Does Digital Transformation Enhance ESG Performance in China's Listed Firms?

Examining the Moderating Influence of Institutional Investor Networks and the Mediating Role of Product Innovation Capability

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1. Introduction

1.1. Research Background

Chinese companies prioritise ESG performance in business strategy and capital market valuation due to their goal of "high-quality growth" and achieving peak carbon emissions by 2030 and carbon neutrality by 2060. First-generation sustainability research treated ESG as an exogenous constraint on profit maximisation, but more recent research approaches it as a multidimensional performance frontier that firms shape through resource orchestration and stakeholder engagement. Alongside this policy and market momentum, the "Digital China" blueprint, dual-circulation strategy, and Made-in-China 2025 initiative are driving unprecedented enterprise-level digital transformation (DT). DT integrates cloud computing, IoT, AI, big-data analytics, and blockchain into value-creation processes (Heavin & Power, 2018). Listed Chinese companies disclose DT expenditures, create chief-digital-officer jobs, and re-engineer supply-chain and customer-interface designs to include digital technology (Wang et al., 2023). At first glance, DT and ESG agendas seem complementary. AI-enabled energy management, blockchain-based material traceability, and cloud-based collaboration can minimise carbon footprints, improve social transparency, and improve governance audits (Fang et al., 2023; Li et al., 2024). Despite these benefits, high data centre electricity demand, rising e-waste streams, and algorithmic bias that undermines fair labour practices, and cyber-security vulnerabilities that weaken stakeholder trust are significant hazards that may offset the benefits of digitalisation (González-González et al., 2023).

The net sustainability effect of DT depends on firm-specific capabilities and the institutional ecosystem that influences managerial incentives. China's rapidly expanding local and global institutional investor network is important yet understudied. Institutional owners controlled over a quarter of tradable A-shares in 2024, forming densely connected shareholding networks that facilitate information flows, joint monitoring, and collective engagement. Network theory states that centrality provides nodes via which the social capital can influence investee behaviour (Borgatti & Halgin, 2011). Network-central institutional investors in China boost business innovation, productivity, and earnings management (Fan et al., 2023; Yang et al., 2024). Nevertheless, it is unclear if such networks increase or decrease DT's sustainability value.

Another overlooked mechanism is product-innovation capabilities. By utilising modular R&D, real-time customer feedback, and data-driven experimentation, DT can accelerate innovation cycles and promote eco-design, inclusive accessibility, and circular-economy business models (Cooper, 2024; Li et al., 2023). Dynamic-capabilities theory posits PIC as a higher-order routine that helps organisations identify, seize, and transform opportunities in turbulent contexts (Teece et al., 1997; Do et al., 2022). If DT primarily improves ESG performance by revitalising PIC, investigations that lack this mediator risk assigning causality to technology as opposed to the innovative capability it releases.

Finally, China's governance architecture—state ownership, unequal disclosure rules, and FinTech adoption—may impact the DT–ESG connection differently from developed-market data (Ren & Isa, 2023; Wang & Hou, 2024). These observations pinpoint three interrelated knowledge gaps: (1) limited clarity on the direct impact of DT on ESG outcomes in A share market, (2) restricted insight into institutional-investor networks, and (3) imperfect understanding of product-innovation capability as a mediator. Addressing these gaps is pivotal

for academic progress and policy design that aligns technical upgrading with sustainable development goals.

1.2. Research aim and objectives

Research Aim:

To probe the influence of Digital transformation on ESG Performance and explore the moderating role of Institutional Investor Networks, as well as the mediating role of Product Innovation Capability in this relationship.

Research objectives:

(1) To explain the relationship between Digital transformation and ESG Performance and to what extent digital transformation can affect the ESG of listed companies;

(2) To explain the moderating role of Institutional Investor Networks on the relationship between Digital Transformation and ESG Performance;

(3) To explain the mediation role of Innovation Capability on the relationship between Digital Transformation and ESG Performance.

1.3. Research Gap

This study fills the existing research gap from the following three aspects.

Firstly, in terms of the research conceptual model, previous studies have primarily focused on the digital transformation of enterprises and the impact of institutional investor networks on corporate performance, with fewer studies examining the ESG impact. Many studies have examined the impact of digital transformation and institutional investor networks on ESG separately, but few have combined these two factors in their research. Additionally, relatively few studies consider product innovation capability as a mediating effect and institutional investor networks as a moderating effect. Secondly, regarding the Research Sample, few studies examine the four previously mentioned variables focusing on Chinese-listed companies. This study can make up for the gap using China's A-share market as a sample. Lastly, in terms of the Research Method, previous literature rarely combines quantitative and qualitative approaches. Qualitative research using grounded theory can better explain why quantitative assumptions are correct.

1.4 Research Contribution

This study uses the Resource-Based View (RBV), Dynamic-Capabilities Theory (DCT), Stakeholder Theory, and Network Theory to build a moderated mediation framework that explains whether DT improves ESG performance and how and under what situations. The research expands sustainability studies beyond performance measurements by understanding ESG a strategic, multi-stakeholder value frontier rather than a compliance consequence (Freeman, 1984; Teece et al., 1997). Network theory is enhanced by institutional-investor centrality as a contextual amplifier of technology-driven sustainability benefits (Borgatti & Halgin, 2011). The study uses an imbalanced panel of China's A-share market to estimate DT intensity, investor-network power, and PIC using patent plus revenue measurements. Baseline OLS

regression, Structural Equation Modeling, Two-way fixed effects, dynamic panel GMM, and conditional-process analysis yield causal insights that outperform descriptive investigations (Fang et al., 2023; Mingyue, 2023). Findings will help boardrooms integrate digital-investment portfolios with sustainability goals. Institutional investors use network leverage for ESG stewardship, and regulators adapt transparency mandates and incentive schemes. The initiative advances China's 2030/2060 climate promise and the UN Sustainable Development Goals by demonstrating how DT accelerates carbon neutrality and inclusive growth. It provides proof for reconciling digital wealth with ecological integrity.

2. Literature Review

2.1. Theory Foundations

2.1.1. Resource Based View

Sustained competitive advantage derives from the resources and capabilities a firm has control of, and are valuable, rare, imperfectly imitable, and not substitutable. These resources and capabilities can be viewed as bundles of tangible and intangible assets, including a firm's management skills, its organisational processes and routines, and the information and knowledge it controls (Barney, 1991). DT-created advanced analytics engines, cloud architectures, and AI-enabled decision dashboards pass the VRIN tests because they use proprietary data, firm-specific learning curves, and path-dependent IT-organisational routine complementarities. ESG criteria like emissions tracking and supply-chain transparency make digital assets critical levers for economic and sustainability value development (Wang et al., 2023).

2.1.2. Dynamic-Capabilities Theory

The dynamic capabilities framework analyses the sources and methods of wealth creation and capture by private enterprise firms operating in environments of rapid technological change. The competitive advantage of firms is generally reliant on distinctive processes (ways of coordinating and combining), shaped by the firm's (specific) asset positions (such as the firm's portfolio of difficult-to-trade knowledge assets and complementary assets), and the evolution path(s) it has adopted or inherited (Teece et al., 1997). This meta-competence relies on product-innovation capability (PIC) to iteratively ideate, rapidly prototype, and launch eco-friendly or socially inclusive products (Cooper, 2024; Li et al., 2023). Big data extend sensing frontiers, platform architectures accelerate seizing, and digital twins facilitate change, turning technical affordances into ESG successes (Liang & Li, 2022).

2.1.3. Stakeholder Theory

A stakeholder is any group or individual who can affect or is affected by the achievement of the firm's objectives". Freeman's stakeholder theory argues that firms should manage and balance the interests of all stakeholders, not just shareholders, for long-term success (Freeman, 1984). ESG measures measure how well the firm meets these diverse claims. Technology like real-time disclosure, blockchain traceability, and AI-driven sentiment analytics make opportunism more expensive and shareholder voice cheaper (Fang et al., 2023). Thus, DT can change managerial focus from shareholder primacy to stakeholder value maximisation.

2.1.4. Network Theory

Network Theory studies how entities (nodes) connect through relationships (edges) and how these structures influence behaviour, communication, and outcomes. In organisational and management research, Network Theory accounts for how the structure and position of firms or individuals in a network affect access to resources, innovation, influence, and performance. Key concepts include centrality, structural holes (Burt, 1992), and social capital. Institutional investors develop dense common-ownership networks that coordinate monitoring, agenda setting, and preferential resource allocation to affect corporate agendas (Bajo et al., 2020; Chen, 2023). Network centrality increases investors' power to reward sustainability leadership or sanction laggards, potentially boosting DT's ESG dividends (Yang et al., 2024).

2.2 Hypothesis Development

RBV states that precious, rare, inimitable, and non-substitutable resources sustain competitive advantage (Barney, 1991). Manfreda and Indihar Štemberger (2019) define DT investments as assets integrated into business routines, protected by data size, proprietary algorithms, and complementary organisational capital.

Secondly, DCT emphasises the firm's ability to sense, seize, and transform in dynamic contexts (Teece et al., 1997). Product-innovation capability operationalises meta-capability, enabling resource portfolio reconfiguration to meet sustainability needs (Liang & Li, 2022)Freeman's (1984).

Thirdly, stakeholder Theory states that organisations that satisfy investors, employees, communities, and regulators create long-term value. ESG performance measures stakeholder value creation's breadth and depth (Boulhaga et al., 2023).

Moreover, organisations are entrenched in social networks that distribute knowledge and resources (Borgatti & Halgin, 2011). Monitoring, expertise, and reputational incentives from institutional-investor networks can guide managerial priorities towards long-term ESG goals (Cohen et al., 2023; Yang, 2024).

The suggested paradigm considers DT as a strategic resource with ESG payoff through dynamic innovation capabilities and network-embedded governance demands. Digitally transformed organisations improve environmental and social results by streamlining processes, reducing waste, and increasing transparency using data analytics, real-time visibility, and platform interoperability (Fang et al., 2023; He, 2024). Integrating digital dashboards improves audit trails and board monitoring, reducing agency expenditures (Jensen & Meckling, 1976; Wang & Esperança, 2023). Chinese manufacturing research identifies positive correlations between DT proxies and ESG evaluations (Ren & Isa, 2023; Wang et al., 2023).

According to resource dependence theory, corporations seek legitimacy and resources from influential stakeholders (Hillman et al., 2009). Central institutional investors have superior information and coordination, allowing them to reward sustainability leaders with liquidity and penalise laggards with exit or voice measures (Cohen et al., 2023; Crane, 2019). Network-embedded investors can spread excellent practices across their portfolios, increasing

peer impact (Lin et al., 2024). Thus, central investor-monitored enterprises should gain more from DT's ESG benefits.

DT provides digital infrastructure (cloud platforms, AI engines, IoT sensors) for agile R&D and 4customer-centric design (Li et al., 2023; Cooper, 2024). ESG scores increase with eco-design (lightweight materials, energy-efficient components) and inclusive products (accessibility features) (Yang et al., 2019). Financial and sustainability outcomes are linked to PIC when aligned with stakeholder expectations (Zhang & Zhang, 2023; Wu & Li, 2023).

Based on the discussion above, this study proposes the following hypothesis as shown in Figure 1,

Figure 1: Proposed conceptual model

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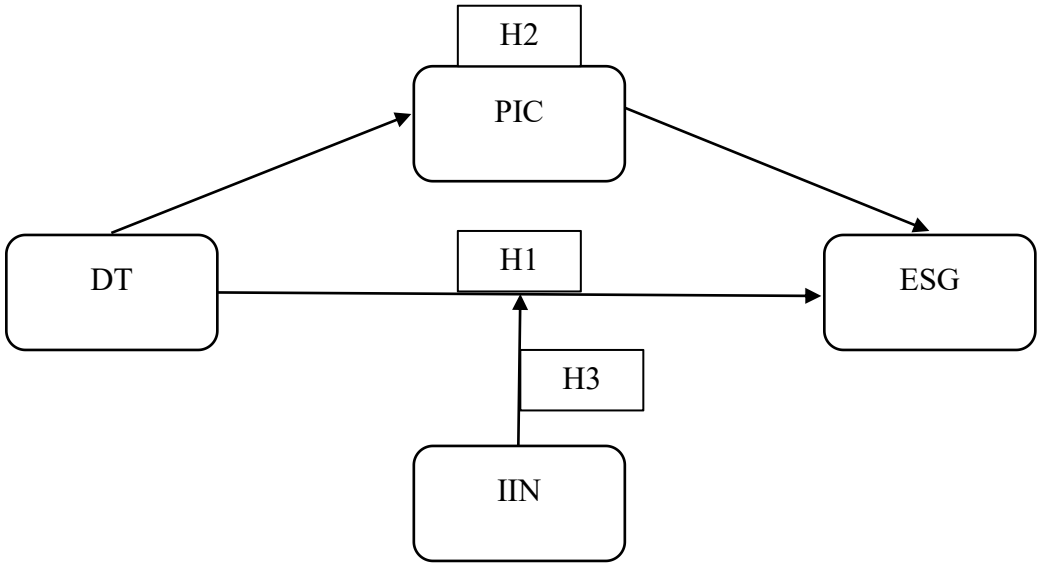

2.2.1. Digital Transformation and ESG Performance

DT uses AI, IoT, and cloud analytics to reduce material intensity, improve worker safety, and tighten compliance controls in production, logistics, and governance systems (Browder et al., 2024; He et al., 2024). Data from Chinese A-share corporations shows positive DT–ESG associations: digitalised firms had improved carbon efficiency, labour rights, and governance scores (Fang et al., 2023). Data lakes, predictive-maintenance algorithms, and blockchain ledgers are VRIN resources steeped in firm-specific data histories and socio-technical routines, making them difficult to replicate (Barney, 1991; Heavin & Power, 2018). Stakeholder theory supports this logic: DT shows real-time ESG footprints to satisfy investor and regulator information needs, lowering legitimacy risks (Behl et al., 2022). Thus, hypothesis 1 is proposed:

H1: Digital transformation positively affects ESG Performance

2.2.2. Mediation Role of Product Innovation Capability

DCT highlights that resource reconfiguration provides a competitive advantage (Teece et al., 1997). Real-time analytics can identify sustainability issues in customer and regulatory data

(Kong et al., 2022). Digital design platforms can rapidly prototype eco-products, reducing costs and time-to-market for ESG-aligned innovations (Cooper, 2024). Iterative upgrades using cloud-based DevOps and digital twins include ESG criteria in continuous product life-cycle management (Liang & Li, 2022). Green-patent intensity predicts stronger stakeholder evaluations (Zhang & Zhang, 2023), and AI-assisted design capabilities increase social inclusion measures (Li et al., 2023). Using stakeholder theory, an innovation that tackles social problems increases reputational capital and ESG ratings (Yang et al., 2019). RBV claims that rivals cannot replicate such innovation outcomes because they rely on tacit, path-dependent knowledge in DT infrastructures. Based on the above discussions, this study proposes hypothesis 2:

H2: Product Innovation Capability mediates the relationship between Digital transformation and ESG Performance.

2.2.3. moderating Role of Institutional Investor Networks

Network theory states that actors with high eigenvector centrality have structural advantages that boost their influence (Borgatti & Halgin, 2011). Central institutional investors have better information, coordination, and reputation (Crane et al., 2019). Central investors use advanced data analytics and cross-firm standards to detect greenwashing and superficial digitalisation better than peripheral investors (Cohen et al., 2023). They can cut capital costs for enterprises with credible digital-sustainability synergies, strengthening management's strategic commitment (Cleary & Wang, 2017). Their portfolio rebalancing moves spread ESG expectations through the market, reducing sustainability pioneers' first-mover disadvantages (Fan et al., 2023). Upper-echelon extensions indicate that boards are more receptive to credible external monitors in complicated, unpredictable situations like large-scale DT projects (Ali et al., 2022). Therefore, hypothesis 3 is proposed

H3: Institutional Investor Networks moderate the relationship between Digital Transformation and ESG Performance.

3. Research Methodology

3.1 Quantitative Approach

Data Source and Sample

This study will use secondary data from the China Stock Market & Accounting Research (CSMAR) and Wind databases on Listed enterprises to test its hypotheses.

Variable	Indicator	References
Institutional Investor Networks	*Network centrality for institutional investors (IIN)* will be operationalised using three indices, using Fan et al. (2023) and Bajo et al. (2020) methods: Degree Centrality (Deg): Institutional investor's direct	Fan et al. (2023); Bajo et al. (2020)

	network linkages. Investor resource acquisition and knowledge dissemination potential are shown by this indicator. Closeness Centrality (Close): Measures an institutional investor's network information transmission efficiency by the inverse of the sum of all network members' distances. Betweenness Centrality (Bet): Measures an institutional investor's network intermediary function in information and resource exchange.	
ESG Performance (ESG)	Wind: ESG score from HUA ZHENG ESG database; possibly sub-indexes on environment, social and governance dimensions	Fang et al., 2023
Product innovation Capability (PIC)	CSMAR: Number of invention patents granted	Yang et al., 2019
Digital transformation (DT)	CSMAR: Composite DT index from CSMAR, encompassing six dimensions: strategic leadership organisational empowerment environmental support technology driven digital achievement digital application	Zhou et al., 2024; Zhang et al., 2023
Control Variables (CVs)	Firm size Firm age Industry type	Zhou et al., 2024; Zhang et al., 2023

Regression model:

H1: $ESG = \alpha_0 + \alpha_1 \times DT + \alpha_2 \times CVs + \mu_1$

H2: $PIC = \beta_0 + \beta_1 \times DT + \beta_2 \times CVs + \mu_2$

$ESG = \gamma_0 + \gamma_1 \times DT + \gamma_2 \times PIC + \gamma_3 \times CVs + \mu_3$

H3: $ESG = \delta_0 + \delta_1 \times DT + \delta_2 \times IIN + \delta_3 \times DT \times IIN + \delta_4 \times CVs + \mu_4$

3.2 Qualitative Approach

These semi-structured interviews will be recorded (with consent) and thematically coded. Supplying these qualitative insights to the quantitative results will deepen our understanding of how DT affects manufacturing resilience in China. This mixed-methods approach reflects the lived experiences of digital transformation pioneers and avoids quantitative design flaws. The study will complete 20 interviews.

3.3 Data Analysis

Quantitative analysis utilising Stata will find patterns, correlations, and causal links using advanced analytical methods. Descriptive statistics summarise data and highlight relevant variables, followed by normality tests to check parametric assumptions. The independent variables will be tested for multicollinearity using Variance Inflation Factor (VIF) analysis to ensure regression correctness. The degree and direction of bivariate associations across the dataset will be assessed using correlation analysis. Regression analysis with fixed effects models will follow these core principles for hypothesis testing. Controlling firm-level factors that remain constant across time improves estimated impacts by addressing unobserved variability. NVivo will help code and thematise qualitative data to complement quantitative conclusions. This phase categorises and interprets textual or transcribed data to find patterns and themes that numerical results may not reveal. Thus, the mixed-methods design integrates objective statistical analysis with contextual understanding to draw comprehensive conclusions.

4. Conclusions

The study integrates RBV, DCT, Stakeholder, and Network theories to explain the joint functions of internal dynamic capacities and external governance networks. The study's wide panel and thorough causal identification technique should resolve DT–ESG scholarship discrepancies. It is expected to show that DT only gives significant sustainability dividends when supported by powerful product-innovation capability and central institutional-investor control. Such data would warn against technology-first approaches that ignore capability building and stakeholder alignment.

The findings will encourage boards to combine digital investment roadmaps with innovation-capacity development and aggressive investor engagement. The study shows institutional investors how network centrality can encourage sustainability action. The findings may help policymakers create disclosure and subsidy regimes encouraging integrated digital and innovative initiatives rather than technology spending. Clarifying these causal connections shows how digital prosperity may coexist with ecological integrity, supporting China's carbon-neutrality goal and the planetary agenda. Future research might apply the

moderated-mediation lens to other emerging economies, evaluate how FinTech adoption deepens investor participation, and examine similar processes in privately held enterprises. In conclusion, the study bridges scholarly and practical discussions on digital transformation and sustainable development into a coherent discourse based on sound theory and facts.

The study acknowledges some limitations. First, its reliance on a specific cohort of China's listed businesses may limit its applicability in other geographic or economic contexts. Second, qualitative interviews can lead to socially desired responses, question misinterpretation, and recollection bias, which can skew self-reported findings.

5. Research Time Plan

	2026				**2027**				**2028**				**2029**			
TASK NAME	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
Comprehensive Literature Review																
Finalise Research Design																
Data Collection																
Data Analysis																
Interpretation																
Draft Thesis																
Present at the International Conference																
Viva Voce																
Final Thesis																

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