient between ESG performance (ESG) and corporate performance (ROA) was 0.221, significantly positive at the 1% level, indicating that companies with better ESG performance typically have higher operational performance. Meanwhile, there was a negative correlation between corporate digitalization level and corporate performance (ROA), with a correlation coefficient of -0.0612. Furthermore, there was also a certain degree of correlation between ESG performance (ESG) and corporate digitalization level (Digital). It is worth noting that corporate digital transformation often requires high upfront investment, which may have a certain impact on corporate profitability in the short term. Therefore, it showed a negative correlation with corporate performance in the correlation analysis, but this result still needs further verification through regression analysis after controlling for relevant variables.

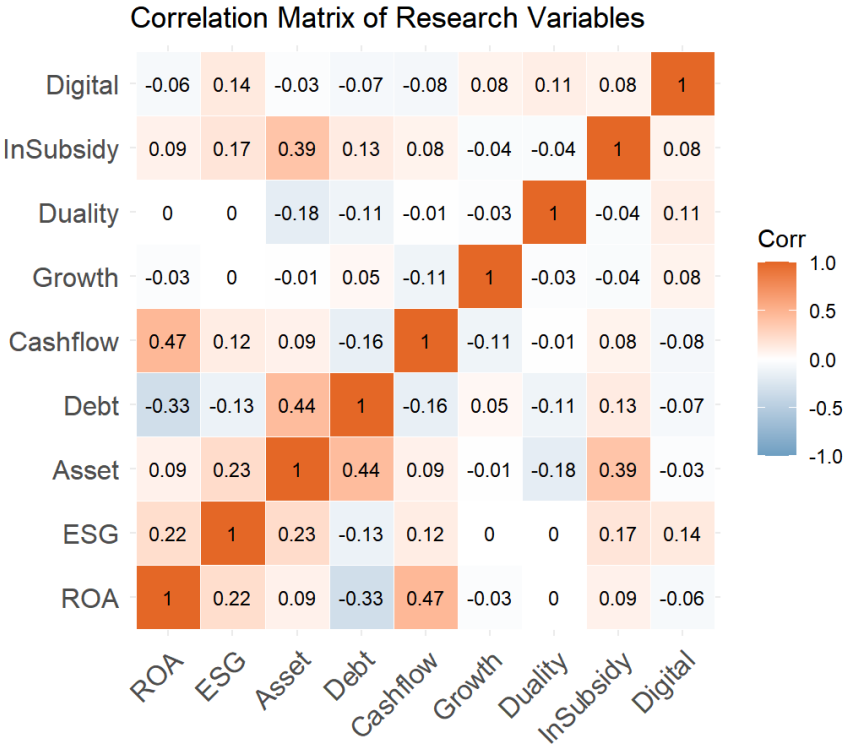
To test for the existence of multicollinearity in the model, this paper conducted a variance inflation factor (VIF) test on each explanatory variable. The results are shown in Table 4. The VIF values of all variables are significantly less than 10, with the maximum value being 1.62 and the average VIF being 1.20. This indicates that there is no significant multicollinearity problem among the explanatory variables in the model, and the model specification has good stability.

Table 3: Correlation analysis results

Variable	ROA	ESG	Asset	Debt	Cashflow	Growth	Duality	lnSubsidy	Digital
ROA	1								
ESG	0.2206***	1							
Asset	0.0850***	0.2276***	1						
Debt	-0.3324***	-0.1308***	0.4399***	1					
Cashflow	0.4663***	0.1196***	0.0888***	-0.1648***	1				
Growth	-0.0265*	0.0022	-0.0133*	0.0484***	-0.1134***	1			
Duality	0.0026	0.0023	-0.1757***	-0.1067***	-0.0091	-0.0258***	1		
lnSubsidy	0.0870***	0.1674***	0.3851***	0.1277***	0.0804***	-0.0428***	-0.0382***	1	
Digital	-0.0612***	0.1372***	-0.0328***	-0.0720***	-0.0838***	0.0759***	0.1115***	0.0840***	1

*Note: *, **, and *** indicate significance at the 10%, 5%, and 1% significance levels, respectively.*
source: Author's survey

Figure 4: Correlation heatmap



Source: Author's survey

Table 4: VIF test results

variable	VIF	1/VIF
Asset	1.62	0.616
Debt	1.40	0.714
lnSubsidy	1.20	0.834
ESG	1.16	0.858
Cashflow	1.09	0.918
Digital	1.06	0.942
Duality	1.05	0.955
Growth	1.02	0.978
Mean VIF	1.20	

Source: Author's survey

5.3 Regression Analysis

5.3.1 Impact of ESG Performance on Corporate Performance

To examine the direct impact of ESG performance on corporate performance, this paper constructs model (1) for regression analysis. Based on controlling for firm size (Asset), financial leverage (Debt), cash flow ratio (Cashflow), revenue growth rate (Growth), duality (Duality), government subsidies (lnSubsidy), and year fixed effects, a firm fixed effects model is adopted, and the standard error is adjusted for clustering at the firm level to mitigate the impact of heteroscedasticity and serial correlation on the estimation results. The regression results are shown in Table 5.

Column (1) of Table 5 reports the baseline regression results of ESG performance on corporate performance (ROA). The regression coefficient of the core explanatory variable ESG is -0.0009, and it is significant at the 5% level ($t = -2.16$, $p = 0.031$). This result indicates that during the sample period, there is a significant negative relationship between corporate ESG performance and current corporate performance; that is, the better the ESG performance of a company, the lower its current financial performance. This result aligns with the "short-term pain" phenomenon described in the preceding literature: firms often need to pay upfront costs for environmental, social, and governance (ESG) investments, while the resulting improvements in operational

efficiency and risk reduction have a certain lag, potentially crowding out financial performance in the short term [7,9]. This also means that the performance transformation of ESG is not immediate but requires a certain time frame.

From the perspective of control variables, the coefficient for firm size (Asset) is significantly positive (0.0280, $p < 0.01$), indicating that larger firms have stronger profitability and resource integration capabilities. The coefficient for the debt-to-equity ratio (Debt) is significantly negative (-0.1862, $p < 0.01$), suggesting that excessive financial leverage weakens firm performance. The cash flow ratio (Cashflow) is significantly positive (0.2371, $p < 0.01$), confirming that robust cash flow is a crucial guarantee for firm performance. The revenue growth rate (Growth) is significantly positive (0.0062, $p < 0.01$), showing that firms with higher growth rates perform better. The coefficients for duality and government subsidies (lnSubsidy) are negative but not significant, indicating that their direct impact on current performance is limited. A significant year-fixed effect indicates that the macroeconomic environment in different years has a systematic impact on firm performance.

The above results provide the necessary preconditions for subsequent testing of the lagged effects of ESG performance: if ESG investment does indeed have the characteristics of cost-first and benefit-later, then the lagged term of introducing ESG should show a significant positive impact. Therefore, this paper will further discuss the dynamic effects of ESG performance to fully reveal its true impact path on corporate performance.

Table 5: ESG performance benchmark regression results on firm performance

Variable	Coefficient	Standard error	t-value	P>|t|	95% confidence interval
ESG	-0.0009**	0.0004	-2.16	0.031	[-0.0018, -0.0001]
Asset	0.0280***	0.0017	16.66	0.000	[0.0247, 0.0313]
Debt	-0.1862***	0.0065	-28.70	0.000	[-0.1989, -0.1735]
Cashflow	0.2371***	0.0102	23.16	0.000	[0.2170, 0.2571]
Growth	0.0062***	0.0007	8.57	0.000	[0.0048, 0.0076]
Duality	-0.0006	0.0015	-0.36	0.718	[-0.0036, 0.0025]
lnSubsidy	-0.0002	0.0002	-1.10	0.272	[-0.0006, 0.0002]
Constant term	-0.5047***	0.0358	-14.08	0.000	[-0.5750, -0.4345]
Year fixed effects	control				
Company fixed effects	control				
Sample size	26,121				
Number of firms	4,531				
R^2 (within)	0.2061				

*Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; standard error is adjusted for clustering at the company level.*
Source: Author's survey

5.3.2 Moderating Effect Test of Digital Transformation

To test the moderating effect of digital transformation on the impact of ESG performance on corporate performance, this paper introduces digital transformation (Digital) and its interaction term with ESG performance (ESG×Digital) on the basis of model (1), constructing model (2). To avoid multicollinearity, ESG and Digital were centered to generate the interaction term. The regression results are shown in Table 6 and Figure 6.

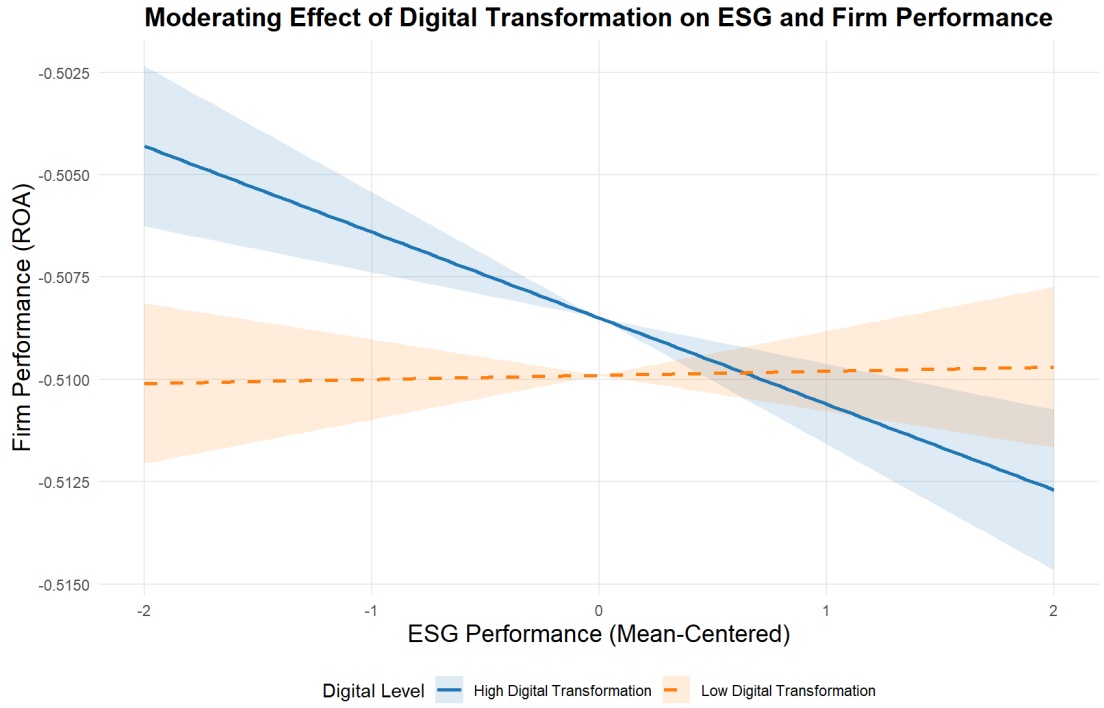
Column (2) of Table 6 reports the estimation results of the moderating effect. The coefficient of the core explanatory variable ESG_c is -0.0010, which is still significant at the 5% level ($t = -2.24$, $p = 0.025$), consistent with the baseline results. The coefficient of digital transformation (Digital_c) is 0.0007, but it did not pass the significance test ($p = 0.284$), indicating that the direct impact of the current degree of digital transformation on corporate performance is not significant, which may be due to the long input-output cycle of digital construction. More importantly, the coefficient of the interaction term ESG_x_Digital is -0.0011 and is significant at the 1% level ($t = -3.17$, $p = 0.002$). This result indicates that digital transformation significantly and negatively moderates the relationship between ESG performance and corporate performance. In other words, for companies with a higher degree of digital transformation, the negative effect of ESG performance on current performance is more pronounced.

This result is consistent with hypothesis H2 (digital transformation plays a moderating role), but the moderating direction differs from the expected positive one. A possible reason is that digital transformation itself requires significant upfront investment. When companies simultaneously promote ESG development and digital innovation, the dual cost pressures may overlap in the short term, further squeezing profit margins and thus reinforcing the short-term negative effects of ESG. Furthermore, highly digitalized companies often face more complex technological challenges, and the integration of ESG concepts may require a longer adjustment period, leading to a temporary decrease in performance conversion efficiency. This finding reveals that digital transformation can become a "stumbling block" to ESG performance conversion at specific stages and for different companies, providing a new perspective for understanding the combined effects of corporate ESG and digitalization.

From the perspective of control variables, the signs and significance of the coefficients of each variable remained relatively stable, indicating that the model setting was relatively robust. The year fixed effect remained significant, indicating that the impact of the macro environment on performance continued.

Further understanding, referring to the research of Zhao et al., digital transformation has a significant threshold effect on the improvement of total factor productivity [25]. that is, only when the investment in digitalization exceeds a certain threshold can the production efficiency dividend be fully released. The negative adjustment effect found in this paper is essentially caused by the superposition of the dual costs of ESG construction and digital transformation in the early stage of investment. When enterprises simultaneously promote two high-investment, long-cycle strategic changes, the resource competition effect doubles the short-term cost pressure. This finding also implies the possible dynamic evolution law of ESG and digitalization, that is, "conflict first, then collaboration". In the short term, the two are in a limited resource competition relationship, and in the long term, digital technology is expected to empower ESG management, reduce marginal costs, and improve operational efficiency.

Figure 5: The moderating effect of digital transformation on the relationship between ESG performance and firm performance (ROA)



Note: This figure plots the marginal effect of ESG performance on ROA at high (1 SD above the mean) and low (1 SD below the mean) levels of digital transformation. All variables are mean-centered. The solid line represents high digital transformation, and the dashed line represents low digital transformation.
Source: Author's survey

Table 6: Regression results of the moderating effect of digital transformation

Variable	Coefficient	Standard error	t-value	P>|t|	95% confidence interval
ESG (Centralized)	-0.0010**	0.0004	-2.24	0.025	[-0.0018, -0.0001]
Digital (Centralized)	0.0007	0.0006	1.07	0.284	[-0.0005, 0.0012]
ESG×Digital	-0.0011***	0.0003	-3.17	0.002	[-0.0017, -0.0004]
Asset	0.0281***	0.0017	16.62	0.000	[0.0248, 0.0314]
Debt	-0.1864***	0.0065	-28.72	0.000	[-0.1991, -0.1737]
Cashflow	0.2372***	0.0102	23.21	0.000	[0.2172, 0.2573]
Growth	0.0062***	0.0007	8.56	0.000	[0.0048, 0.0076]
Duality	-0.0006	0.0015	-0.34	0.735	[-0.0035, 0.0025]
lnSubsidy	-0.0002	0.0002	-1.09	0.277	[-0.0006, 0.0002]
Constant term	-0.5092***	0.0362	-14.08	0.000	[-0.5802, -0.4383]
Year fixed effects	control				
Company fixed effects	control				
Sample size	26,121				
Number of firms	4,531				
R^2 (within)	0.2068				

*Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; standard errors are adjusted for clustering at the company level; ESG and Digital have been centrally processed.*
Source: Author's survey

5.3.3 Lag Effect Test of ESG Performance

The benchmark regression found a significant negative correlation between ESG performance and current corporate performance. This may be because the initial cost of ESG investment is dominant, while the benefits are lagged. To test the dynamic process of ESG performance transformation, this paper introduces ESG lags of 1 to 6 periods for regression analysis. The model setting is consistent with the benchmark regression, and the results are shown in Table 7.

Columns (1) to (6) of Table 7 report the regression results for ESG lags of 1 to 6 periods, respectively. From the trend of coefficient changes, the coefficients of L1.ESG to L5.ESG are all significantly negative at the 1% level, indicating that ESG investment continues to suppress corporate performance for a period of 2–3 years. This result verifies the phenomenon of "short-term pain". Specifically, the coefficients for L1.ESG were -0.0034 ($p < 0.01$), L2.ESG -0.0042 ($p < 0.01$), L3.ESG -0.0020 ($p < 0.01$), L4.ESG -0.0029 ($p < 0.01$), and L5.ESG -0.0027 ($p < 0.01$). The coefficient for L6.ESG turned positive (0.0012), but failed the significance test ($p = 0.273$), indicating that the long-term positive effect of ESG performance has not yet fully manifested during the sample observation period, and a longer time interval is needed for performance transformation.

This result partially supports the expectation of Hypothesis H1: the impact of ESG performance on firm performance has a significant lag, and in the short term, the effect is mainly negative, while the long-term positive effect may take more than 3 years to manifest. This finding reveals the long-term nature of ESG investment returns and explains why some companies are hesitant to invest in ESG due to short-term performance pressures.

Table 7: ESG performance test on the lag effect of firm performance

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROA	ROA	ROA	ROA	ROA
L.ESG	-0.0034***					
	(0.0006)					
L2.ESG		-0.0042***				
		(0.0006)				
L3.ESG			-0.0020***			
			(0.0007)			
L4.ESG				-0.0029***		
				(0.0008)		
L5.ESG					-0.0027***	
					(0.0009)	
L6.ESG						0.0012

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROA	ROA	ROA	ROA	ROA
						(0.0011)
Asset	0.0286***	0.0266***	0.0325***	0.0322***	0.0421***	0.0586***
	(0.0022)	(0.0027)	(0.0034)	(0.0046)	(0.0067)	(0.0100)
Debt	-0.1961***	-0.2047***	-0.2237***	-0.2235***	-0.2407***	-0.2951***
	(0.0082)	(0.0100)	(0.0114)	(0.0142)	(0.0182)	(0.0237)
Cashflow	0.2412***	0.2342***	0.2440***	0.2357***	0.2200***	0.1905***
	(0.0119)	(0.0133)	(0.0143)	(0.0153)	(0.0179)	(0.0237)
Growth	0.0062***	0.0062***	0.0061***	0.0061***	0.0074***	0.0076***
	(0.0009)	(0.0010)	(0.0011)	(0.0012)	(0.0013)	(0.0016)
Duality	-0.0020	-0.0031	-0.0018	0.0003	-0.0008	-0.0012
	(0.0019)	(0.0021)	(0.0025)	(0.0029)	(0.0034)	(0.0040)
lnSubsidy	-0.0003	-0.0005*	-0.0003	-0.0005*	-0.0008**	-0.0007*
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)
cons	-0.5030***	-0.4625***	-0.6041***	-0.5916***	-0.7999***	-1.1804***
	(0.0474)	(0.0595)	(0.0738)	(0.1020)	(0.1514)	(0.2256)
N	20336	16460	13159	10478	8058	5763
R2	0.195	0.178	0.192	0.184	0.191	0.184
adj. R2	0.194	0.177	0.191	0.183	0.190	0.183

Note: Standard errors in parentheses
** p < 0.1, ** p < 0.05, *** p < 0.01*
Source: Author's survey

5.4 Robustness Test

To ensure the baseline regression conclusions and avoid measurement deviation that may arise from a single performance indicator, this paper retests the model by replacing the explained variable. Return on equity (ROE) and Tobin's Q are used as substitute variables for firm performance. While maintaining the two-way fixed effects between individual companies and years, model (1) is re-regressed. The results are shown in columns (1) and (2) of Table 8.

In column (1), the regression coefficient for ESG performance is -0.0087. Although it does not pass the statistical significance test ($p > 0.1$), its sign is completely consistent with the baseline regression (negative), indicating that ESG performance also has an inhibitory effect on ROE. Regarding control variables, the coefficient for the debt-to-equity ratio (Debt) was -0.5900, significantly negative at the 1% level; the coefficient for the cash flow ratio (Cashflow) was 0.2437, significantly positive at the 1% level; the coefficient for the revenue growth rate (Growth) was 0.0008 but not significant; Duality and government subsidies (lnSubsidy) were both insignificant. The performance of these control variables largely matched the benchmark regression, indicating that the model specification has good stability.

In column (2), the regression coefficient of ESG performance on Tobin's Q value was -0.0139, significantly negative at the 10% level, further demonstrating the lagged impact of ESG performance on corporate market capitalization. The coefficient for firm size (Asset) was -0.6920 (significant at 1%), and the coefficient for the debt-to-equity ratio (Debt) was 0.4227 (significant at 1%), opposite in sign to the ROA model in the benchmark regression. This difference is reasonably explainable: Tobin's Q, as a market indicator, reflects investor expectations; large-scale and low-leverage companies face limited growth potential, leading to lower market valuations. ROA, on the other hand, as an accounting indicator, directly reflects current profitability. Despite the difference in the signs of the control variables, the core explanatory variable, ESG, remains robust.

In summary, changing the performance measurement indicator used as the explained variable does not fundamentally reverse the core conclusions, indicating the model's robustness.

Table 8: ESG performance test on the lag effect of firm performance

	(1)	(2)
	ROE	TobinQ
ESG	-0.0087	-0.0139*
	(0.0054)	(0.0077)
Asset	0.0439	-0.6920***
	(0.0287)	(0.0463)
Debt	-0.5900***	0.4227***
	(0.1144)	(0.1528)
Cashflow	0.2437***	1.0979***
	(0.0757)	(0.1506)
Growth	0.0008	-0.0238*
	(0.0091)	(0.0130)
Duality	0.0183	-0.0570*
	(0.0123)	(0.0311)
lnSubsidy	-0.0021	-0.0069
	(0.0034)	(0.0051)
2016.year	0.0000	0.0000
	(.)	(.)
2017.year	-0.0012	-0.3089***
	(0.0252)	(0.0257)
2018.year	0.0062	-0.8103***
	(0.0220)	(0.0300)
2019.year	0.0352	-0.5465***
	(0.0288)	(0.0318)
2020.year	0.0298	-0.1963***
	(0.0303)	(0.0402)
2021.year	0.0255	-0.0106
	(0.0244)	(0.0389)
2022.year	0.0107	-0.3705***
	(0.0250)	(0.0356)
2023.year	0.0182	-0.3148***
	(0.0255)	(0.0347)
2024.year	0.0086	-0.2831***
	(0.0249)	(0.0368)
cons	-0.6789	17.7763***
	(0.5933)	(1.0022)
N	25954	25954
R2	0.009	0.124
adj. R2	0.008	0.123

Note: Standard errors in parentheses
** p < 0.1, ** p < 0.05, *** p < 0.01*
Source: Author's survey

5.5 Heterogeneity Analysis

To examine whether the impact of ESG performance on corporate financial performance differs based on industry pollution levels, we divided the full sample into a heavily polluting industry group (heavy=1) and a lightly polluting industry group (heavy=0) for grouped regression analysis. Furthermore, we introduced an interaction term between ESG and the heavy pollution dummy variable for a full-sample test. The results are shown in Table 9.

The grouped regression results show that in the heavily polluting industry group, the regression coefficient for ESG is 0.005, and significant at the 1% level (t=13.74); in the lightly polluting industry group, the regression coefficient for ESG is 0.007, also significant at the 1% level (t=10.94). This indicates that regardless of whether a company operates in a heavily polluting industry, improving ESG performance can significantly

improve its financial performance (ROA). However, in terms of coefficient magnitude, the marginal effect of ESG in the lightly polluting industry (0.007) is slightly higher than that in the heavily polluting industry (0.005), suggesting that lightly polluting companies can reap greater profits through ESG practices.

To more rigorously examine the statistical significance of the differences between the two groups of coefficients, we added an interaction term (ESG_x_heavy) between ESG and the heavy pollution dummy variable to the full-sample model. The regression results for the interaction term showed that the main effect coefficient of ESG was 0.006 ($p<0.01$), the coefficient of the heavy pollution dummy variable (heavy) was 0.012 ($p<0.01$), and the coefficient of the interaction term (ESG×heavy) was -0.001, which was significant at the 10% level ($p<0.1$). This result validates the findings of the grouped regression: the performance conversion momentum of ESG is weakened in heavily polluting industries, while the positive effect of ESG on financial performance is significantly stronger in lightly polluting industries than in heavily polluting industries.

The aforementioned heterogeneity may stem from the following reasons: Heavily polluting industries typically face stricter environmental regulations and higher compliance costs, meaning their ESG investments are primarily focused on meeting regulatory bottom lines rather than creating competitive advantages, thus limiting their impact on financial performance. In contrast, lightly polluting industries are more likely to gain market recognition, enhance brand image, and improve operational efficiency through differentiation strategies, thereby more effectively translating ESG performance into financial gains. Furthermore, investors and stakeholders in heavily polluting industries may hold a more cautious attitude towards ESG information, partially offsetting the positive effects of ESG.

The signs and significance of the control variables were largely consistent across groups: firm size (Asset), cash flow, and growth were significantly positively correlated with ROA, while debt level was significantly negatively correlated with ROA. The effects of board size and duality varied slightly across groups, and digitalization was significantly negative in both groups, reflecting the short-term cost effects of digitalization investments. These results are consistent with existing literature, enhancing the reliability of the regression results.

Table 9: Heterogeneity test results

Variable	Heavy pollution group (1)	Light pollution group (2)	Full sample (3)
ESG	0.005***	0.007***	0.006***
	(0.000)	(0.001)	(0.001)
heavy			0.012***
			(0.003)
ESG × heavy			-0.001*
			(0.001)
Asset	0.010***	0.010***	0.010***
	(0.000)	(0.001)	(0.000)
Debt	-0.123***	-0.096***	-0.114***
	(0.002)	(0.004)	(0.002)
Cashflow	0.429***	0.328***	0.398***
	(0.006)	(0.011)	(0.006)
Growth	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.000)
Boardsize	0.003	0.005	0.003
	(0.002)	(0.004)	(0.002)
Duality	0.002**	-0.000	0.001
	(0.001)	(0.002)	(0.001)
Digital	-0.002***	-0.003***	-0.003***
	(0.000)	(0.001)	(0.000)
Constant	-0.175***	-0.223***	-0.199***
	(0.008)	(0.015)	(0.008)
obs	18,730	7,224	25,954
R^2	0.366	0.242	0.334

Note: Standard errors in parentheses
** p < 0.1, ** p < 0.05, *** p < 0.01*
Source: Author's survey

6. Research Conclusions and Policy Recommendations

6.1 Main Conclusions

This paper uses A-share listed companies from 2016 to 2024 as the research sample, with digital transformation as a moderating variable, to systematically explore the impact mechanism of ESG performance on corporate performance (ROA). Heterogeneity analysis was also conducted in conjunction with industry pollution attributes. The core research conclusions are as follows:

ESG performance has a significant short-term negative effect and lag characteristic on corporate performance: The baseline regression results show that the regression coefficient of ESG performance on current corporate performance is significantly negative, confirming the "short-term pain, long-term benefit" characteristic of ESG investment—corporations in environmental, social, and governance aspects incur costs first, while benefits have a significant lag. Furthermore, it was found that the negative impact of ESG can last up to a lag of 5 periods. The coefficient turns positive after a lag of 6 periods but fails the significance test, indicating that the long-term positive effect of ESG performance on corporate performance requires more than 3 years to gradually manifest.

Digital transformation has a significant negative moderating effect on the relationship between ESG and corporate performance over a certain period: While digital transformation itself has no significant direct impact on current corporate performance, its interaction term coefficient with ESG is significantly negative at the 1% level. This indicates that digital transformation has not become a driving force for ESG performance conversion; instead, the combined cost of both factors amplifies the short-term negative effects of ESG. Companies with high levels of digital transformation not only bear the direct costs of ESG investment but also need to continuously invest in the R&D and implementation of related digital technologies. Furthermore, the integration of ESG concepts and digital systems requires a period of adjustment, further reducing the efficiency of short-term performance conversion.

The impact of ESG performance on corporate performance exhibits heterogeneity based on industry pollution attributes: Dividing the sample into heavily polluting and lightly polluting industries reveals that ESG performance has a significant positive impact on corporate performance in both categories, but the marginal effect of ESG is higher in lightly polluting industries. The full-sample interaction term test shows that the interaction term coefficient between ESG and the heavy pollution dummy variable is significantly negative, confirming that heavily polluting industries hinder the positive impact of ESG on corporate performance. The reason is that ESG investments in heavily polluting industries are mostly used to meet environmental regulations, making it difficult to translate into a competitive advantage. In contrast, lightly polluting industries can achieve differentiation strategies through ESG practices, making it easier to convert ESG performance into brand value and financial gains.

The impact of control variables on firm performance is stable: firm size, cash flow ratio, and revenue growth rate all have a significant positive impact on firm performance, while financial leverage has a significant negative impact. The direct impact of board size and the combination of board and board positions is not significant. Digital transformation has a significant negative impact in all regression models, consistently and strongly reflecting the cost effect of early-stage digital construction investments.

6.2 Policy and Management Recommendations

(I) **For the Government:** Improve the policy guidance system for the integration of digitalization and ESG to alleviate the dual cost pressure on enterprises.

Introduce differentiated fiscal and tax support policies: For enterprises in heavily polluting industries, establish a special subsidy project for the integration of ESG and digitalization, providing tax breaks for enterprises conducting digital technology R&D and digital carbon emission monitoring projects; for enterprises in lightly polluting industries, encourage them to achieve differentiated development through the combination of ESG and digitalization, and provide policy incentives to enterprises that obtain high ESG ratings and meet digitalization standards.

Construct a standardized system for the integration of ESG and digitalization: Unify the standards for digital disclosure of ESG information by enterprises, promote the application of big data, cloud computing, and other

technologies in the collection, calculation, and disclosure of ESG information, and reduce the cost of ESG information disclosure for enterprises; release industry-specific digital transformation guidelines, and clarify the application areas and implementation plans of digital technologies in conjunction with the key points of ESG construction in various industries.

Build a collaborative platform for industry, academia, and research: Promote cooperation among universities, research institutions, and enterprises to develop ESG digital management tools adapted to different industries, alleviating the problems of insufficient human resources and excessive R&D costs for enterprises; conduct ESG and digitalization integration training to improve the comprehensive scheduling and operational capabilities of enterprise management.

(II) **For Enterprises:** Scientifically plan the proportion and progress of ESG and digitalization investment to improve resource utilization and performance conversion efficiency.

Develop a long-term ESG and digitalization development strategy: Abandon short-term performance orientation, rationally plan the scale and pace of ESG and digitalization investment in conjunction with the enterprise's development stage, and avoid short-term performance squeeze caused by dual cost pressures; integrate ESG concepts into the entire process of digital construction, such as using big data analysis to strengthen environmental cost control and using blockchain technology to improve the transparency of ESG information, to achieve synergistic development of both.

Develop differentiated ESG strategies based on industry characteristics: Heavily polluting industries should focus their ESG investments on upgrading green production technologies and improving compliance through digital pollutant monitoring, gradually transforming ESG investment from a “cost incurred” to a “competitive return.” Lightly polluting industries can leverage the effects of ESG practices to build brand advantages, combining digital technologies to accurately target consumers and investors, amplifying the value transformation leverage of ESG.

Optimize internal resource integration and talent development: Establish cross-departmental cooperation mechanisms for ESG and digital management, breaking down information barriers between departments and improving resource allocation efficiency; strengthen employee training to cultivate well-rounded talents with both ESG concepts and digital skills, injecting vitality into the integration of ESG and digitalization.

(III) **For Investors:** Investors should abandon short-term speculative mentality, establish a long-term investment philosophy, and incorporate the company's ESG performance along with the degree of digital transformation into the comprehensive valuation system, and pay attention to the long-term value of the company's ESG investment; for companies in heavily polluting industries, focus on the compliance of their ESG investment and the implementation effect of digital transformation; for companies in lightly polluting industries, pay attention to the competitive advantages brought about by the combination of ESG and digitalization, and grasp the foresight and scientific nature of investment decisions.

7. Research Limitations and Future Prospects

7.1 Research Limitations

This paper systematically explores the relationship between ESG performance, digital transformation, and corporate performance, but the following limitations remain:

Insufficient consideration of more detailed levels of corporate heterogeneity: This paper only conducts heterogeneity analysis based on industry pollution attributes, without considering the impact of factors such as company size and ownership structure on the relationship between ESG and corporate performance. For example, state-owned enterprises and private enterprises differ in their ESG investment and digital transformation resource reserves, potentially leading to different performance conversion effects. The depth of heterogeneity analysis needs to be expanded.

Insufficient exploration of the mediating transmission mechanism of ESG and digital transformation integration: This paper only verifies the moderating role of digital transformation, without further analyzing the specific mediating paths through which both influence corporate performance. For instance, whether

performance improvement is achieved through mitigating information asymmetry or reducing agency costs requires further exploration of the influencing mechanisms.

7.2 Future Research Prospects

Based on the shortcomings of this study, further research can be carried out in the following directions:

Expanding the research scope of corporate heterogeneity: In the future, multi-dimensional heterogeneity analysis can be carried out by combining the characteristics of corporate ownership, scale, marketization degree, etc., to explore the differences in the interaction effects of ESG performance and digital transformation among different types of enterprises, and broaden the application of research conclusions, such as further subdividing the differentiated paths of state-owned enterprises and private enterprises according to the framework of enterprise management reform in the digital economy era [26].

Discussing the mediating mechanism of ESG and digital transformation affecting corporate performance: Variables such as information asymmetry, resource allocation efficiency, and agency costs can be introduced to construct a mediating model, and systematically study the transmission path and internal logic of the integration of ESG and digital transformation affecting corporate performance.

Considering the moderating role of the external macro environment: Future research can introduce macro variables such as the intensity of environmental regulation and the level of digital economic development to analyze their moderating role in the relationship between ESG, digital transformation and corporate performance, improve the theoretical framework of the integration of the three, and provide a basis for the government to formulate corporate development strategies.

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Conflicts of Interest

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