Driving Sustainability through Artificial Intelligence and Financial Innovation: The Roles of Green Innovation and Information Transparency

Abstract

How do firms' innovation capabilities shape the relationship between artificial intelligence (AI), financial innovation and Environmental, Social and Governance (ESG) performance nexus? This study investigates this underexplored nexus using survey data from 267 Chinese firms, analysed with Partial Least Squares-SEM and PROCESS models. Our results show that artificial intelligence and financial innovation positively influence ESG performance, with green innovation and information transparency serving as key mediators. Sectoral and regional patterns suggest that AI-driven green innovation is particularly impactful in manufacturing, whereas financial innovation's effect on ESG performance is pronounced in financial institutions through enhanced transparency. Regional differences indicate that firms in Guangzhou benefit more from artificial intelligence and financial innovation, while financial innovation's influence is stronger in Jiangsu. These findings highlight the strategic importance of integrating artificial intelligence and financial innovation into their ESG initiatives, highlighting innovations and transparency to advance sustainable outcomes in emerging economies.

Keywords: Artificial intelligence, Financial Innovation, ESG, Transparency, Green innovation, China.

1. Introduction

Organisations are increasingly required to show sustainability through measurable Environmental, Social and Governance (ESG) performance indicators, essential for assessing corporate responsibility, long-term value creation, and investor confidence. (Abbas Khan et al., 2024; Duan et al., 2019; Lee et al., 2019). Simultaneously, the integration of artificial intelligence (AI) and financial innovation (FI) into corporate strategies offers substantial opportunities to enhance organisational ESG initiatives. (Dai et al., 2025a; Eccles and Klimenko, 2019; He et al., 2024; Wang et al., 2023). Despite these promises, scholarly research into the combined effect of AI and FI on ESG performance remains limited, particularly in emerging markets like China, which encounter significant sustainable development challenges.

AI is revolutionizing organizational approaches to sustainability initiatives through advanced data analytics, automation, and predictive modelling. These capabilities improve corporate decision-making and contribute to long-term sustainability goals. (Dwivedi et al., 2021; Li et al., 2025a; Rajagopal et al., 2022; Zhang and Yang, 2024). Empirical evidence suggests that AI can improve environmental risk identification, optimise resource use, enhance energy efficiency, and increase transparency through real-time ESG reporting. (Lian et al., 2023; Su and Xue, 2024; Wan et al., 2024; Yi et al., 2024). Similarly, FI through Fintech and green finance helps firms mobilise resources for sustainability, reduces information asymmetry, improves green capital access, and incorporates ESG metrics into financial decisions (Johnson and Kwak, 2012; Michalopoulos et al., 2011; Qayyum et al., 2025). However, the presence of AI and FI alone does not ensure improvements in ESG; successful outcomes depend on organisational mechanisms that transform innovation potential into actual sustainability results. This study proposes that green innovation (GI) and information transparency (ITRAN*)* are critical mediators in this process.

GI involves the development and implementation of environmentally friendly products, processes, and technologies, helping firms reduce ecological impact and enhance social legitimacy (Bonsu et al., 2025; Chen and Lee, 2020; Xie and Wang, 2024; Yu et al., 2025c; Zhang et al., 2024). AI empowers companies to utilise data and analytics for green innovation, while FI offer resources and incentives to aid these efforts, connecting operational efficiency with sustainability goals. (Behera et al., 2025; Liao et al., 2023).

Information transparency (ITRAN) refers to the accessibility, accuracy, and openness of ESG-related information. It mediates the relationship between innovation and ESG outcomes by fostering stakeholder trust, reducing uncertainty, and promoting accountability. (Rossi et al., 2024; Zhang et al., 2020). AI-driven analytics and Fintech increase the reliability and comprehensiveness of ESG disclosures, enhancing firms' credibility in their sustainability commitments (J. Nair et al., 2025). Despite their importance, few studies have empirically examined GI and ITRAN as mechanisms linking AI and FI to ESG outcomes, leaving a critical gap in emerging market research. Previous studies have mainly examined AI, FI, and ESG in isolation, concentrating on aspects such as operational results, financial performance, or governance structures (Dai et al., 2024; Hassan and Mhmood, 2021; He et al., 2024; Khamisu et al., 2024; Michael et al., 2024; Mooneeapen et al., 2022; Yu et al., 2024; Zewail and Saber, 2023). This fragmented approach hinders our comprehension of the collective impact of organisational resources and capabilities on driving sustainability. To address this gap, this present research develops a unified analytic framework to examine how AI and FI influence ESG through GI and ITRAN. Accordingly, we address three key research questions

1. To what extent do AI and FI impact ESG performance in emerging markets?

2. Do Green Innovation mediate the relationship between AI and ESG performance?

3. Do ITRAN mediate the relationship between FI and ESG performance?

This study examines China, a country facing challenges in balancing economic growth with environmental sustainability. As the world's largest carbon emitter, China has swiftly advanced its policy frameworks through robust national initiatives to integrate sustainability with technological innovation, positioning itself at the forefront of developments in AI, digital finance, and sustainable development. For example, the government's efforts link digital and financial innovations to ESG objectives via the Artificial Intelligence Development Plan and Green Finance Pilot Zones. To empirically test our framework, we collected survey questionnaires from 267 Chinese organisations between July and October 2025, employing Partial Least Squares-SEM and the PROCESS model. Our results indicate that AI and FI positively influence ESG performance, with GI and ITRAN acting as mediators. Notably, sectoral and regional patterns suggest that AI-driven GI is especially influential in manufacturing, whereas FI’s impact on ESG performance is significant in financial institutions through increased transparency. Regional differences show that firms in Guangzhou gain more from AI and FI, while FI’s influence is stronger in Jiangsu.

Our research makes three important contributions. First, we develop an integrated theoretical model that examines how AI and FI influence ESG performance through mediating roles of green innovation and information transparency, providing a comprehensive understanding of the mechanisms linking technological and financial innovation to ESG outcomes in Chinese firms. Second, this research empirically tests the mediating effects of GI and ITRAN in the context of AI and FI-enabled ESG performance, offering new evidence on how firms translate technological and FI into meaningful sustainability outcomes. Finally, we contribute to the literature by using validated questionnaires at the firm level, addressing the limitations of prior studies that rely predominantly on secondary sources, thereby providing more accurate and actionable insights for managers and policymakers.

Our paper is structured in five sections. In the first two sections, literature, theoretical frameworks, and hypothesis development are examined, while research methodology is presented in section three. Section 4 presents the empirical findings and results, while Section 5 concludes the study by highlighting implications for both theory and practice.

2. Literature Review and Theoretical Framework

Organisations are increasingly leveraging digital technologies and financial innovations to improve their ESG (Korankye et al., 2025; Kwilinski et al., 2023). Prior research indicates that AI enhances sustainability decision-making by utilising advanced data analytics, automation, and predictive capabilities for environmental management and governance. (Dwivedi et al., 2021; Zhang and Yang, 2024). Similarly, studies on FI highlight the importance of Fintech, digital finance, and green financial instruments in enhancing access to sustainable capital, minimising information asymmetry, and incorporating ESG factors into financial decision-making. (Ahmad et al., 2022; Alshagri et al., 2024). At the same time, research highlights green innovation and information transparency as vital ways that technological and financial progress lead to sustainable results. Green innovation enables companies to reduce their environmental impact through eco-friendly products and cleaner production methods, boosting resource efficiency and social legitimacy. (Osei-Assibey Bonsu et al., 2025; Xie and Wang, 2024; Yu et al., 2025a). Additionally, information transparency enhances accountability and stakeholder trust by improving the accessibility, accuracy, and credibility of ESG disclosures. (Qin and Lee, 2024; Rossi et al., 2024). Despite advancements, notable gaps remain. First, earlier research has primarily addressed AI and ESG performance independently or from organisational and governance viewpoints, overlooking the impact of financial innovation on ESG outcomes (Dai et al., 2024; Michael et al., 2024; He et al., 2024). Similarly, research on digital technologies and sustainability often highlights technological innovation or firm performance, neglecting the interconnection with ESG outcomes (Tomás et al., 2025; Bonsu et al., 2025b). As a result, empirical evidence regarding the combined effects of AI and FI on ESG performance is scarce, especially in emerging markets like China, which encounter notable sustainability and institutional obstacles (Zhang et al., 2020a; Hou et al., 2025).

Second, the roles of GI and ITRAN as mediators between AI, FI, and ESG performance relationships at the firm level have not been thoroughly investigated. Although prior ESG research has extensively examined direct effects and financial performance implications, it has largely neglected the transformational mechanisms linking FI to ESG outcomes. Specifically, insufficient attention has been devoted to understanding how ITRAN mediates the relationship between FI and ESG performance through improvements in stakeholder trust, disclosure quality, and governance effectiveness. Finally, most empirical studies predominantly utilise secondary or archival data, limiting understanding of firms' internal capabilities and managerial views on AI adoption, FI and ESG practices. There is a noticeable scarcity of firm-level survey data (Song et al., 2025; Wang et al., 2025; Zhou et al., 2025), particularly in the context of China.

To address these gaps, this study adopts a multi-theoretical framework integrating the *resource-based view (RBV)* (Barney, 1991), *dynamic capabilities view (DCV)* (Teece et al., 1997), and *stakeholder theory (ST)* (Freeman, 1984). This integrated perspective constructs a cohesive analytical framework to examine the joint influence of AI and FI on ESG performance, mediated by GI and ITRAN. Specifically, RBV and DCV frame AI and FI as strategic resources and capabilities, while stakeholders' theory illustrates how GI and ITRAN enable firms to convert these resources into ESG outcomes, addressing stakeholder expectations and institutional pressures.

RBV suggests that firms' distinctive bundles of valuable, rare, inimitable, and non-substitutable (VRIN) resources are key factors in achieving competitive advantage and performance. (Barney, 1991). In this study, AI and FI are considered strategic resources for firms because they are embedded in organisational routines, are hard to replicate, and can generate long-term value. AI improves firms' information processing and predictive abilities, and FI enhances capital allocation efficiency and promotes sustainability-oriented financial instruments. (Zhang et al., 2025c). These resource attributes enable firms to improve their ESG performance through better capital allocation and managerial focus on environmental protection, social responsibility, and governance improvement.

Building on RBV, the DCV illustrates the deployment and transformation of strategic resources into ESG outcomes in dynamic environments (Teece et al., 1997). AI and FI act as dynamic capabilities enabling firms to identify ESG-related risks and opportunities, capitalise on them through specific investments, and adjust organisational processes accordingly. Through these capabilities, AI improves green innovation in companies by lowering R&D information uncertainty, enhancing cleaner production techniques, and encouraging the adoption of eco-friendly technologies (Feng et al., 2024; Rahman et al., 2025). Advanced analytics and automation enhance green innovation, reducing costs and complexities while serving as a direct means for AI to improve ESG performance (Jing and Zhang, 2024). These positions assert that GI is superior to alternatives like general digital capabilities or technology integration, as it effectively transforms AI-driven potential into measurable environmental and social outcomes. In contrast, FI primarily enhances information transparency. By enhancing organisations' ability to assess, structure, and publish ESG-related financial information like green financing operations, sustainability-linked investments, and risk exposure, FI decreases information asymmetry and improves disclosure quality (Kandpal et al., 2024). Information transparency is a key mediator that enhances FI's resource potential by converting financial tools into credible ESG outcomes. ITRAN and GI, while distinct concepts, are complementary; GI aims to translate AI into sustainable operational outcomes, whereas ITRAN focuses on utilising FI to enhance governance, stakeholder trust, and accountability. AI and FI may affect transparency and green innovation, but these aspects are secondary to the primary focus of this study on ESG improvement. Therefore, this study focuses on GI as the main mediating mechanism for AI and ITRAN as the main mediating mechanism for FI in accordance with theoretical prudence and empirical focus.

Our research indicates that the relationship between AI, FI, and ESG performance is increasingly interconnected, especially within inter-organisational and supply-chain frameworks. Recent research indicates that digital technologies in green supply chains enhance eco-innovation by improving internal process optimisation, inter-firm coordination, data sharing, and collaborative problem-solving (Wang and Zhang, 2024). AI enhances environmental data integration among suppliers and partners, improving logistics, production planning, and collaboration on green technologies. This promotes green innovation by extending sustainability-focused R&D and process improvements across firms. (Hwang et al., 2025). Similarly, FI through Fintech enhances information transparency in value chains, leading to improved traceability, accountability, and consistency in ESG disclosures among interconnected firms. (Albert et al., 2025). These inter-organisational dynamics highlight the mediating roles of GI and ITRAN, offering a systemic interpretation of how AI and FI are connected to ESG performance in China.

Stakeholder theory highlights the significance of certain mechanisms in achieving effective ESG outcomes, particularly in the context of China. (Freeman, 1984). Firms face complex stakeholder networks, including regulators, investors, customers, and local communities, that demand substantial environmental improvements and credible ESG disclosures. (Alessa et al., 2024; Nagriwum et al., 2025). Green innovation aligns stakeholder expectations with environmental performance, while information transparency fosters accountability and trust. AI and FI enhance firms' responsiveness to stakeholder pressures and bolster ESG performance. (Wu et al., 2025).

RBV considers AI and FI as strategic resources, whereas DCV views their deployment through GI and ITRAN as capabilities. The supply-chain perspective highlights the importance of inter-organisational reinforcement, while stakeholders’ theory contextualises the relevance of these mechanisms for attaining ESG outcomes in China's policy-oriented and stakeholder-focused environment. This study formulates a conceptual framework and hypothesises suggesting that AI and FI lead to improved ESG performance, mediated by green innovation and ITRAN as separate, complementary mechanisms.

2.2. Hypothesis Development and Conceptual Framework

2.2.1. Artificial Intelligence and ESG performance

According to DCV, technology adoption, particularly in AI, is key for companies as it enhances resource integration and adaptability, resulting in sustainable performance outcomes. (Teece et al., 1997). Artificial intelligence refers to systems that can learn, adapt, and make sophisticated decisions, not just simple monitoring tools (Biloslavo et al., 2025). In firms, AI includes predictive analytics, decision-support systems, and intelligent monitoring that enhance environmental efficiency, social responsibility, and governance transparency (Russell Stuart and Peter, 2016). AI helps companies identify environmental and social risks, enhance ESG opportunities, and adapt operations for sustainability through data-driven decision-making and analysis. In this regard, AI improves efficiency and stakeholder engagement, shaping firms' ESG performance by enhancing internal and external mechanisms (Yu et al., 2025d). Evidence suggests that AI improves business operations by automating processes, reducing costs, and minimising errors, while also enhancing resource optimisation and governance transparency (Huang et al., 2025). For instance, intelligent monitoring tools in manufacturing and service industries provide real-time insights into energy consumption, waste management, safety compliance, and operational transparency, aiding in ESG-oriented decisions. (Li et al., 2024). Additionally, AI adoption enhances firms' capability to respond dynamically to stakeholder demands and societal expectations externally. Stakeholders' theory highlights the importance of balancing diverse interests in firms for legitimacy and long-term value creation, with AI technologies enhancing transparency, accountability, and communication (Freeman, 1984). For instance, AI systems enhance ESG reporting, manage supply chain risks, ensure compliance, and promote responsible practices and stakeholder trust, boosting internal efficiency and sustainability through external connections. Despite the growing exploration of AI and sustainability (Feng et al., 2026; Manikandan et al., 2025; Zhang et al., 2025a), empirical evidence on AI adoption's influence on ESG performance in China is limited, primarily relying on secondary data, which restricts understanding of how AI capabilities lead to sustainability improvements at the organisational level (Song et al., 2025, Wang et al., 2025, Zhang and Yang, 2024). This study addresses the gap and argues that AI can enhance ESG performance by improving environmental efficiency, strengthening social responsibility and enhancing governance transparency. Therefore, this study proposes the first hypothesis:

H1: The adoption of artificial intelligence is positively associated with ESG performance.

2.2.2. Financial innovation and ESG performance

Financial innovation is crucial for improving the ESG performance of firms and financial institutions. DCV considers FI a dynamic capability that enables firms to identify sustainability opportunities, adopt new financing models, and allocate resources to green and socially responsible projects. Financial innovation includes green bonds, AI-based credit scoring, peer-to-peer lending, big data analytics, and blockchain platforms, which enhance access to sustainable financing and ESG-focused resource allocation. FI, such as green bonds and blockchain platforms, boosts firms' ability to fund ESG initiatives, secure sustainable financing, manage ESG risks, and invest in long-term environmental and social value. As explained by stakeholder theory, FI improves ESG performance by aligning corporate financing decisions with stakeholder expectations (Freeman, 1984). Innovative financial practices that incorporate ESG considerations are essential for firms to meet the increasing global demand for responsible investments and ethical corporate behaviour, thereby enhancing their legitimacy in financial, lending, and investment decisions. For example, AI-based credit scoring, peer-to-peer lending, and big data analytics help in identifying ESG risks and promote responsible financing, while blockchain technology enhances transparency and governance in financial processes. In emerging markets, strong policy and institutional support for green finance and digital transformation reinforce the link between financial innovation and ESG performance. The Chinese government promotes financial technology integration with sustainability goals through initiatives like the Guidelines for Establishing a Green Financial System and the Digital Economy Development Plan, focusing on financial innovation within its "dual carbon" strategy to build a green and inclusive financial system. Financial innovation strategies also improve SMEs' participation in sustainability investments by expanding digital access to finance and developing green financial products. Despite considerable attention to the nexus between green technology and sustainability, research on how FI influences ESG outcomes remains limited. Consequently, we examine how FI enhances ESG performance through targeted financing mechanisms, emphasising the role of FI adoption and increasing ESG disclosure requirements in supporting sustainability-led transformation, leading to the following hypothesis:

H2: Financial innovation is positively associated with firms’ ESG performance.

2.2.3. Green Innovation as a mediator between AI and ESG performance

DCV suggests that AI adoption can transform technological resources into sustainability-oriented innovations, enhancing ESG performance (Teece, 2007). AI-driven green innovation combines significant technological investment, organisational learning, and integration mechanisms, making it a resource difficult for competitors to replicate. In the Chinese context, the mediating role of green innovation is particularly noticeable, considering the country's strategies for intelligent manufacturing and digital green transformation. This highlights AI's contribution to economic growth and sustainability, supported by the New Generation AI Plan and Dual-Carbon Goals, targeting carbon peak by 2030 and neutrality by 2060 (Hu et al., 2025b). This environmental policy promotes AI adoption for developing eco-innovative solutions that enhance resource efficiency, decrease pollution, and enable circular production systems. Research indicates that AI-powered green innovation helps businesses optimise energy use, prevent failures, boost efficiency, minimise waste, and incorporate sustainability into their design and supply chains (Li and Chen, 2025; Li et al., 2025b; Wan et al., 2025). Notably, green innovation enhances social and governance outcomes by fostering better labour practices, promoting supply chain sustainability, and increasing transparency in reporting. However, research on AI-driven green innovation in emerging markets, particularly in China, is scarce and neglects the social and governance dimensions. Additionally, the evolution of AI-driven innovation capabilities in China combines state guidance with market competition, a topic that remains underexplored. Hence, we suggest that AI adoption enhances GI, environmental efficiency, governance transparency, and social responsibility in firms, thereby enhancing ESG outcomes.

H3: *Green innovation mediates the relationship between AI adoption and firms' ESG performance*.

2.2.4. Information transparency as a mediator between FI and ESG performance

According to RBV, FI enhances efficiency, transparency, and stakeholder responsiveness in emerging markets, promoting sustainability through fintech and innovative financing (Barney, 1991). However, resources must be effectively utilised through appropriate capabilities to generate ESG outcomes (Teece et al., 1997). In this context, information transparency (ITRAN) serves as the crucial capability that transfers FI into ESG performance. Information transparency involves delivering accurate, timely, and comprehensive data about a company's operations and sustainability practices, which is crucial for connecting financial innovation with ESG performance (Qin and Lee, 2024; Rossi et al., 2024). Financial innovation enhances firms' ability to gather, verify, and communicate ESG-related data through methods like blockchain reporting, big data analytics, and AI-driven risk assessment (Nguyen et al., 2025; Teece et al., 1997). These approaches improve reporting accuracy and decrease information asymmetry, aligning business strategies with environmental and social expectations, thereby fostering trust, accountability, and legitimacy among stakeholders (Freeman, 1984). Notably, ITRAN is the key mediator for financial innovations, translating them directly into credible ESG outcomes, unlike other mechanisms that contribute indirectly or less systematically to ESG performance. Practically, Fintech platforms enhance ESG outcomes through standardised reporting, real-time monitoring of green finance projects, and traceable transactions, thus ensuring effective allocation of financial tools towards sustainable initiatives. The mediating role of information transparency is vital in China's financial reforms, particularly through the Digital Economy Development Plan and Green Finance Guidelines, supporting the integration of AI and big data into financial systems (Cheng et al., 2024). While green financing opportunities and regulatory frameworks are expanding, disparities in transparency remain due to variations in enforcement, data infrastructure, and governance capabilities across different industries and regions (Nasir and Ahmed, 2024; Singh, 2022). FI enhances transparency and accountability in ESG reporting by standardising processes, improving data traceability, and reducing uncertainty for stakeholders, which helps firms improve ESG performance and attract sustainability-focused investors. Despite its critical role, previous research has largely neglected how FI translates into ESG outcomes, particularly through information transparency, focusing instead on investment efficiency and financial performance. This research suggests that ITRAN is a central mechanism through which FI is converted into measurable ESG gains, ensuring accountability, stakeholders' confidence and long-term sustainable value creation. Therefore, we hypothesize that

H4: Information transparency mediates the relationship between financial innovation and firms' ESG performance.

Fig 1 below illustrates our research conceptual framework. To summarize, our paper expects a positive association between AI and ESG performance (H1). Further, FI is expected to positively impact ESG performance, supporting H2. Additionally, we propose a positive mediation effect of green innovation impacting AI and ESG performances (H3). Finally, we expect a positive mediating impact of information transparency between FI and ESG performance (H4).

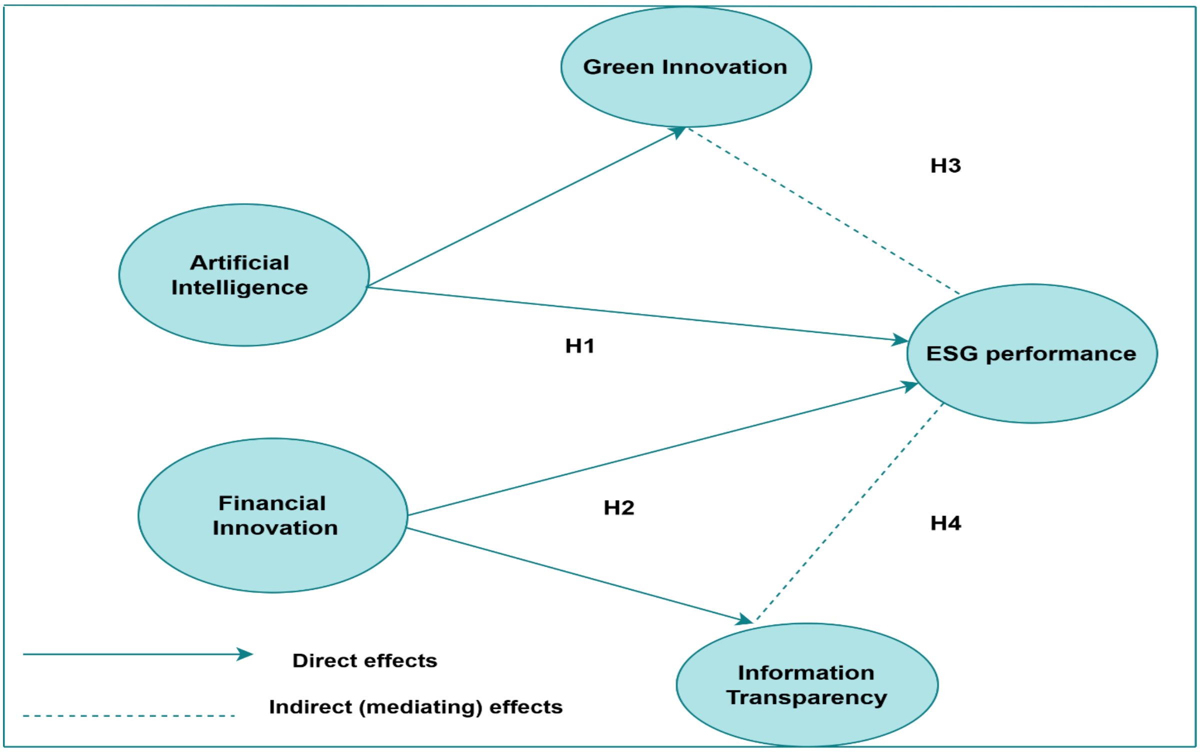

Figure 1 Research Framework

3. Research Methodology

The study utilised an English-language survey instrument to measure variables related to the respondent's demographic and firm profile. Our team employed a 5-point Likert-type scale for all constructs, with one Native Chinese author reviewing and translating the English version into Chinese. The reliability of the Chinese version was verified by back-translation into English and comparison with the original, before being utilised for data collection in China.

A pretest was conducted with experts in digital technology and sustainability to evaluate the validity, relevance, clarity, and alignment of the questionnaire with the study's objectives and the comprehension of the target population. In addition, three experts in innovation and governance were consulted to validate the content of the questionnaire and accurately capture its key constructs and dimensions. The instrument was revised to improve representativeness, accuracy, comprehensive variable coverage, and contextual relevance based on feedback received. Additionally, the instrument was enhanced by incorporating scales from previous studies to bolster its content validity. A pilot test with 15 selected organisations' respondents enhanced the instrument's clarity, relevance, and comprehensibility by addressing ambiguities and ensuring relevance to the target population.

The survey form consisted of three sections aimed at analysing demographics, firm characteristics, and industry competition. The final segment involved respondents assessing study constructs adapted from existing literature and contexts, enhanced by integrating scales from prior research. Artificial intelligence was modified and adapted from (Duan et al., 2019; Liu et al., 2025; Wang et al., 2025; Zhang and Yang, 2024). FI was measured with five items adopted. (Gao et al., 2024; Laeven et al., 2015). Green innovation was adapted from previous studies. (Asadi et al., 2020; Obuobi et al., 2024; Osei-Assibey Bonsu et al., 2025; Yang et al., 2021). Information transparency was adopted from (Qin and Lee, 2024). Finally, ESG performance was assessed through six items reflecting three dimensions: environmental, social, and governance performance. For the main analysis, these items were combined into a single ESG performance score to represent overall corporate sustainability outcomes, reflecting firms' effectiveness in addressing economic, social, and environmental responsibilities. Each dimension was measured using two items adapted from (Duan et al., 2019; Liu et al., 2025; Wang et al., 2025; Zhang and Yang, 2024). In additional analyses, the three dimensions were examined separately to explore dimension-specific effects. The measurements are shown in the Appendix.

To mitigate omitted variable bias, we control firm size (measured by the number of employees) and firm age (in years since incorporation), both of which were log-transformed to approximate a normal distribution. Moreover, we controlled for industry competition, which may influence the readiness and speed of organisations in the adoption of innovations for ESG goals. This was measured using respondents' perception of sector-specific competition on a scale from 1 (highly competitive) to 7 (weakly competitive), following previous studies. (Bonsu et al., 2025; Zhou et al., 2016). Finally, we accounted for R&D intensity by assessing the ratio of R&D employees to total full-time employees. Notably, despite data limitations preventing the inclusion of fixed effects for industry, region, and firm ownership type, the controls used in the analysis effectively capture important firm-level characteristics. The robustness of the results was validated through variance inflation factors (VIFs) and sensitivity checks, indicating that omitted variable bias is not likely to significantly impact the findings.

3.1. Sample and data collection

The study utilised a survey questionnaire to collect data for an empirical investigation of the conceptualised model. The sampling frame consisted of active firms in key technology and economic zones, including Shanghai, Jiangsu, Zhejiang, Shandong, and Guangzhou. Firms were identified through publicly available company registries, industry association directories, and professional business listings, which listed contact information for managers overseeing ESG, innovation, and financial operations. From this frame, 1,200 firms were randomly selected for a survey, with the research purpose clearly communicated to respondents, who were assured of confidentiality and that their data would be used solely for academic purposes.

Data collection was conducted from July to October 2025. This period focused on improving response consistency and minimising the effects of policy changes and market fluctuations. The integration of AI and FI within the DCV context enables firms to adapt and reconfigure resources effectively. This period offered reliable insights into the impacts of AI adoption, financial innovation, green innovation, and ESG performance. While operational control was achieved, future studies may benefit from a longer or multi-period analysis to assess enduring relationships among these elements. Data quality was ensured through attention checks to filter out inattentive responses, data cleaning to eliminate missing values, and validation of conflicting responses.

The final sample contained 267 valid responses, yielding a response rate of 22%. To mitigate any non-response bias, contact was made with non-responding organisations twice, through email and phone. We then used independent-samples t-tests to compare early respondents (first 150) to late respondents (last 117) on important firm-level variables (firm age, firm size, industry competition) and study constructs, with each response coming from a senior manager from a different firm. There were no significant changes ($p>0.05$), indicating that non-response bias was unlikely to have influenced the findings. Surveys were completed by key informants: senior managers overseeing ESG, innovation, or financial operations, facilitating accurate firm-level data on AI adoption, financial and green innovation, information transparency, and ESG performance. This selection ensures reliable reporting on the firm’s strategic initiatives and sustainability outcomes by confirming respondents' knowledge and authority, thereby minimising reporting bias.

3.2. Data Analysis and Model Assessment

This paper tests the hypothesis using the Partial Least Squares-Structural Equation Modelling (PLS-SEM), a critical estimating tool in Business and management research (Bonsu et al. 2025; Benitez et al. 2020). PLS-SEM is particularly suitable for modelling complex relationships among multiple latent constructs, integrating three distinct theoretical perspectives, and addressing measurement errors to support robust predictive modelling (Guenther et al., 2023; James et al., 2024). While the overall sample of 267 survey responses offers sufficient statistical power for the full model, we acknowledge that subgroup analyses by industry or region may lead to smaller sizes that reduce reliability and necessitate careful interpretation. However, PLS-SEM enables effective hypothesis testing and model evaluation with its predictive focus, bootstrapping techniques, and analysis of effect sizes and predictive relevance (Wang and Zhang, 2024), providing insights into the AI–FI–ESG performance relationship and indicating avenues for further investigation in larger samples (Abbasi et al., 2024).

After the data collection and cleaning process, we received 267 completed responses, showing 41.4% response rate after several reminders through email and phone. In a study with 267 participants, 23% were from manufacturing, 33% from technology/IT, 32.7% from services/logistics, and 23% from financial institutions. We found that 25.7% of participants were aged between 26 and 35 years, while 25.4% were aged between 36 and 45 years. Male participants were greater than females (M=56.3% vs. F=43.7%). For education, 39.1% of individuals held an undergraduate degree, 19.6% held a postgraduate degree, and 41.3% reported having other certificates.

To mitigate common method bias (CMB) in data from a single survey instrument, we implemented procedural and statistical remedies following established guidelines. (Podsakoff et al., 2012). First, clear construct definitions were provided, questionnaire items were randomised, and respondent anonymity and confidentiality were assured to mitigate evaluation apprehension and response pattern biases (Podsakoff et al., 2003). Second, Harman's single-factor test was conducted as an initial diagnostic, indicating that the largest factor accounted for 17.04% of the total variance, below the threshold of 50%, suggesting that CMB is unlikely to be a dominant concern (Podsakoff et al., 2003). Consistent with recent methodological recommendations, we acknowledge that this test alone offers limited evidence. Third, we performed a collinearity assessment using variance inflation factors (VIFs) for all constructs in the PLS-SEM model, finding all VIF values below 3.3 (Kock, 2015). This suggests that common method bias does not significantly affect the estimated relationships. In addition, a marker-variable approach was employed as a supplementary diagnostic (Lindell and Whitney, 2001). Including respondent gender as a marker variable did not significantly impact the structural path coefficients in the study. Despite gender's potential correlation with other constructs, the consistent results indicate that method variance is unlikely to influence the findings. Collectively, these assessments indicate that common method bias does not significantly threaten the study's validity.

Following that, we assessed our model by employing a two-step procedure to evaluate the fit and hypothesis interrelationship of the proposed model. Our model's reliability and validity were assessed using SPSS V26 and PLS-SEM through confirmatory factor analysis, composite analysis, and structural path examination to test the hypothesis (Junaid et al., 2022). We assess the measurement scale of indicators for variables through Confirmatory

Factor Analysis (CFA) to ensure construct reliability, convergent validity, and discriminant validity. Therefore, we use properties such as Cronbach's α, Factor Loadings, Composite Reliability (CR), and Average Variance Extracted to achieve our goal. Table 1 shows that the measurement model outputs satisfy reliability standards, as all constructs have factor loadings exceeding 0.5. Additionally, the CR and AVE confirm convergent validity, as both exceed the thresholds of 0.7 and 0.5, respectively (Hair, 2009). Finally, the Cronbach's α value for variables is greater than 0.7 (Bonsu et al., 2025).

Table 1: Reliability and Convergent Tests

Variables	Items	Estimates	VIF	Sources
Artificial Intelligence Adoption		Cronbach's α =0.87, CR=0.89,AVE=0.63		(Liu et al., 2025, Wang et al., 2025, Zhang and Yang, 2024, Duan et al., 2019).
	AI1	0.84	2.31.	
	AI2	0.85	2.45	
	AI3	0.76	1.98	
	AI4	0.77	2.10	
	AI5	0.74	1.87	
Financial Innovation		Cronbach's α =0.85, CR=0.86,AVE=0.56		(Laeven et al., 2015, Gao et al., 2024)
	FI1	0.73	1.92	
	FI2	0.73	1.88	
	FI3	0.75	2.05	
	FI4	0.74	1.97	
	FI5	0.79	2.22	
Green Innovation		Cronbach's α =0.85, CR=0.88, AVE=0.61		(Asadi et al., 2020; Obuobi et al., 2024; Osei-Assibey Bonsu et al., 2025; Yang et al., 2021)
	GIC1	0.76	2.04	
	GIC2	0.81	2.36	
	GIC3	0.74	1.91	
	GIC4	0.78	2.15	
	GIC5	0.82	2.42	
Information Transparency		Cronbach's α =0.85, CR=0.86,AVE=0.62		(Qin and Lee, 2024).
	ITRAN1	0.79	2.21	
	ITRAN2	0.73	1.89	
	ITRAN3	0.79	2.17	
	ITRAN4	0.82	2.48	
ESG performance		CA=0.87, CR=0.90,AVE=0.52		(Liu et al., 2025, Wang et al., 2025, Zhang and Yang, 2024, Duan et al., 2019).
	ESGP1	0.73	1.85	
	ESGP2	0.78	2.09	

	ESGP4	0.77	2.01	
	ESGP4	0.80	2.34	
	ESGP5	0.77	2.07	
	ESGP6	0.81	2.46	

Discriminant validity was assessed using the Fornell–Larcker standard criteria and Heterotrait–Monotrait ratio (HTMT). As shown in Table 2, the square root of AVE for each construct exceeds its correlation with other constructs, satisfying the Fornell-Larcker criterion standards (Fornell and Larcker, 1981). HTMT values for all construct pairs remained below the recommended threshold of 0.85, confirming discriminant validity (Henseler et al., 2024) *(See Table 3*). Despite moderate correlations among some constructs, the variance inflation factor (VIF) values for all predictor constructs were below 3, suggesting that multicollinearity is not an issue. Together, these results demonstrate that the constructs are both conceptually and statistically distinct.

Table 2 Discriminant Validity Results

Constructs	**AI**	**FI**	**GI**	**ITRAN**	**ESG**
AI	***0.79***				
FI	0.41	**0.75**			
GI	0.47	0.48	**0.78**		
ITRAN	0.55	0.54	0.51	**0.79**	
ESG	0.57	0.42	0.32	0.49	**0.72**

Note: AI, FI, GI, and ITRAN denote Artificial Intelligence, financial innovation, Green Innovation, and Information Transparency. The √AVE values are the bolded values on the diagonal.

Table 3 HTMT Results

Constructs	**AI**	**FI**	**GI**	**ITRAN**	**ESG**
AI					
FI	0.74				
GI	0.77	0.71			

ITRAN	0.64	0.68	0.66		
ESG	0.69	0.71	0.82	0.79	

Note: HTMT values are reported with values below the conservative threshold of 0.85, indicating satisfactory discriminant validity.

4. Empirical Results

We present the empirical results leading to our research hypothesis testing. Notably, the constructs' predictive relevance is assessed using R^2 and Q^2 with Cohen's (1998) requirement of R^2 being over 0.26 for substantial predictive power (Cohen, 1998). Table 4 reveals that AI, FI, GI and ITRAN account for 68% of the total variance in ESG performance. The results indicate that both constructs have excellent predictive capacity. Moreover, the Q^2 value indicates the predictive significance of endogenous components, with a value greater than 0 indicating their predictive significance. The findings further showed that research variables obtained predictive relevance (ESGP Q^2=0.471). Notably, PLS-SEM is an effective method for evaluating conceptual models, particularly in managing complex mediation and simultaneously estimating measurement and structural models. It provides standardised path coefficients, allowing for the comparison of relationship strengths among constructs.

Table 4 Hypothesis Results through PLS-SEM

Hypothesis		Estimates	P-value	Supported
H1	AI→ESG	0.346 (4.376)	<.001	Yes
H2	FI→ESG	0.416 (5.266)	<.001	Yes
H3	AI→GI→ESG	0.122 (8.569)	<.001	Yes
H4	FI→ITRAN→ESG	0.360 (5.950)	<.001	Yes
	FA→ESG	0.016(0.228)	n.s	
	FS→ESG	-0.261(-3.791)	<.001	
	INDC→ESG	0.246(3.899)	<.001	
	R&D→ESG	0.207(3.477)	<.001	
Obs		267		

Note*:* FA, FS, INDC, R&D denote firm age, firm size, industry competition and research and development intensity. N.S denotes non-significance.

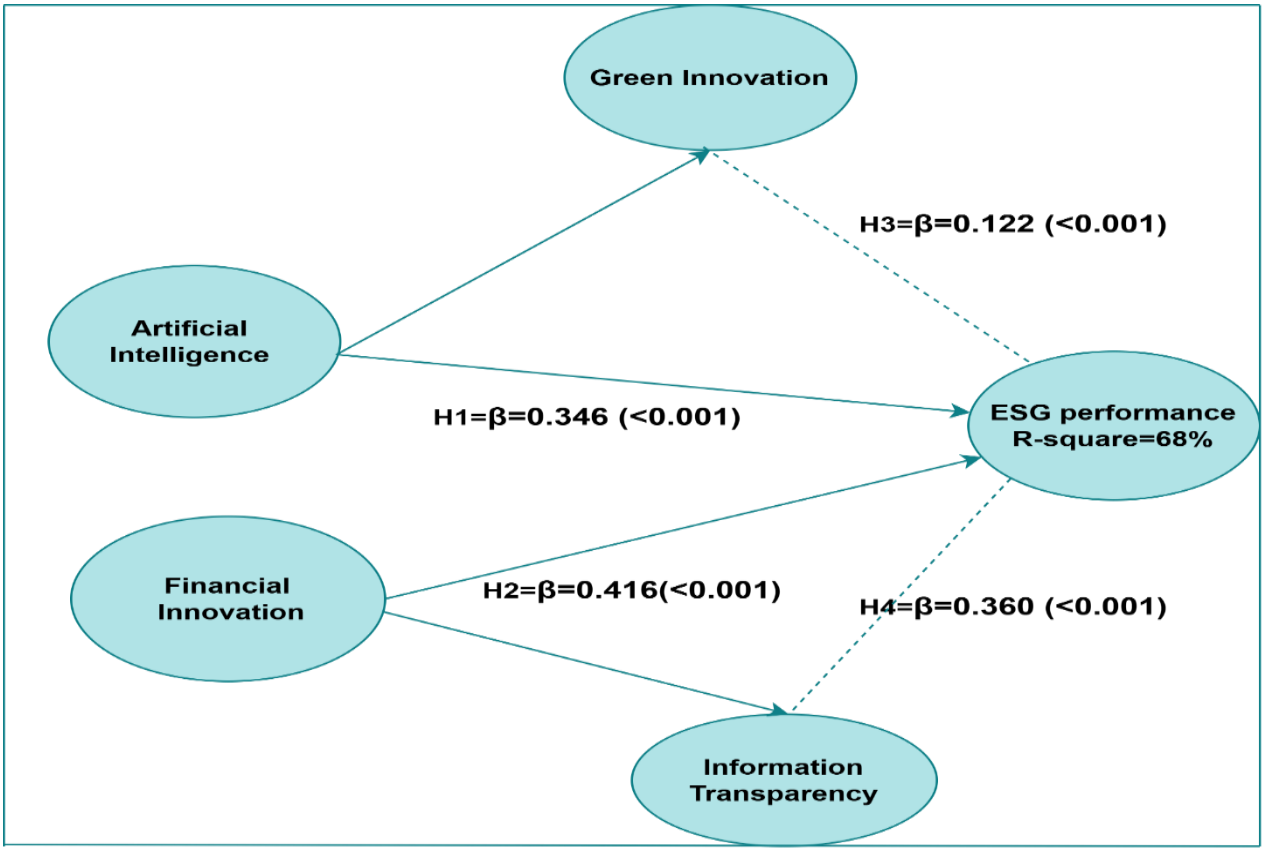

Figure 2: PLS-SEM Results

From both Figure 2 and Table 4, H1 is supported, that AI has a positive and significant association with firms' ESG performance (β=0.346, Pv<0.001), indicating that integrating artificial solutions into firms’ operations at a level of 1% can effectively address sustainability and governance issues, enhancing organisations' ESG performance. H2, which posits that FI positively influence ESG performance of Chinese organizations is supported. This indicates that firms developing or adopting innovative financial instruments, technologies, and practices generally perform better on ESG dimensions, corroborating earlier studies in the literature. H3 is strongly supported as the mediating role of green innovation on the relationship between AI and EG performance. Our findings indicate that green innovation capability plays an essential role in influencing ESG performance in organisations through AI adoption. The results confirm previous research (Weng, 2025). Finally, H4 is confirmed, demonstrating notable indirect effects of ITRAN on the connection between FI and companies' ESG performance, suggesting that ITRAN serves as a strategic intangible resource that improves the value of FI in promoting sustainable outcomes.

4.1. Robustness and Heterogeneity Analysis

To assess the robustness of the PLS-SEM findings, we additionally conduct Hierarchical regression modelling (HRM) analyses. Specifically, HRM was utilised to investigate the direct effects corresponding to H1 and H2 as presented in Table 5. Unlike PLS-SEM, the regression models present unstandardized coefficients, making their estimated magnitudes not directly comparable to the standardised path coefficients found in the structural model. The regression results support the PLS-SEM findings, indicating statistically significant relationships between AI, FI, and ESG performance. A notable positive correlation is observed between these innovations and corporate ESG performance, confirming the validity and robustness of the findings.

Table 5 Robustness Findings for Direct hypothesis

Variables	ESG performance	ESG performance
	Model1	Model2
Controls Variables		
Firm Age	0.161(0.228)n.s	0.065(1.299)***
Firm Size	-0.261(-3.791)*	0.119(2.368)**
Industry competition	0.246(3.899)**	0.097(2.084)**
R&D intensity	0.207(3.477)***	0.022(1.643)***
Main predictors		
Artificial intelligence	0.661(14.425)***	0.198(3.953)***
Financial Innovation	0.528(12.213)***	0.125(3.254)***
Model summary		
Adj R^2	0.517	0.709
R^2	0.526	0.715
ΔR^2	0.726	0.846
Max VIF	1.501	2.292
Obs	267	267

Note*:* ***, **, * denotes 1%, 5% and 10% significance level. T-stat is in parentheses. N.S denotes non-significance.

PROCESS macro mediation (Model 4) analysis is used as a robustness check to confirm the indirect effects found in the PLS-SEM model. This analysis estimates unstandardized indirect and total effects with a 95% unbiased confidence, differing in magnitude from the standardised coefficients in PLS-SEM. Accordingly, the PROCESS results are designed to affirm the existence, direction, and statistical significance of mediation relationships, rather than to yield directly comparable effect sizes. As reported in Table 6, the indirect effects of AI on ESG via

GI and of FI on ESG via information transparency remain positive and statistically significant, lending further support to the robustness of our main findings. These results indicate that AI adoption improves ESG performance, especially when combined with green and financial innovations that enhance information transparency. Accordingly, the findings highlight the importance of aligning technological investment, GI, and transparent financial practices for improved ESG performance.

Table 6 Robustness Test for the Mediation Hypothesis

Hypothesis		Indirect	Direct Effect	Total Effects
H3	AI→GI→ ESG	0.538***(0.071)	0.187***(2.975)	0.8149***(15.9206)
		CI = [0.379,0.657]	CI = [0.063,0.311]	CI = [0.714,0.915]
H4	FI→ITRAN→ESG	0.507***(0.080)	0.389***(6.511)	0.896***(16.406)
		CI = [0.351,0.659]	CI = [0.272,0.507]	CI = [0.788,1.004]

Note: ***, **, * denotes 1%, 5% and 10% significance level

4.1.1. Findings by Industry Type

We analyse the impact of AI and FI with GI and ITRAN on ESG performance across manufacturing, IT/Technology, Services/Logistics, and financial institutions in China. Notably, although formal statistical tests for sectoral differences were not conducted, the observations should be regarded as exploratory patterns rather than conclusive evidence of heterogeneity.

From Table 7, both PLS-SEM and PROCESS Models (Model 4) indicate that the financial institutions sector may exhibit a relatively stronger relationship between AI and ESG performance. This pattern reflects that financial institutions handle large volumes of both structured and unstructured data, including transaction records, credit histories, and ESG disclosures. Notably, Chinese banks and investment firms are increasingly using green finance products, including green loans, ESG-linked bonds, and sustainable investment funds. AI plays a critical role in assessing ESG risks, ensuring compliance, and enhancing investment decisions, thereby improving ESG outcomes for financial firms. Moreover, the results indicate that financial institutions might face more significant impacts of FI on ESG performance, attributed to their reliance on data, green finance offerings, and regulatory incentives. AI innovations appear to contribute to measurable ESG outcomes, particularly in areas such as risk assessment and green lending. This process corresponds with the RBV and DCV, enabling organisations to leverage unique skills and adapt resources to improve sustainability performance.

For the mediation, all the industries demonstrated notable mediation effects of AI on ESG performance via green innovation, with the manufacturing sector appearing to show relatively larger effects compared to other sectors. This pattern may reflect the resource-intensive nature of manufacturing, where AI helps optimise energy use, reduce waste, and improve production efficiency, thereby supporting ESG outcomes. The stricter environmental regulations in China motivate manufacturing firms to integrate AI with green innovations, while sectors like IT and logistics prioritise service-oriented innovations, leading to a less direct ESG impact from AI. However, we find that ITRAN significantly mediates the relationship between FI and ESG performance, with the pattern appearing relatively stronger in financial institutions. This highlights the importance of transparent information for the effective utilisation of AI in finance, particularly concerning green loans, ESG-linked bonds, and sustainable investment products, to achieve measurable ESG outcomes (Liu and You, 2023). Additionally, regulatory pressures in China highlight the need for transparency in compliance and stakeholder trust, especially in green finance and ESG disclosure. Financial institutions are pivotal in integrating ESG factors into financial decision-making, more so than industries such as manufacturing and logistics. Overall, our findings indicate that the effectiveness of Fintech solutions for sustainability, including AI and FI, varies by sector and is influenced by factors like green innovation and information transparency.

Table 7 Findings by industry type results

	Manufacturing	Technology/IT	Services/Logistics	Financial institutions
Variables	ESG performance	ESG performance	ESG performance	ESG performance
H1	0.403(4.376)***	0.081(1.180)**	0.257(3.624)***	0.412(7.434)**
H2	0.213(6.437)**	0.038(0.597)***	0.248(4.385)***	0.506(0.416)***
H3	0.079(0.110)***	0.068(0.189)***	0.077(0.110)***	0.010(0.038)***
H4	0.013(0.241)***	0.011(0.207)***	0.012(0.238)ns	0.017(0.322)***
R^2	0.32	0.44	0.47	0.24
Obs	68	79	69	51

Note: ***, **, * denotes 1%, 5% and 10% significance level. T-stat is in parentheses.

4.1.2. Findings by Regions

We performed a regional difference since our study collected data from four regions in China: Jiangsu, Zhejiang, Shanghai and Guangzhou. Table 8 reports the coefficient estimates and associated t-statistics for each region. These results indicate potential regional differences in how AI and FI influence ESG outcomes. The analyses are exploratory; while coefficients and t-statistics offer inferential insight, formal multi-group comparisons or interaction tests were not conducted. Accordingly, the observed differences should not be interpreted as definitive evidence of statistically significant regional variation.

Firms in Guangzhou may exhibit a stronger relationship between AI and ESG performance. This pattern illustrates Guangzhou's industrial structure, encompassing manufacturing, logistics, and technology services. It benefits from supportive regional policies, a strong AI talent ecosystem, advanced digital infrastructure, and competitive pressures, all enhancing its ESG performance. Meanwhile, the impact of FI on ESG performance appears relatively stronger in Jiangsu province. This pattern reflects Jiangsu's developed financial ecosystem, supportive green finance policies, diverse corporate landscape, and advanced digital infrastructure that facilitate the integration of financial solutions into ESG outcomes. Moreover, the study suggests that in Jiangsu, green innovation significantly influences the link between AI and ESG performance, likely due to the province's strong industrial base and AI-driven sustainable practices. In contrast, Guangzhou appears to exhibit a relatively stronger positive indirect effect of ITRAN on the relationship between FI and ESG performance. This pattern indicates the city's developed financial ecosystem, regulatory backing for green finance, and focus on transparent reporting. This indicates that regional industrial structures, policy environments, and sectoral strengths shape the influence of AI and financial innovations on ESG outcomes. While these exploratory results provide initial insights into potential regional heterogeneity, future research with larger samples and formal multi-group or interaction tests is needed to confirm whether these regional differences are statistically significant.

Table 8 Findings by Regions Results

Hypothesis	Jiangsu	Shanghai	Zhejiang	Guangzhou
	Estimates	Estimates	Estimates	Estimates
H1	0.029 (0.321)***	0.005 (0.0747)**	0.018 (0.2626)***	0.040 (0.7288)**
H2	0.037(0.031)***	0.002(0.0378)***	0.017 (0.3178)***	0.021 (0.6313)**
H3	0.058 (0.081)***	0.043(0.0120)***	0.056 (0.080)***	0.010 (0.037)***
H4	0.010 (0.017)***	0.007(0.0131)***	0.009(0.0173)	0.017 (0.0316)***
R^2	0.45	0.57	0.39	0.56
Obs	71	70	59	67

Note: ***, **, * denotes 1%, 2% and 5% significance level. T-stat is in parentheses.

4.2. Additional Analysis

We analyzed the impact of AI, FI, GI, and ITRAN on ESG, considering environmental, social, and governance performance dimensions. The findings were based on regression models as shown in Table 9. The results indicate that AI enhances environmental and social performance yet has a negative and insignificant effect on governance performance. From a DCV and RBV perspective, this suggests that AI serves as a dynamic capability that bolsters GI and operational enhancements, improving environmental outcomes and supporting social sustainability initiatives. However, to translate AI adoption into better governance outcomes, governance performance may require extra organisational structures, monitoring systems, or managerial supervision (Zhang and Yang, 2024). Contrary to this, FI exhibits a negative relationship with environmental and social performance but positively impacts governance. This pattern illustrates the RBV and ST, highlighting that FI improves ESG reporting quality, regulatory compliance, and stakeholder trust by promoting better information processing, transparency, and accountability, rather than directly influencing operational or social sustainability outcomes. Accordingly, FI plays a crucial role in overall ESG performance through governance; however, its impact on environmental and social aspects is limited without additional technical advancements and green initiatives. Therefore, firms should integrate financial inclusion with green and digital strategies to improve the role of financial systems in achieving broader sustainability objectives. Additionally, GI plays a vital role in enhancing the impact of AI on ESG dimensions, particularly by improving environmental performance and highlighting the importance of green innovation in realizing substantial ESG gains from AI investments. Finally, ITRAN positively influences social and governance performance, whereas its impact on environmental performance is minimal. The study highlights the importance of transparency in stakeholder engagement and governance, highlighting that financial innovations are more effective with clear and reliable information disclosure. Collectively, these findings suggest that firms should use AI for environmental and social initiatives, while employing FI alongside transparency mechanisms to improve governance performance.

Table 9: ESG dimensions Results

Variables	Environmental performance	Social performance	Governance performance
AI	0.148 (1.810)***	0.075(1.073)***	-0.049 (-0.743)***
FI	-0.121(-1.382)***	-0.086 (-1.148)***	0.120 (1.681)***
GI	0.352 (3.588)***	0.185 (2.192)***	0.138 (1.724)**
ITRAN	0.002 (0.021)**	0.329 (4.902)**	0.386(6.040)***
R^2	0.56	0.67	0.71

Obs	260

Note*:* AI, FI, GI, and ITRAN denote Artificial Intelligence, financial innovation, green innovation, and Information Transparency. ***, **, * denotes 1%, 5% and 10% significance level. T-stat is in parentheses.

5. Discussions

First, our findings supported that AI is positively and significantly associated with firms' ESG performance. The findings correspond with previous studies (Liu et al., 2025; Song et al., 2025; Wang et al., 2025; Zhang and Yang, 2024; Zhou et al., 2025). The findings indicate that AI adoption in organisational processes enhances firms' capabilities for achieving sustainability-oriented objectives, complying with environmental standards, improving social responsibility, and strengthening governance practices (Zhang and Yang, 2024). Our findings support and extend the DCV that AI serves as a strategic dynamic capability, enabling firms to identify opportunities and transform operational processes for sustainable advantage. Consequently, we argue that organisations embedding AI capabilities show enhanced adaptability and resilience, vital dynamic capabilities that contribute to better ESG performance (Liu et al., 2025). This empirical evidence supports the theory that AI helps organisations implement sustainability practices, resulting in improved ESG performance. Practically, we suggest that managers should incorporate AI tools into key business processes like supply chain management, financial analysis, and compliance monitoring to enhance resource efficiency and ESG performance. Additionally, we recommend that Chinese policymakers promote the integration of AI into ESG reporting and performance frameworks by offering tax incentives, subsidies, or grants to companies implementing sustainable AI technologies.

Second, the strong positive relationships observed between FI and ESG performance resonate with recent studies that highlight green technological innovation as essential for reducing carbon emissions, suggesting that finance-driven creativity enhances corporate sustainability (Hasan and Du, 2023; Khan et al., 2025; Liao et al., 2022). From a practical insight, FI improves ESG performance through enhanced access to sustainable finance, optimised capital allocation, and the integration of ESG factors into financial decision-making (Hasan and Du, 2023). For instance, innovations like green bonds and sustainability-linked loans enhance financial transparency and governance, allowing companies to finance environmentally and socially responsible projects through data-driven monitoring and reporting (Han and Li, 2022). Additionally, incorporating ESG metrics into financial products can increase profitability and sustainability for innovative firms, improve risk management, and attract long-term, responsible investors. DCV highlights the role of firms' capabilities in sensing, seizing, and transforming sustainability trends. It positions FI as a dynamic capability that allows firms to recognise ESG-related opportunities, effectively allocate financial resources, and adjust internal processes for sustained long-term results. Therefore, firms demonstrating financial innovation are better equipped to adapt to environmental regulations, social expectations, and investor demands for responsibility. While research has validated a positive association between green innovation and sustainability (Asadi et al., 2020; Obuobi et al., 2024; Osei-Assibey Bonsu et al., 2025; Yang et al., 2021), FI's impact on ESG outcomes remains underexplored. Our findings indicate that FI significantly enhances firms' ESG performance by promoting resource efficiency, improving transparency, and facilitating sustainable investment practices. Therefore, we suggest that organisations engaged in FI demonstrate improved environmental and governance outcomes, indicating that such mechanisms effectively advance sustainability goals.

Third, the results demonstrate a positive indirect effect on ESG performance through GI, supporting previous research (Weng, 2025). This suggests that AI enhances green innovation through predictive analytics for cleaner manufacturing, prioritisation of impactful R&D, optimisation of resource use, and support for sustainable product development (Wang and Zhang, 2024; Wang and Zhang, 2025). Beyond firm-internal effects, AI enhances collaboration between departments and external partners, including suppliers and technology firms, fostering coordinated sustainability initiatives and knowledge sharing to improve ESG outcomes (Wang and Zhang, 2025). The impact of AI-enabled GI varies by sector and region. In manufacturing and energy-intensive industries, AI-driven process optimisation and emissions monitoring provide significant environmental advantages, while in IT and services, AI enhances sustainable digital infrastructure and promotes energy-efficient operations. Firms in policy-intensive areas like Shanghai and Zhejiang are more influenced by stricter regulations and incentives, leading to greater adoption of AI-enabled green solutions (Shaik et al., 2024; Song et al., 2025). These findings improve the DCV by demonstrating that AI serves as a strategic resource, helping firms identify ESG-related opportunities, alter internal processes, and partner effectively to convert green innovation into tangible sustainable performance (Teece et al., 1997). Theoretically, we propose that AI enhances firms' dynamic capabilities while adding a digital dimension that facilitates this conversion. Yet, research on the mediating effects of GI on AI and ESG performance in emerging markets, particularly in China, is limited. By empirically validating this indirect effect, this paper posits that AI-driven digital capabilities are essential for firms in China to merge technological innovation with sustainability objectives. From a managerial perspective, integrating AI investments with green innovation and inter-organisational collaboration is vital for optimising ESG outcomes, supported by policies aligning with national sustainability goals like the dual carbon strategy. Finally, the results indicated significant indirect effects of ITRAN on the relationship between FI and companies' ESG performance, suggesting ITRAN functions as a strategic intangible resource that enhances FI's value in fostering sustainable outcomes. Specifically, FI helps companies manage ESG-linked financing, monitor environmental and social risks in real time, and coordinate sustainable investment choices both internally and with external partners.

When combined with high-quality information transparency, these capabilities reduce information asymmetry, boost stakeholder trust, and improve decision-making, increasing the influence of FI on ESG performance (Feng et al., 2023; Qin and Lee, 2024). Sectoral and regional differences further shape this mechanism. In financial institutions, transparency-enabled financial institutions promote green lending and sustainable investment, while transparent reporting in manufacturing aligns financing with emissions reduction and energy efficiency efforts. Regionally, firms in regions with stringent ESG disclosure requirements or robust green finance policies benefit more from the synergy between the transparency of financial institutions and their operations (Yu et al., 2018). These insights highlight that FI and information transparency act together as dynamic capabilities, enabling adaptability to changing regulatory, market, and stakeholder pressures. We suggest that firms must enhance coordination by aligning financial data with comprehensive ESG reporting to ensure transparency in sustainable value creation. Policymakers should aid in establishing standardised ESG disclosure frameworks and promote incentives for green finance (Wang and Zhang, 2025).

5.1. Theoretical Contributions

Our findings provide the following theoretical contribution. First, we propose a unified framework that integrates AI and FI through GI and ITRAN, enhancing the current literature. Existing literature on Fintech and innovation often overlooks the specific effects of AI and FI on ESG performance (Bai, 2024; Hu et al., 2025a). Moreover, research indicates that while digital technologies impact sustainability performance, the effects of AI and FI on ESG criteria, particularly in regulated markets such as China, are still underexplored. Our results show that GI significantly influences the relationship between AI adoption and ESG performance. Our study highlights the importance of AI and FI in relation to ESG performance, addressing a gap in digital transformation research. We provide an empirical analysis of how AI influences internal decision-making and ESG outcomes.

Second, we highlight the essential role of FI in shaping ESG performance via information transparency. Many studies underline the FI effect on investment efficiency and firm performance but often overlook the role of information transparency as a bridge linking financial innovation to ESG advancements. Our findings highlight that information transparency is essential for improving ESG performance via financial products and services, thereby addressing existing literature gaps. Finally, we extend multiple theoretical perspectives by demonstrating that integrating AI and FI improves ESG performance, provided there are strong organisational capabilities. Drawing on the RBV and DCV, we show that capabilities such as AI, FI, and GI are identified as strategic assets in the context of Fintech, enabling the translation of innovation into positive ESG impacts. Extending the stakeholders theory, we highlight that information transparency and leadership commitment are critical in connecting AI adoption and FI to ESG performance. Collectively, we offer a comprehensive understanding of how Fintech innovations enhance sustainability in emerging markets through multi-theoretical methods.

5.2. Practical and Policy Implications

We offer practical and policy implications derived from the findings. First, the adoption of AI and FI enhances ESG performance and sustainability. However, achieving these benefits relies on complementary organisational capabilities, with firms lacking internal capacities in GI and ITRAN unlikely to gain from investments in AI or FI. Consequently, organisations are encouraged to invest in green R&D, adopt AI-driven sustainability initiatives, and implement strong data transparency systems. Policymakers can aid this by promoting AI and financial inclusion, offering guidance on ESG reporting standards, and fostering green innovation ecosystems and digital literacy. These measures integrate technological and financial innovations with sustainability goals, supporting initiatives like China's dual-carbon strategy. Second, the effects of AI and FI on ESG performance vary across industries and regions, underscoring the need for tailored strategies. Technology-intensive sectors could benefit from incentives for AI-based environmental monitoring, while resource-dependent or developing areas may require targeted assistance to enhance financial innovation and sustainability. Finally, workforce knowledge and skills are vital for achieving ESG improvements. Accordingly, organisations should adopt training programs focused on green technologies, sustainability reporting, and responsible financial practices. Policymakers can support these initiatives through educational and digital literacy programs that improve firms' capacity to utilise AI and FI for sustainable outcomes.

6. Conclusions, Limitations and Further Research

Organisational capabilities significantly influence the relationship between AI, FI, and ESG performance. This study examines this interaction through GI and ITRAN using data from Chinese firms gathered through a structured questionnaire and robust analytical models. Our findings show that both AI and FI positively influence ESG performance, with GI and ITRAN serving as positive mediators in these relationships. Sectoral and regional patterns suggest that AI-driven GI is particularly impactful in manufacturing, whereas FI’s effect on ESG performance is pronounced in financial institutions through enhanced transparency. Regional differences indicate that firms in Guangzhou benefit more from AI and FI, while FI’s influence is stronger in Jiangsu. These findings suggest that coordinated green innovation, effective ESG information management, and AI-driven FI significantly improve corporate sustainability and ESG performance, crucial for managers and policymakers involved in China's dual-carbon strategy.

Our paper highlights limitations that indicate potential directions for future research. First, we used self-reported survey data, which may result in social desirability bias, despite statistical controls. To enhance empirical strength, future research should integrate survey responses with objective ESG metrics or sustainability indicators. Moreover, our sample of 267 was adequate for PLS-SEM but small for subgroups, which reduced statistical power and reliability. Future research should utilise larger samples in smaller industry sectors to better examine heterogeneity effects and provide more robust insights. Second, we rely on cross-sectional data, restricting causal inference concerning dynamic capabilities that change over time. Future research should consider longitudinal or quasi-experimental designs to better establish causal relationships. Third, the findings regarding Chinese firms may not apply universally to other regulatory environments, as local digital infrastructure and ESG disclosure pressures influence the relationship between AI, FI, and ESG performance. Further research in various regions is necessary to evaluate these mechanisms across different contexts. While key mediating factors such as green innovation and information transparency were discussed, additional elements like organisational culture and technology maturity require attention. Future studies should adopt multi-level or mixed-methods approaches to investigate the complex dynamics of capabilities, collaboration, and external pressures on AI- and FI-enabled ESG performance.

Finally, we conceptualise AI broadly, without distinguishing between traditional analytics-based AI and generative AI (GenAI). As GenAI technologies support GI, automated ESG reporting, and stakeholder communication, future research should explore how GenAI affects the relationship between AI adoption and ESG performance. Additionally, evolving AI governance and regulatory frameworks may enhance legitimacy and trust in responsible AI deployment, thereby strengthening sustainability impacts. Future research is needed to explore how GenAI capabilities and AI regulation influence green innovation and ESG outcomes, especially in emerging economies. Our analysis investigates the endogeneity between AI adoption and ESG performance through PLS-SEM and PROCESS mediation with bootstrapped confidence intervals, addressing the lack of an external instrumental variable. These methodologies yield reliable estimates while accounting for measurement error, though we caution against drawing causal inferences given the cross-sectional nature of the survey data.

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Appendix- Survey Measurement

Variables	Items	Sources
Artificial Intelligence Adoption	“Please specify the extent to which you agree or disagree with the below”	(Liu et al., 2025, Wang et al., 2025, Zhang and Yang, 2024, Duan et al., 2019).
	In my firm, we use artificial intelligence technologies to support key business activities.	
	AI systems are integrated into organisational decision-making processes.	
	Artificial intelligence improves operational efficiency in our organisation.	
	Our organisation continuously invests in AI-related technologies and skills.	
	AI adoption enhances our firm’s ability to adapt to environmental and market changes.	
Financial Innovation	“Please specify the extent to which you agree or disagree with the below”	(Laeven et al., 2015, Gao et al., 2024)
	Our organisation actively adopts innovative financial products or services.	
	Digital financial technologies are widely used in our financial operations.	
	Financial innovation supports our firm’s strategic objectives.	
	Our organization utilizes new financing channels to improve funding efficiency.	
	Our financial practices are more innovative than those of our competitors.	

Green Innovation	"Please specify the extent to which you agree or disagree with the below"	(Asadi et al., 2020; Obuobi et al., 2024; Osei-Assibey Bonsu et al., 2025; Yang et al., 2021)
	Our firm develops environmentally friendly products or services.	
	Green technologies are adopted to reduce environmental impacts.	
	In our firm, we invest in R&D for environmental improvement.	
	Green innovation is a core element of our firm's strategy.	
	Green innovation improves our firm's competitive advantage.	
Information Transparency	"Please specify the extent to which you agree or disagree with the below"	(Qin and Lee, 2024).
	Our firm provides timely and accurate information to stakeholders.	
	Environmental and social information is disclosed transparently.	
	Financial and non-financial disclosures are reliable.	
	Stakeholders can easily access relevant organisational information.	
ESG performance	"Please specify the extent to which you agree or disagree with the below"	(Liu et al., 2025, Wang et al., 2025, Zhang and Yang, 2024, Duan et al., 2019).
Environmental performance	Our firm has effectively reduced its environmental impact.	
	Our organisation complies with environmental regulations and standards.	
Social performance		
	Our firm ensures employee well-being and workplace safety.	
	Our organisation actively fulfils its social responsibilities.	
Governance performance		
	Our firm maintains transparent and ethical governance practices.	
	Our board and management effectively oversee sustainability-related issues.	