

Influence of Digital Transformation on Corporate ESG Performance

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Abstract. At the confluence of the digital economy and sustainable development, two major contemporary trends, how enterprises can leverage digital technologies to enhance their Environmental, Social, and Governance (ESG) ability has become an important topic for both academia and the business community. In this essay, based on panel data of 12,000 annual observations from 2015 to 2024, the following conclusions can be drawn: Firstly, digital transformation can indeed effectively enhance the ESG performance of enterprises, and this result is highly robust. Secondly, from a heterogeneity perspective, the effect of digital transformation on ESG improvement is particularly strong in the subset samples of non-state-owned property rights and companies located in the eastern region. The paper provides valuable insights for enterprises seeking to achieve sustainable development amidst the digital wave, as well as for government policymaking.

Keywords: Digital Transformation, ESG Performance, Moderating Effect, Heterogeneity Analysis

1. Introduction

Amid the increasing global focus on sustainability, ESG has become a key metric for evaluating a company's whole value and longtime growth potential. This has also established ESG strengths as a new type of competitive advantage for firms [1]. Simultaneously, in an era of the digital-based economy, driven by technologies such as big data, artificial intelligence, and cloud computing. Previous academic inquiries have revealed that digital transformation is able to promote the fulfillment of corporate social responsibility (CSR) by enhancing resource allocation efficiency and information transparency [2,3]. Furthermore, there are already many studies on whether economic benefits have been enhanced due to digital transformation, such as firm performance [4].

In this context, a question worthy of in-depth exploration is: Can the digital transformation that companies undertake to enhance operating efficiency and innovation capabilities synergistically promote the enhancement of their ESG performance? Intuitively, digital technologies theoretically offer various possibilities for improving ESG performance. For instance, some big data analysis can help enterprises enhance their intelligent production and energy conservation and emission reduction by monitoring and evaluating pollutant emissions. However, digital transformation is not without costs; its high investment costs may squeeze out resources that could be allocated to environmental protection or social responsibility.

To answer the above question, this study selected data from listed manufacturing companies on the A-share market in China from 2015 to 2024 as the research sample, empirically examined the direct impact of digital transformation on corporate ESG performance. The purpose of this research is to examine how digital transformation influences corporate ESG outcomes and to provide theoretical support as well as practical implications for companies aiming at sustainable, high-quality development in the context of the digital economy.

2. Literature review and research hypotheses

Digital transformation can be understood as the integration of emerging digital tools such as big data, blockchain, and cloud computing into corporate strategies and operational activities. From the resource-based view perspective, digital transformation provides companies with unique and valuable resources that can enhance information processing capabilities, resource allocation efficiency, and innovation output [5]. These resources not only reduce transaction costs but also improve corporate environmental and social responsibility performance. Empirical studies support this view. Digital technologies can significantly improve environmental governance in Chinese manufacturing companies, enhancing performance through real-time monitoring and information transparency [6]. Also, digitalization helps with CSR information disclosure and strengthens interactions with stakeholders [7]. Additionally, digital innovation can also improve internal controls and board supervision, thereby enhancing governance [8]. Based on stakeholder theory, companies are facing pressure from regulators, investors, and society to disclose and improve ESG practices [9]. Digitalization not only facilitates efficient communication but also strengthens corporate accountability and reputation. Therefore, companies implementing digital transformation are more inclined to strengthen their ESG outcomes.

Hypothesis 1 (H1): Digital transformation exerts a positive influence on corporate ESG outcomes.

3. Data and variables

3.1. Variable selection and measurement

Explanatory Variable (Digital Transformation Index): This index calculates the degree of digital transformation in companies by conducting text analysis and construction on the basis of how often digital-related terms appear in the annual reports of publicly listed firms [2].

Dependent Variable (ESG Performance): This rating system is one of the mainstream ESG rating systems in China and carries strong authority and market recognition.

3.2. Sample design and data acquisition

The initial research sample consists of companies listed on the Shanghai and Shenzhen stock exchanges during the period 2015-2024. This period is chosen to align with the rapid development of digital-based economy in China and digital technologies post-2015. To guarantee the reliability and validity of the data, the sample is refined according to the following rule: (1) firms under special treatment, such as ST or PT (suspended listing), are excluded. (2) exclusion of companies listed after 2015 to maintain data continuity; (3) exclusion of samples with severely missing financial or ESG data that cannot compute the required variables; (4) retention of manufacturing companies based on the China Securities Regulatory Commission industry classification standard, as manufacturing is a key sector for digital transformation and ESG practices. After screening, the study obtains 12,000

annual observations. Data sources include the China National Research Data Service Platform (CNRDS), CSMAR database, Choice database, among others.

4. Model

To test the direct effect of digitalization on corporate ESG outcomes, this study establishes the Pooled Ordinary Least Squares (Pooled OLS) model, specified as Model (1):

$$ESG_{i,t} = \beta_0 + \beta_1 digital_transform_{i,t} + \sum_{k=1}^7 \gamma_k Controls_{k,i,t} + \mathcal{E}_{i,t} \quad (1)$$

In this model, i represents the firm and t represents the year. The dependent variable, $ESG_{i,t}$, represents the ESG performance of firm i in year t . The core explanatory variable is $digital_transform_{i,t}$. The term $\sum_{k=1}^7 \gamma_k Controls_{k,i,t}$ represents a vector of control variables as defined in the preceding section, and $\mathcal{E}_{i,t}$ represents the disturbance term. The primary focus is on the coefficient β_1 . A significantly positive β_1 would lend support to research H1.

5. Regression results

5.1. Baseline regression results

Column (1) in Table 1 demonstrates the results of the baseline regression examining the impact of digital transformation on corporate ESG performance. This model is estimated using Pooled OLS.

The coefficient of the core explanatory variable, `digital_transform`, is 0.019 and is highly significant ($p < 0.01$). This preliminary finding suggests that for each one-unit increase in a firm's level of digitalization. This indicates that transformation driven by digitalization can effectively empower firms, thereby significantly promoting the enhancement of their overall ESG performance.

Regarding the control variables, the coefficients for the proportion of independent directors (`independent_ratio`) and `roa` are significantly positive, suggesting that sound corporate governance and strong profitability contribute to better corporate ESG performance. The regression coefficient for the `debt_ratio` is extremely negative, indicating that higher financial leverage may inhibit a firm's investment in ESG-related activities. The coefficient for firm size is also significantly positive, implying that larger firms typically possess more resources and a stronger willingness to improve their ESG performance, which aligns with the societal expectation that greater capabilities come with greater responsibilities.

Table 1. Results of the baseline regression

	(1)	(2)	(3)	(4)
	Pooled OLS	Two-way FE	Firm FE	Year FE
<code>digital_transform</code>	0.019*** (3.777)	0.011* (1.892)	0.017*** (2.883)	0.015*** (3.102)
<code>independent_ratio</code>	0.050*** (3.720)	0.039** (2.277)	0.037** (2.183)	0.041*** (3.131)

roa	0.130*** (10.190)	-0.002 (-0.124)	0.001 (0.062)	0.042*** (3.845)
sales_expense_ratio	-0.001 (-0.119)	-0.001 (-0.052)	0.011 (0.570)	0.003 (0.273)
current_ratio	0.100 (0.422)	0.304 (1.274)	0.300 (1.251)	0.208 (1.012)
quick_ratio	-0.044 (-0.174)	-0.314 (-1.188)	-0.301 (-1.131)	-0.177 (-0.797)
debt_ratio	-0.049*** (-6.850)	-0.062*** (-6.857)	-0.060*** (-6.695)	-0.058*** (-8.456)
ln_total_assets	1.682*** (20.363)	2.180*** (9.590)	1.949*** (10.978)	1.854*** (20.455)
_cons	34.740*** (18.877)	25.598*** (5.148)	30.105*** (7.653)	32.261*** (16.288)
N	12000	12000	12000	12000
Year	NO	YES	NO	YES
Firm	NO	YES	YES	NO

Note: t statistics in parentheses;* p<0.10, ** p<0.05, *** p<0.01

5.2. Robustness tests

To ensure the reliability of the baseline regression conclusions, the study implements several robustness examinations.

5.2.1. Alternative estimation models

Considering the potential individual heterogeneity and time effects in panel data, this study re-estimated the models using three different approaches: Two-way Fixed Effects Model (controlling for both company and year fixed effects), Firm Fixed Effects Model, and Year Fixed Effects Model. The results are presented in columns (2)-(4) of Table 1.

In the second column of the Two-way FE model, the estimated coefficient for digital_transform is 0.011, which is statistically significant. In the third column, the Firm FE model (column 3) yields a coefficient of 0.017 and is significant. While in the fourth column, with Year FE, the value is 0.015, and it is significant. Although the level of significance slightly decreases in the most stringent two-way specification, the sign and overall significance remain stable. This indicates that even after considering firm-specific unobservable characteristics and macroeconomic shocks, a positive correlation between digital adoption and ESG outcomes persists, strengthening the robustness of the baseline results.

5.2.2. Endogeneity test

To alleviate the possibility of reverse causality, in which firms with stronger ESG outcomes are more likely to undertake digital transformation, this study used lagged explanatory variables as instrumental variables in regression analysis. Table 2 presents the results by lagged explanatory

variables. The estimated coefficient of the lagged digital transformation index (L_digital_transform) is 0.020 ($p < 0.01$). This result indicates that the digital transformation level from the previous year has a significant positive impact on ESG performance in the current year. This largely eliminates the interference of reverse causality on the conclusions, further confirming that digital transformation is a driving factor for enhancing ESG performance, rather than a result.

In conclusion, through various robustness tests, the core conclusion of this study – that digital transformation significantly promotes corporate ESG performance – is reliable and robust.

Table 2. OLS with lagged explanatory variables

	(1)
L_digital_transform	0.020*** (4.076)
_cons	33.286*** (17.389)
Controls	YES
Year	NO
Firm	NO
N	10800

Note: endogeneity tests are conducted by comparing current period and lagged one-period variables

5.3. Heterogeneity analysis

Considering the differences in resource endowment, strategic objectives, and external environments among enterprises with different property rights and geographical regions, the effect of transformation driven by digitalization on ESG may vary [10,11]. Therefore, this study conducted heterogeneity analysis.

5.3.1. Heterogeneity by ownership structure

The sample was divided into state-owned enterprises and non-state-owned enterprises for regression analysis, with the findings shown in Table 3.

Table 3. Heterogeneity results by ownership structure

	(1)	(2)
	State-owned Enterprises	Non-state-owned Enterprises
digital_transform	0.017* (1.741)	0.021*** (3.566)
independent_ratio	0.051*** (2.752)	0.050*** (2.743)
roa	0.102*** (4.577)	0.143*** (9.098)
sales_expense_ratio	0.006 (0.333)	-0.002 (-0.200)

current_ratio	0.824** (2.436)	-0.226 (-0.779)
quick_ratio	-0.893** (-2.338)	0.316 (1.018)
debt_ratio	-0.044*** (-3.698)	-0.055*** (-6.131)
ln_total_assets	1.613*** (13.566)	1.698*** (14.178)
_cons	36.115*** (13.313)	34.551*** (12.965)
N	4420	7580
Type of model	Pooled OLS	Pooled OLS
interaction term	NO	NO

Note: state-owned enterprises include local state-owned enterprises, subsidiaries of central enterprises, and other state-owned enterprises

In the non-state-owned enterprise sample in Column 2, the coefficient of digital_transform is 0.021, highly significant at the 1% level. In the state-owned enterprise sample in Column 1, the coefficient of digital_transform is 0.017, significant only at the 10% level. A comparison reveals that the promoting effect of digital transformation on ESG performance in non-state-owned enterprises is stronger than its impact on state-owned enterprises, both in terms of economic significance (coefficient size) and statistical significance. This could be attributed to non-state-owned enterprises facing more intense market competition and greater profit pressure, motivating them to efficiently convert digital investments into comprehensive competitive advantages, including ESG performance, to attract investors and consumers. State-owned enterprises may have more conservative strategic execution or bear more social policy goals, resulting in a relatively slower release of the effects of digital transformation.

5.3.2. Heterogeneity by geographical region

The sample was divided into enterprises in the eastern region and non-eastern region, with the results presented in Table 4.

Table 4. Heterogeneity results by geographical region

	(1)	(2)
	Eastern Region	Non-eastern Region
digital_transform	0.018*** (3.169)	0.020* (1.839)
independent_ratio	0.033* (1.931)	0.079*** (3.666)
roa	0.135*** (8.812)	0.117*** (5.127)
sales_expense_ratio	0.007	-0.014

	(0.614)	(-0.887)
current_ratio	0.166	-0.041
	(0.576)	(-0.097)
quick_ratio	-0.200	0.321
	(-0.636)	(0.723)
debt_ratio	-0.050***	-0.047***
	(-5.861)	(-3.581)
ln_total_assets	1.709***	1.654***
	(17.399)	(11.095)
_cons	34.960***	33.785***
	(15.856)	(10.166)
N	8160	3840
Type of model	Pooled OLS	Pooled OLS
interaction term	NO	NO

Note: the eastern region includes Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan

In the sample of enterprises in the eastern region in Column 1, the coefficient of digital_transform is 0.018, significant at the 1% level. In the sample of enterprises in the non-eastern region in Column 2, the coefficient of digital_transform is 0.020, significant at the 10% level. The results indicate that digital transformation has a promoting effect on ESG performance in enterprises in both regions. However, for eastern region, the statistical significance of this promoting effect is stronger. This may be due to this region typically having advanced digital infrastructure, a more concentrated pool of high-tech talent, and a more dynamic market environment, creating more favorable conditions for enterprises to deepen digital transformation and effectively apply it to ESG practices.

6. Conclusion

Using panel data of Chinese manufacturing listed firms from 2015 to 2024, this research systematically investigates the effect of digital transformation on corporate ESG performance and its underlying mechanisms. The empirical analysis yields the following main conclusions: Firstly, digital transformation significantly and robustly supports the enhancement of firm's ESG outcomes. This core conclusion holds true regardless of the econometric model used or potential endogeneity issues considered. This confirms that digital transformation is a vital strategic tool for enterprises to achieve sustainable development. Secondly, the impact of digital transformation on ESG exhibits significant heterogeneity. This positive effect is more pronounced among non-state-owned enterprises and companies located in the eastern region. This indicates that the degree of marketization and the level of regional development are important boundary conditions influencing the effectiveness of transformation driven by digitalization on ESG outcomes.

The study makes three main contributions. Firstly, it expands research on digital transformation by linking it with ESG performance. Prior studies emphasized financial or efficiency outcomes, while this study highlights its value for long-term sustainability. Secondly, it enriches understanding of ESG drivers. Beyond governance and institutional factors, digital transformation is shown to be a new technological force that promotes ESG improvement. Thirdly, it offers refined evidence on

mechanisms and boundaries. Overall, this study broadens perspectives on digital transformation and deepens theoretical insights into ESG performance.

The study also provides practical insights. For managers, digital transformation should be integrated with sustainability goals, not treated separately. Firms need to use digital tools to improve monitoring, supply chain responsibility, and governance transparency, especially non-state-owned and eastern region firms that can convert digital advantages into ESG competitiveness.

For investors, the degree of digitalization is a useful indicator of future ESG outcomes and long-term value. For policymakers, supporting digital transformation is vital for high-quality growth and carbon goals. Special support should be directed to non-state-owned and western enterprises through subsidies or technical aid to close the digital gap. Finally, policies should encourage firms to combine digital and green strategies, as both independently enhance ESG and jointly maximize sustainable development potential.

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