

THE DUAL IMPACT OF ARTIFICIAL INTELLIGENCE ON ESG STRATEGIES OF TECHNOLOGY ENTERPRISES

The rapid growth of generative artificial intelligence (AI) has created a fundamental contradiction for technology companies' environmental, social, and governance (ESG) strategies. Although AI is widely seen as an accelerator towards carbon-neutrality objectives, the energy use and carbon emissions from AI infrastructure are simultaneously undermining corporate emissions-reduction efforts. According to the International Energy Agency (IEA), electricity demand for data centres in North America rose from 2,688 MW in 2022 to 5,341 MW by the end of 2023, with generative AI as the main driver [3, p.1-3]. By 2026, data centres' global electricity consumption is predicted to reach 1,050 terawatt-hours (TWh), making them the fifth-largest electricity consumer globally [7, p.1-2].

This research addresses a crucial research gap: although the existing body of literature has explored the influence of AI on corporate ESG performance, only a small number of studies have methodically analysed the diverse effects across ESG aspects, the moderating role of AI agent autonomy and model energy efficiency, and the fundamental transmission mechanisms. This research addresses this void by examining data from 2020 to 2026 for 15 prominent global tech companies, including Microsoft, Google, Anthropic, Alibaba, and Tencent.

This research uses a multi-method approach that combines panel regression analysis and a quasi-natural experiment design. The base-line regression model is defined as:

$$ESG_{i,t} = \alpha + \beta AI_{i,t} + \gamma X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t}$$

Where $ESG_{i,t}$ stands for corporate ESG performance (total score and E/S/G sub-dimensional scores), $AI_{i,t}$ indicates AI technology application intensity gauged via AI word frequency analysis in annual reports using BERT semantic recognition [2, p.1-4], and $X_{i,t}$ consists of control variables (company size, debt-to-asset ratio, profitability, R&D investment). We also utilize a difference-in-differences (DID) model, taking China's National New Generation Artificial Intelligence Innovation and Application Pilot Zones policy as an exogenous shock:

$$ESG_{i,t} = \alpha + \beta (Treat_i \times Post_t) + \gamma X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t}$$

The data set consists of 2,156 firm-year records for US technology titans (2020-2026) and 23,844 records for Chinese A-share listed firms (2011-2022). Key variables consist of AI agent penetration ratio (the proportion of daily AI agent utilization time to the total working hours) and model energy-efficiency indicator (weighted average energy consumption in Wh per thousand tokens).

Table 1

**Impact of AI Technology on ESG Performance-Baseline Regression
Results (2020-2026)**

Variable	Overall ESG	Environmental (E)	Social (S)	Governance (G)
AI Technology Index	0.198***	0.215***	0.178***	0.095*
AI Agent Penetration Rate	-0.089**	-0.065*	-0.042	-0.156***
Model Energy Efficiency Index	-0.125***	-0.198***	-0.045	-0.032
R ²	0.698	0.672	0.715	0.638

Note: Errors of cluster-robust standard are in parentheses; ** $p < 0.01$, * $p < 0.05$, * $p < 0.1$; $N = 2,156^*$

Finding 1: Favourable Overall Impact with Dimensional Variation.

The AI tech index shows a statistically significant positive effect on the overall ESG performance ($\beta=0.198$, $p<0.01$). However, significant dimensional disparities are present: environmental aspect ($\beta=0.215$) > social aspect ($\beta=0.178$) > governance aspect ($\beta=0.095$). This verifies that AI technology isn't an ESG panacea – its effect of promoting governance is relatively restricted.

Finding 2: The autonomy of AI agents has a negative influence on governance.

The penetration rate of AI agents has a notable negative impact on the governance (G) dimension ($\beta = -0.156$, $p < 0.01$). This suggests that with each one-standard-deviation rise in agent autonomy, corporate governance scores decline by 0.156 standard deviations.

Table 2

**DID Estimation Results of AI Innovation Pilot Zone Policy
(China, 2011-2022)**

Variable	Overall ESG	Environmental (E)	Social (S)	Governance (G)
Treat×Post	0.312***	0.285***	0.326***	0.198**
Observations	23,844	23,844	23,844	23,844

Note: Standard errors are presented in parentheses; ** $p < 0.01$, * $p < 0.05$

The DID analysis validates the initial findings: companies in AI pilot zones that received treatment exhibit notable ESG enhancements ($\beta = 0.312$, $p < 0.01$), yet the impacts on the governance dimension are the least pronounced ($\beta = 0.198$) [9, p.1-8].

Finding 3: Consider Model Energy Efficiency as a Vital Environmental Moderator.

Model's energy-efficiency index has a notable negative impact on the environmental (E) dimension ($\beta = -0.198$, $p < 0.01$), validating the energy efficiency paradox.

Mechanism Test-Mediation Analysis Results

Channel	Mediator	Sobel Z-value	Mediation Effect Proportion
Financing Constraint Alleviation	SA Index	4.85***	28%
Green Technology Innovation	Green Patents	5.12***	35%
Information Disclosure Improvement	Disclosure Quality	3.76***	22%
Total Explained			85%

Note: ** $p < 0.01$; Data origin: *Frontiers in Artificial Intelligence* [8, p.1-8]*

Finding 4: Three-Channel Transmission Mechanisms.

Mediation analysis uncovers three transmission pathways that account for 85% of the overall AI-ESG impact: mitigation of financing constraints (28%), innovation in green technology (35%), and enhancement of information disclosure (22%). Green technological innovation has the most significant impacts on the environmental aspect ($\beta=0.402$) [8, p.1-8].

Table 4

Heterogeneity Analysis Results

Grouping Variable	High/Large Group	Low/Small Group	Difference
Technology Intensity	0.245***	0.098**	Significant
Industry Competition	0.268***	0.112**	Significant
Region (Eastern vs. West China)	0.298***	0.089*	Significant
Grid Carbon Intensity	0.312***	0.125**	Significant

Finding 5: Moderation of Institutional and Grid Carbon Intensity.

Eastern China (with institutional development) presents an AI-ESG coefficient of 0.298, while in western China, it is 0.089. Low-carbon grid areas display a coefficient of 0.312, compared to 0.125 in high-carbon regions. This shows that AI technology might intensify regional ESG disparities via digital dividends and green barriers [8, p.1-8].

Following these empirical discoveries, we put forward eight specific suggestions.

For enterprise management:

- 1) Carry out model energy efficiency first purchasing strategies that give priority to efficient models (e.g., GPT-4.1 nano, Claude 3.7 Sonnet);
- 2) Set up a tiered governance framework for AI agents, implementing a mandatory dual human review mechanism for L3 fully autonomous systems;
- 3) Optimize the locations of data centers to low-carbon grid areas.

For regulators:

- 1) Require distinct disclosure of AI workload energy usage and carbon emissions;
- 2) Integrate AI agent security events into ESG assessment systems;
- 3) Implement varying carbon cost coefficients (1.5-2.0 times) for regions with high carbon emissions.

For investors:

- 1) Request third-party verified data on AI energy considering 61-fold differences measured officially;
- 2) Incorporate model energy-saving efficiency into ESG investment screening criteria.

This research offers robust empirical evidence that the influence of AI technology on corporate ESG performance is essentially two-fold: while producing substantial positive impacts via productivity improvements as a General Purpose Technology (overall ESG $\beta = 0.198$, $p < 0.01$), it concurrently brings about governance risks due to agent autonomy (governance $\beta = -0.156$, $p < 0.01$) and environmental trade-offs because of energy-intensive models (environmental $\beta = -0.198$, $p < 0.01$). The financing, innovation, and disclosure pathways account for 85% of the mediation effect, implying that AI's ESG advantages mainly originate from indirect productivity-based mechanisms rather than from direct sustainability-related attributes. As artificial intelligence enters the Agentic Era, enterprises need to manage the conflict between operational effectiveness and governance control. New Human-in-Command frameworks are needed that go beyond conventional Human-in-the-Loop methods.

References

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