

Corporate Digital Transformation Improves ESG Performance in China

Jingwen Chen, Qian Yin*, Suqing Fan, Bichen Fan

Nanjing University of Finance & Economics Hongshan College, Nanjing, 210003, China

*Corresponding author: *Qian Yin, hongshan201804@qq.com*

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Abstract: Under the digital economy background and “dual-carbon” goals, digital transformation is a critical approach for companies to reach a high-quality development. This study analyzes the relationship between digital transformation and corporate Environmental, Social, and Governance (ESG) performance, using digital transformation decision-making data extracted via Python text analysis. A fixed-effects model is utilized to examine if there is a positive effect between corporate digital transformation and ESG performance with panel data from China’s A-share listed companies from 2013 to 2021, including its mechanisms and pathways. Although a few research have revealed the active relationship in this field, the validity of data source is from Bloomberg more, but less from Huazheng database which is specialised for Chinese enterprises. The research yields the following findings: Firstly, digital transformation in listed companies significantly enhances ESG performance and the conclusions remain valid after conducting robust tests including variable substitution. Secondly, digital transformation enhances corporate ESG performance by easing financing constraints and boosting innovation capabilities. Thirdly, state-owned enterprise and large corporations both exert positive pronounced effects. These findings are conducive for managers to better decision-making.

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1. Introduction

ESG is crucial in reaching the “dual-carbon” goals, serving as an essential approach for sustainable growth ^[1]. For a high-quality economic development, digital transformation can improve the ESG outcomes ^[2]. It provides businesses with abundant data sources and powerful analytical tools, empowering them to uncover data value and identify new business opportunities ^[3]. It operates well in terms of enhancing corporate management, decreasing inventory costs, and boosting asset utilization, allowing enterprises to reduce operational expenses and increase profitability, thereby positively influencing corporate ESG development. Indeed, it is necessary to admit the managing controversy between profit maximization and ESG pursuit in most companies. With a high-cost investment and profitable loss in exchanging of ESG performance, most enterprises may lose incentive and feel it difficult to accept. Based on this, a fixed model is used and the A-share listed companies in China are examined

in this paper to detect the relationship between digital transformation and ESG performance, along with the mechanisms influencing this relationship.

Digital transformation of enterprises has a multifaceted impact on production, operation, and management systems. Specifically, it strengthens corporate competitiveness, increases enterprise value and business performance, optimizes investment efficiency, reinforces social and environmental value creation, mitigates financing risks ^[4-9]. Digital transformation-driven organizational restructuring can significantly enhance the governance structure of ESG performance within and outside companies ^[10]. Within the broader context of sustainable development imperatives, digital transformation inevitably exerts varying degrees of influence on corporate ESG performance. Technological innovation is essential for digital transformation because it directly improves enterprises' ability to meet environmental and social responsibilities ^[11]. Moreover, an enhanced degree of digital transformation is more conducive to easing financing constraints. This mitigates uncertainty for external investors and creditors in both pre-loan evaluations and post-loan monitoring, curbing opportunistic behaviors harmful to creditors' interests and thus easing financing constraints ^[12].

2. Data and methods

2.1. Origin and handling of data

This paper utilizes Huazheng ESG rating scores, patent obtained data from listed companies via the China Research Data Service Platform (CNRDS), and additional enterprise-level data derived from the CSMAR database. Following the necessary processing, 24141 valid observations were retained.

2.2. Variable definitions

The definitions and sources of the variables are arranged in **Table 1** and **Table 2**.

Table 1. Variable and symbol

Aspects	Variable	Symbol
Dependent variable	ESG performance	ESG_score
		Bloomberg_ESG
Explanatory Variable	Digital transformation	DT
		ADT
Mediator	Financial constraint	KZ
	Technical innovation	Patent
Controls	Firm age	Age
	Firm size	Size
	Gearing ratio	Lev
	Return on assets	ROA
	Cash flow	OCF
	Dual positions	Dual
	Top-four accounting firm	Four
Major shareholder's shareholding ratio	Top1	

Table 2. Variable sources

Variable	Source/reference/calculation
ESG performance	Huazheng Index Bloomberg Index
Digital transformation	Referring to Wu <i>et al.</i> (2021), using Python crawlers and text analytics, digital transformation is gauged via keyword frequency from annual reports The average value of Enterprise Digital Transformation Index from CSMAR
Financial constraint	A financial constraint index from CSMAR
Technical innovation	The level of innovation is quantified by taking the total number of invention patents acquired.
Firm age	Ln (1 + the company's years of listing)
Firm size	Ln (Total assets)
Gearing ratio	Debt/Total Assets
Return on assets	Profit/ Total Assets
Cash flow	OCF/Total Assets
Dual positions	If the chairman and general manager are combined, it is 1; otherwise, it is 0.
Top-four accounting firm	If the accounting firm is one of the Big Four, then 1, otherwise it is 0.
Major shareholder's shareholding ratio	Share proportion of the largest shareholder

2.3. Model construction

This paper uses the fixed effects model to assess the influences of the digital transformation of listed companies on ESG performance. The baseline model is as follows:

$$ESG_{i,t} = \alpha_0 + \alpha_1 DT_{i,t} + \alpha_j Control_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

Equation (1) serves as the foundational regression equation analyzing the impact of digital transformation on firms' ESG performance. $ESG_{i,t}$ represents the performance score of listed companies in terms of environment, social responsibility and governance; $DT_{i,t}$ represents the frequency/index of the digital transformation decisions or behaviors of the parent company; $Controls_{i,t}$ represent other control variables.

3. Empirical results

3.1. Descriptive statistics

In **Table 3**, the average ESG score of the sample enterprises was 72.94, the median was 73.31, the distribution was close to normal, the overall performance was at an upper-middle level, and the differences among the companies were small ($SD = 5.682$), indicating that enterprises generally attached great importance to ESG construction.

Table 3. Descriptive statistics

VarName	Mean	SD	Min	Median	Max
ESG_score	72.940	5.682	36.620	73.310	92.930
DT	0.612	0.968	0.000	0.000	5.814
lev	0.427	0.204	0.008	0.418	0.998
size	22.296	1.320	15.577	22.110	28.548

Table 3 (Continued)

VarName	Mean	SD	Min	Median	Max
age	2.211	0.763	0.693	2.303	3.466
ROA	0.033	0.087	-2.834	0.035	0.786
OCF	0.047	0.074	-0.744	0.046	0.876
TOP1	35.717	15.011	0.004	34.000	155.190
dual	0.284	0.451	0.000	0.000	1.000
Boardsize	8.483	1.675	4.000	9.000	18.000
Four	0.058	0.234	0.000	0.000	1.000
Occupy	-0.018	0.054	-0.909	-0.008	0.698

3.2. Benchmark regression

In **Table 4**, column (1) presents the findings on how digital transformation affects firms' ESG performance. Column (1) is empirically determined by a fixed effects model and the regression coefficient of DT is 0.101.

Table 4. Benchmark regression analysis

Variables	(1)	(2)	(3)	(4)
	ESG_score	ESG_score	Bloomberg_ESG	Bloomberg_ESG
DT	0.101* (0.053)		0.216** (0.089)	
ADT		0.136*** (0.046)		0.291*** (0.083)
Lev	-0.461*** (0.036)	-0.459*** (0.036)	-0.343*** (0.060)	-0.343*** (0.059)
Size	1.489*** (0.095)	1.484*** (0.095)	1.437*** (0.154)	1.427*** (0.153)
Age	-1.187*** (0.164)	-1.190*** (0.164)	0.298 (0.405)	0.323 (0.405)
ROA	1.930*** (0.630)	1.942*** (0.630)	2.225*** (0.856)	2.161** (0.854)
OCF	-0.939* (0.491)	-0.946* (0.490)	0.644 (0.799)	0.642 (0.797)
Dual	-0.086 (0.103)	-0.087 (0.103)	-0.052 (0.188)	-0.076 (0.188)
Four	-0.018 (0.253)	-0.010 (0.252)	2.877*** (0.567)	2.916*** (0.568)
Occupy	1.241 (0.788)	1.217 (0.787)	-3.885*** (1.253)	-3.990*** (1.244)

Table 4 (Continued)

Variables	(1)	(2)	(3)	(4)
	ESG_score	ESG_score	Bloomberg_ESG	Bloomberg_ESG
Constant	44.608*** (2.046)	44.649*** (2.038)	-2.666 (3.481)	-2.638 (3.457)
Obs	23,817	23,817	8,833	8,833
R-squared	0.647	0.647	0.853	0.853
Industry/Year/Firm FE	YES	YES	YES	YES
adj_R2	0.585	0.585	0.465	0.827

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

3.3. Mechanism analysis

In **Table 5**, columns (1) and (2) illustrate the mediating function of financial constraints under the impact of digital transformation on firms' ESG performance. The regression coefficient of financing constraints (KZ) in Column (2) is -0.110 at the 1% level, which means a reduced financial constraint will bring a positive ESG performance. Besides, columns (3) and (4) of **Table 4** illustrate the mediating effect of technical innovation on improving firms' ESG performance. It shows the regression coefficients of digital transformation in column (4) are significantly positive at the 1 % level, and the regression coefficient of technical innovation (Patent) is 0.017, which indicates that digital transformation can improve a firm's ESG performance by motivating its innovation techniques.

Table 5. Mechanism testing

Variables	(1)	(2)	(3)	(4)
	KZ	ESG_score	Patent	ESG_score
DT	0.057*** (0.017)	0.108** (0.054)	0.566*** (0.156)	0.092* (0.053)
KZ		-0.110*** (0.026)		
Patent				0.017*** (0.003)
Controls	Yes	Yes	Yes	Yes
Constant	14.571*** (0.661)	46.216*** (2.086)	-57.171*** (4.545)	45.572*** (2.047)
Obs	23,817	23,817	23,817	23,817
R-squared	0.835	0.647	0.798	0.647
Industry/Yea-r/Firm FE	YES	YES	YES	YES
adj_R2	0.806	0.585	0.806	0.585

Robust standard errors are shown in parentheses. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.4. Heterogeneity analysis

The influences of digital transformation on ESG performance systematically varies due to firm-level heterogeneity. It is investigated the impact across various ownership regime. In **Table 6**, Column (1) indicates that digital transformation virtually enhances the ESG scores of state-owned enterprises (SOEs). This may because SOEs possess superior accumulations of capital, human resources, and technological assets relative to their non-state counterparts, thereby equipping them with the requisite resources to implement comprehensive ESG initiatives. Column (2) indicates that digital transformation significantly enhances the ESG scores of large-size enterprises (who are above the median level of the firm size). This may be resulted from the strong asset strength and R&D capabilities in large companies, which can increase investment in innovation on digital projects.

Table 6. Heterogeneity tests results

Variables	(1)	(2)
	ESG_score	ESG_score
DT	-0.063 (0.065)	0.011 (0.069)
DT_SOE	0.475*** (0.101)	
DT_SIZE		0.166** (0.076)
Controls	Yes	Yes
Constant	44.146*** (2.042)	45.334*** (2.083)
Observations	23,817	23,817
R-squared	0.647	0.647
Industry/Year/Firm FE	YES	YES
adj_R2	0.585	0.585

Robust standard errors are shown in parentheses. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4. Conclusion

This letter concludes that digital transformation notably improves enterprises' ESG scores. Digital transformation enhances corporate ESG performance through easing financing constraints and promoting technological innovation. The digital transformation of state-owned enterprises and large corporations significantly enhances ESG performance. Managers in those companies should drive ESG growth through continuously innovating technical products and superlatively weakening the financing difficulty, achieving sustainable business growth and high-qualified development, leading to an excellent ESG performance among others. This study helps fill a major gap in existing theory. Additionally, it provides suggestions to different managers ranging from large companies to SOE enterprises. It is expected to conduct more Endogeneity test to consolidate the robustness test, and explore new mechanisms.

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