Can AI Technology Applications Enhance Corporate ESG Performance?

An Empirical Test Based on A-Share Listed Companies

Zhen Liu*, Ke Xu

School of Innovation and Entrepreneurship, Shandong University, Tsingtao, 266200, China

*1094873522@qq.com

Abstract. At present, artificial intelligence has gradually integrated into the entire process of corporate production and operations, profoundly impacting business development. This study utilizes data from A-share listed companies between 2010 and 2024. By constructing a multidimensional AI application measurement system, it empirically demonstrates that AI technology adoption significantly enhances corporate ESG performance. This improvement occurs through two pathways: boosting total factor productivity and strengthening internal control quality. Heterogeneity tests reveal that this impact is more pronounced in non-state-owned enterprises, small and medium-sized enterprises, non-heavily polluting industries, and high-tech sectors.

Keywords: Artificial Intelligence, Corporate ESG Performance, Total Factor Productivity, Internal Control Quality

1 Introduction

Since the 18th National Congress of the Communist Party of China, the Party Central Committee with Comrade Xi Jinping at its core has incorporated ecological civilization into the "Five-Sphere Integrated Plan," championing the principle that "lucid waters and lush mountains are invaluable assets." In 2020, China formally set targets to reach peak carbon emissions by 2030 and achieve carbon neutrality by 2060. In recent years, China has successively introduced policies such as the "Ten Measures for Air Pollution Prevention and Control" and "Ten Measures for Water Pollution Prevention and Control". However, the country still faces challenges such as high total pollutant emissions and arduous ecological restoration tasks. At the same time, governance issues like corporate "greenwashing" and financial fraud have become increasingly frequent. Consequently, governments and regulatory authorities are placing greater emphasis on the comprehensive performance of enterprises in environmental, social responsibility, and corporate governance.

Against this backdrop, ESG—as an investment philosophy and evaluation standard focusing on corporate environmental, social, and governance performance—effectively complements traditional financial performance assessment methods. While Chinese

D. Magni et al. (eds.), *Proceedings of the 2026 3rd International Conference on Applied Economics, Management Science and Social Development (AEMSS 2026)*, Advances in Economics, Business and Management Research 389,
https://doi.org/10.2991/978-94-6239-672-2_34

enterprises are actively exploring ESG performance, issues such as superficial understanding, shortage of specialized talent, and difficulties in investment and financing persist. Data indicates that only 19% of domestic listed companies hold an A-level or higher ESG ratings. There is an urgent need to explore new drivers for green governance to optimize ESG performance.

As a product of the new wave of technological revolution and industrial transformation, artificial intelligence has profoundly altered corporate production and operational models. It is recognized as a potential driver for corporate green transformation and social responsibility fulfillment. However, current research on the specific impact of AI technology on corporate ESG performance remains in its infancy, with significant gaps in studies regarding the quantification of technology application, impact mechanisms, and heterogeneity analysis.

2 Literature Review

Existing research indicates that artificial intelligence technologies can influence corporate ESG performance across three dimensions: environmental, social, and governance. At the environmental level, AI primarily enhances environmental performance by driving green technological innovation and optimizing resource allocation. Studies indicate that AI significantly enhances corporate green innovation levels and total factor productivity, thereby reducing pollution emissions. On the social front, AI applications boost social performance by empowering the workforce and elevating product quality. On one hand, AI drives corporate employee training initiatives, elevating human capital (Zhang, 2020) [1]. On the other hand, it safeguards product quality and safety by enhancing production precision (Qi, 2022) [2]. At the governance level, AI's core contribution lies in improving corporate governance by increasing information transparency and optimizing decision-making processes. Technological applications can improve the quality and efficiency of disclosures in accounting information and sustainability reporting (Sun, 2025) [3]. More importantly, AI plays a positive role at the foundational level of governance by strengthening internal control systems and providing high-precision, low-cost decision support for ESG management.

3 Theoretical Analysis and Research Hypotheses

3.1 Theoretical Analysis and Hypothesis Formulation

As artificial intelligence technology becomes deeply integrated into corporate operations, it is reshaping enterprises' practices across the three dimensions of environmental, social, and governance (ESG), emerging as a key driver of sustainable development. In the environmental dimension, AI not only achieves precise energy consumption management and pollution control through intelligent monitoring and algorithmic optimization, thereby enhancing energy efficiency (Li Hongbing et al., 2023) [4], but also significantly promotes the “quantitative growth and qualitative improvement” of green technologies by reconstructing data-driven green innovation value chains, reducing

emission intensity at the source. In the social dimension, AI empowers enterprises to shift from reactive compliance to proactive responsibility. Leveraging big data analytics, it enables precise insights and efficient responses to diverse stakeholder demands—including employees and communities—thereby enhancing the efficiency of social resource allocation and overall social performance. In the governance dimension, AI significantly boosts transparency in information disclosure and the effectiveness of internal controls by strengthening information processing and real-time monitoring capabilities. Intelligent systems can automatically analyze and report ESG data gaps, bolstering external oversight (Flammer et al., 2021) [5]. Simultaneously, they reduce agency costs through risk early warning, elevating the quality of board decision-making and supervision. Thus, artificial intelligence comprehensively empowers the overall enhancement of corporate ESG performance through multiple pathways: synergistically advancing green innovation, optimizing social responsibility practices, and strengthening governance foundations. Based on the above analysis, this paper proposes the core hypothesis:

H1: The application of artificial intelligence technology significantly enhances corporate ESG performance.

3.2 Mechanism Analysis and Hypothesis Formulation

The enhancement of corporate ESG performance through artificial intelligence applications is primarily achieved via two key intermediary pathways: "total factor productivity" and "internal control quality." First, AI significantly boosts a company's TFP by optimizing production decisions and resource allocation. This technology-driven efficiency improvement generates financial surpluses while freeing up managerial attention, creating "resource surpluses" available for ESG investments. This, in turn, strengthens the company's capacity and resource base for environmental, social, and governance practices. Second, AI reshapes corporate internal control systems. Through continuous data capture, pattern recognition, and real-time alerts, AI enables objective, dynamic monitoring of financial, compliance, and operational activities, substantially strengthening the oversight effectiveness and risk prevention functions of internal controls. This enhanced governance capability provides reliable institutional safeguards for ESG practices. Based on these mechanisms, AI does not directly impact ESG outcomes but instead indirectly and powerfully drives comprehensive improvements in corporate ESG performance by enhancing two core internal processes: boosting production efficiency and optimizing governance structures. Therefore, this paper proposes the following hypotheses:

H2a: The application of AI technology can indirectly enhance corporate ESG performance by increasing total factor productivity.

H2b: The application of AI technology can indirectly enhance corporate ESG performance by strengthening the quality of internal controls.

3.3 Data Sources

This study selected listed companies on the Shanghai and Shenzhen A-share markets from 2010 to 2024 as research samples, subjecting them to the following processing: - Exclusion of financial sector listed companies; - Exclusion of listed companies under ST or *ST status; - Exclusion of samples with missing data; - Truncation of all continuous variables at the upper and lower 1% to mitigate the impact of extreme values on research outcomes. Following these procedures, the final dataset comprises 8,959 observations. Corporate ESG performance data is sourced from Huazheng ESG Ratings, while all other financial data originates from the Guotai An database.

3.4 Model Design and Variable Definition

This paper uses Model (1) to examine the impact of AI technology adoption on corporate ESG performance. The specific model is as follows:

$$ESG_{i,t} = \alpha_0 + \alpha_1 AI_{i,t} + \sum \alpha_j Controls_{i,t} + Year + Industry + \varepsilon_{i,t} \quad (1)$$

In this model, i represents the firm, t represents the year; ESG denotes the firm's ESG performance, AI indicates the application of artificial intelligence; Controls are the control variables defined above; Industry is the industry dummy variable; Year is the year dummy variable; α_0 is the constant term; α_1 and α_2 are the regression coefficients; ε is the error term. Below are the specific definitions of key variables in Model (1):

Dependent Variable. Corporate ESG performance (ESG). This study employs Huazheng ESG rating data as a proxy variable for corporate ESG performance. This metric has gained broad recognition in both academic and industry circles, providing a relatively comprehensive and accurate reflection of corporate ESG performance levels. The rating system categorizes listed companies' ESG performance into nine tiers (from C to AAA), assigning values from 1 to 9, where higher values indicate superior ESG performance.

Independent Variable. Artificial Intelligence Technology Application (AI). This study constructs a multidimensional composite indicator to measure corporate AI technology application levels, comprising three dimensions: First, AI investment levels(AI1), measured by the proportion of AI-related expenditures within corporate intangible assets. Second, annual report AI keyword frequency(AI2), calculated by text mining the occurrence frequency of AI-related keywords in listed companies' annual reports and applying standardization. Third, AI patent application volume(AI3), measured using the logarithmic form of the company's AI-related patent applications filed during the year. Principal component analysis synthesizes these three dimensions into a composite AI application index.

Control Variables. Drawing from relevant literature, the following variables serve as controls: Enterprise size (Size), debt-to-asset ratio (Lev), return on assets (Roa), board size (Board), proportion of independent directors (Indep), management compensation (TMTPay), dual roles (Dual), listing duration (ListAge), largest shareholder ownership (Top1), cash flow (Cashflow), Tobin's Q ratio (TobinQ), and enterprise growth (Growth).

4 Empirical Findings and Analysis

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics. The results indicate that the mean ESG performance score for the sample enterprises is 4.872, with a minimum value of 1 and a maximum value of 9, demonstrating significant individual differences in ESG performance among the sample enterprises. The mean for AI technology application was 0.043, with a maximum of 0.572 and a minimum of 0, indicating substantial disparities in AI adoption levels across enterprises. Furthermore, the value ranges of all control variables are within reasonable intervals, indicating that the selection of variables is reasonable and the quality of the sample data is relatively high.

Table 1. Descriptive statistics

Variable	N	Mean	SD	Min	Max
ESG	8959	3.983	0.966	1.250	6.250
AI1	8959	0.005	0.009	0	0.066
AI2	8959	5.133	14.501	0	97
AI3	8959	17.830	71.448	0	577
TFP	8959	9.105	1.054	6.796	11.985
ICQ	8959	6.255	1.191	0.000	6.731

4.2 Analysis of Baseline Regression Results

Table 2. Baseline regression results

Variable	(1) ESG	(2) ESG	(3) ESG
AI	0.0833***	0.1978***	0.0800***
	(10.356)	(18.326)	(7.596)
Controls	YES	NO	YES
Constant	-0.0000	-0.0004	-0.0009
	(-0.000)	(-0.035)	(-0.097)
Observations	8,959	8,932	8,932
R-squared	0.186	0.137	0.282
Year FE	NO	YES	YES
industry FE	NO	YES	YES
F	145.6	335.9	154.8

*** p<0.01, ** p<0.05, * p<0.1

Table 2 presents the baseline regression results examining the relationship between AI technology adoption and corporate ESG performance. The findings indicate that regardless of whether year and industry effects are controlled for, or whether control variables are included, the coefficient measuring the impact of AI technology on corporate ESG performance is statistically significant at the 1% level. This confirms that the

adoption of artificial intelligence technology significantly enhances corporate ESG performance(H1).

4.3 Robustness Test

Replacing the dependent variable. Although different rating agencies share a broadly consistent understanding of ESG's core principles, slight variations in specific indicator systems, weighting configurations, and data sources may lead to differing final evaluation outcomes. This study replaces Huazheng Ratings with Shangdao Ronglv ESG Ratings(ESG-ST) for testing to mitigate estimation biases from differing measurement approaches. As shown in Column (1) of Table 3, the coefficient for AI technology adoption remains significantly positive at the 1% level. This indicates that core conclusions hold even after switching ESG measurement methods, demonstrating robust adaptability of the findings across different evaluation frameworks.

Substituting the Core Explanatory Variable. To more precisely measure corporate deployment of AI technology at the strategic level, this study further constructs an AI indicator (MDA_AI) using Management Discussion and Analysis (MD&A) text for testing. As shown in Column (2) of Table 3, the coefficient for MDA_AI remains significantly positive at the 1% level. This indicates that the positive impact of AI on corporate ESG performance remains robust even after changing the measurement method of the explanatory variable, further validating Hypothesis 1.

Table 3. Robustness Test

Variable	(1) ESG-ST	(2) ESG	(3) ESG
MDA-AI		0.0782*** (6.175)	
AI	0.0271*** (4.014)		0.0636*** (4.786)
Controls	YES	YES	YES
Constant	0.0004 (0.075)	-0.0009 (-0.096)	-0.0016 (-0.139)
Observations	8,932	8,932	5,522
R-squared	0.706	0.281	0.271
Year FE	YES	YES	YES
industry FE	YES	YES	YES
F	219.0	153.1	78.48

*** p<0.01, ** p<0.05, * p<0.1

Adjusting the sample period. To further exclude the interference of major exogenous shocks on the core findings—specifically the impact of the COVID-19 pandemic—this study removed samples from 2019 onwards and re-examined the data using only the 2010–2018 period. The regression results are shown in Column (3) of Table 3. The coefficient for artificial intelligence technology application (AI) remains significantly positive at the 1% level. This indicates that even when controlling for major

exogenous shocks, the positive promotional effect of artificial intelligence on corporate ESG performance remains robust.

5 Mechanism Testing and Heterogeneity Analysis

5.1 Mechanism Testing

Based on the preceding analysis, enterprises can enhance their ESG performance through two mechanisms: improving internal control quality and boosting total factor productivity. Therefore, we first examine the impact of artificial intelligence (AI) technology on the instrumental variables, clarify the underlying causal relationships within the mechanism, and then assess the influence of these instrumental variables on corporate ESG performance.

$$Channel_{i,t} = \alpha_0 + \alpha_1 AI_{i,t} + \Sigma\alpha_2 Controls_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t} \quad (2)$$

$$ESG_{i,t} = \alpha_0 + \alpha_1 AI_{i,t} + \alpha_2 Channel_{i,t} + \Sigma\alpha_3 Controls_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t} \quad (3)$$

In the above model, Channel serves as the instrumental variable. The meanings of other variables remain consistent with the basic regression model (1). If the coefficient α_1 in equation (2) and the coefficient α_1 in equation (3) are both significant and greater than zero, it demonstrates that artificial intelligence can positively influence corporate ESG performance through the aforementioned mechanism.

Table 4. Mechanism Testing

Variable	(1) ESG	(2) TFP	(3) ESG	(4) ICQ	(5) ESG
AI	0.0800***	0.0290***	0.0762***	0.0490***	0.0740***
	(7.596)	(4.956)	(7.241)	(4.158)	(7.083)
TFP			0.1323***		
			(6.853)		
ICQ					0.1231***
					(12.949)
Controls	YES	YES	YES	YES	YES
Constant	-0.0009	-0.0003	-0.0008	-0.0002	-0.0009
	(-0.097)	(-0.059)	(-0.093)	(-0.023)	(-0.095)
Observations	8,932	8,932	8,932	8,932	8,932
R-squared	0.282	0.779	0.286	0.102	0.296
year FE	YES	YES	YES	YES	YES
industry FE	YES	YES	YES	YES	YES
F	154.8	1337	148.4	39.55	158.4

*** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the results of the mediation effect test for total factor productivity and internal control quality. Column (1) presents the benchmark regression results, indicating that AI technology application significantly and positively promotes corporate ESG performance. Column (2) shows that AI technology application enhances TFP. In Column (3), the coefficient for TFP is significantly positive at the 1% level, while the coefficient for AI technology application is significantly positive at the 1% level but decreases from 0.0800 to 0.0762. This indicates that AI technology application improves corporate ESG performance by enhancing TFP. Columns (4) and (5) examine the mediating effect of internal control quality, revealing that AI technology application positively influences corporate ESG performance by elevating internal control quality. Hypotheses 2a and 2b are thus validated.

5.2 Heterogeneity Analysis

Considering that varying firm characteristics may lead to differences in the impact of AI technology adoption on ESG performance, this study conducts heterogeneity tests across four dimensions: ownership structure, firm size, industry attributes, and regional distribution.

Heterogeneity in Ownership Structure. The sample is divided into two groups—state-owned enterprises (SOEs) and non-state-owned enterprises (NSOEs)—for regression analysis. As shown in Table 5 Column (1), the coefficient for AI application in the non-state-owned enterprise sample is 0.098, significantly positive at the 1% significance level. In contrast, the AI coefficient for state-owned enterprises is 0.032, only significant at the 5% level and substantially smaller than that for non-state-owned enterprises. This disparity primarily stems from differing governance mechanisms between SOEs and non-SOEs. Non-SOEs exhibit higher marketization levels and faster decision-making efficiency, enabling more flexible integration of AI technology with ESG management. In contrast, SOEs face constraints from institutional mechanisms, resulting in relatively lower flexibility in technology adoption and ESG transformation.

Table 5. Heterogeneity Analysis

	(1)		(2)		(3)		(4)	
Variable	Ownership		Size		Polluting		High-Tech	
	NSOEs	SOEs	SMEs	LEs	NHPIs	HPIs	NHTIs	HTIs
AI	0.0879***	0.0488***	0.0857***	0.0491**	0.0933***	-0.0056	0.0589***	0.0829***
	(6.44)	(2.72)	(-6.78)	(-2.01)	(8.350)	(-0.183)	(3.151)	(6.378)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
_cons	-0.0476***	0.0683***	0.0101	-0.556	0.0578***	-0.1787***	0.0328**	-0.0433***
	(-3.22)	(-3.35)	(-0.7)	(-1.59)	(5.073)	(-6.653)	(2.096)	(-3.100)
year FE	YES		YES		YES		YES	
industry FE	YES		YES		YES		YES	
r2	0.294	0.34	0.264	0.356	0.305	0.232	0.326	0.258
N	5236	3682	6847	2069	6,365	2,567	4,195	4,737

*** p<0.01, ** p<0.05, * p<0.1

Heterogeneity in Enterprise Size. Using the median of total assets as the classification criterion, the sample was divided into large enterprises(LEs) and small-to-medium enterprises (SMEs). As shown in Table 5 (2), the AI impact coefficient for SMEs is 0.087, significantly positive at the 1% level. For large enterprises, the AI impact coefficient is 0.049, also significantly positive at the 1% level but smaller than that for SMEs. This discrepancy arises because SMEs, having started ESG management later with weaker foundations, can rapidly address management shortcomings through AI adoption, achieving leapfrog improvements in ESG performance. In contrast, large enterprises possess relatively mature ESG management systems, where the marginal enhancement effect of AI is comparatively weaker.

Heterogeneity in Polluting Industries. The sample was divided into heavily polluting industries(HPIs) and non-heavily polluting industries (heavily polluting industries defined according to relevant classification standards from the Ministry of Environmental Protection). As shown in Table 5 (3), the AI impact coefficient in non-heavily polluting industries is 0.082, significantly positive at the 1% level. In heavily polluting industries, the AI impact coefficient is 0.027, significant only at the 10% level. This primarily stems from the fact that ESG improvement in heavily polluting industries faces more stringent environmental constraints and higher transformation costs. The application of AI technology can only alleviate environmental pressures to a certain extent and struggles to rapidly drive significant improvements in ESG performance. Conversely, non-heavily polluting industries face relatively lower ESG transformation pressures, enabling them to more efficiently leverage the enabling role of AI technology.

Heterogeneity in High-Tech Enterprises. Using the "Guidelines for Industry Classification of Listed Companies" to determine the industry codes of high-tech listed companies, firms were categorized into "high-tech industries" and "non-high-tech industries" for heterogeneity analysis. Results shown in Table 5 (4) indicate that AI technology's promotional effect is significant in both high-tech and non-high-tech industries, but stronger in high-tech sectors. This suggests that industries with higher technology intensity are better positioned to embed AI into business processes and innovation systems, thereby more effectively translating it into ESG governance efficacy.

6 Conclusions

This study constructs a multidimensional AI technology application measurement system to empirically examine the promotional effect of AI technology on corporate ESG performance. It demonstrates that AI technology indirectly enhances ESG performance by improving total factor productivity and strengthening internal control quality. This impact exhibits greater marginal effects in non-state-owned enterprises and small-to-medium enterprises. From an industry perspective, the effect is more pronounced in non-heavily polluting industries and high-tech sectors.

Based on these findings, the paper offers the following practical implications: Enterprises should prioritize AI investment and adoption, developing tailored AI application and ESG transformation strategies aligned with their ownership structure, scale,

and industry characteristics. By fully leveraging AI's enabling capabilities—particularly through boosting TFP and strengthening internal controls—companies can drive sustained improvements in ESG performance. Governments should strengthen digital infrastructure development, prioritizing digital support for western regions and heavily polluting industries. They should improve ESG disclosure systems and related supportive policies to guide enterprises toward deep integration of digitalization and sustainable development.

References

1. Zhang Longpeng,Zhang Shuangzhi.Technology Empowerment: The Effect of Technological Innovation on the Integrated Development of Artificial Intelligence and Industry [J].Finance and Economics,2020,(06):74-88.
2. Qi Jianhong,Zhang Zhitong. Robotic Applications and Export Product Scope Adjustments: Can Efficiency and Quality be Achieved Simultaneously? [J]. World Economy,2022,45(09):3-31.
3. Sun Wenting,Zuo Fei. Artificial Intelligence and the Quality of Accounting Information Disclosure - From the Perspective of Internal Management and Production Efficiency of Enterprises [J]. Friends of Accounting,2025,(10):111-119.
4. Li Hongbing,Zheng Qingbiao,Li Zhen et al. Industrial Intelligence in China and Urban Air Pollution Control:An Empirical Study Based on the Application of Industrial Robots [J]. Management Review, 2023, 35(9): 300-311.
5. Flammer C, Toffel M W, Viswanathan K. Shareholder activism and firms' voluntary disclosure of climate change risks[J]. Strategic Management Journal, 2021, 42(10): 1850-1879.