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THE IMPACT OF FINTECH AND CORPORATE SOCIAL RESPONSIBILITY ON GREEN INNOVATION AND GREEN FINANCE: A THEORETICAL PERSPECTIVE FROM PAKISTAN'S BANKING INDUSTRY

Usman Ali Mangrio[*1], **Dr. Kamran Khan**[2]

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Corresponding Author: *
Usman Ali Mangrio

Abstract

The contemporary banking landscape is defined by an irreversible paradigm shift where digital innovation and environmental stewardship converge to redefine institutional value. This paper provides a strategic examination of the nexus between Fintech Adoption (FA), Corporate Social Responsibility (CSR), Green Finance (GF), and Environmental Sustainability Performance (ESP). Grounded in the Stakeholder Theory, this analysis elucidates how Fintech serves as a foundational engine for both financial and environmental outcomes. Utilizing insights derived from sophisticated Structural Equation Modeling (SEM) and Necessary Condition Analysis (A), we demonstrate that Fintech adoption is the primary moderator enhancing the effectiveness of Green Finance. Furthermore, the findings reveal that while CSR is essential for legitimacy, its direct impact on financial performance is often insignificant without the mediating role of green financial products. This perspective offers a roadmap for policymakers and industry practitioners in emerging economies, specifically Pakistan, to navigate the transition toward a low-carbon, digitally resilient financial architecture.

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Introduction

The world banking industry is experiencing a radical shift with the intersection of financial technology and the growing need to develop in a sustainable manner that critically folds into a nexus between the digital revolution and environmental conservation. This is redefining the banking institutions across the globe, and it has major impacts on the way the banking institutions operate in terms of their operational models, competitive forces, and strategic orientations on sustainability and financial performance (Yuan, 2025). This intersection creates even more opportunities and challenges in the context of such emerging economies as Pakistan, where financial institutions are concerned with balancing the development of technologies and the urgent need to preserve nature and improve ecological conditions and social responsibility (Yuan, 2025). Elkington created the Triple Bottom Line framework that can be used as a theoretical framework in the current research because its key tenet is that corporate sustainability should be examined in economic, social, and environmental terms to help banks focus on a comprehensive performance analysis (Ahmad et al., 2024).

Basing their arguments on the Resource-Based View, this paper hypothesizes that fintech capabilities can be used by financial institutions as rare, inimitable resources to increase their competitive edge and at the same time meet environmental and societal needs (Yuan, 2025). The application of the stakeholder theory can be considered the continuation of this theoretical background whereby it argues that banks should fulfill the different interests of various stakeholders, such as regulators, investors, customers, and communities, to ensure their long-term legitimacy and survival (Mubarak et al., 2024). As a result, this study examines the theoretical foundations of the interaction between Fintech implementation and Corporate Social Responsibility efforts and green innovation and green finance in the banking industry of Pakistan based on the

premise that technological capabilities and ethical commitments are not just complementary factors that drive sustainable competitive advantage but are mutually dependent on one another (AlQudah et al., 2025; Yuan, 2025).

The Resource-Based View is a critical resource to analyzing the role of Fintech capabilities as strategic resources that are valuable, rare, inimitable, and non-substitutable, thus allowing banks to perform better due to green innovation (Yuan, 2025). In the RBV, such technological capabilities, such as digital payment systems and blockchain-based authentication systems, are intangible assets, which enable companies to achieve more effective and intricate environmental strategies in comparison to competitors (Zaid et al., 2024). With the integration of these sophisticated digital technologies into their corporate practices, banks have the potential to improve their absorptive capacity and thus be able to discover, absorb as well as utilize external knowledge regarding sustainable practices and opportunities in green finance (Mubarak et al., 2024). Such an ability to assimilate knowledge is especially crucial in the environment of green finance as banks need to address sophisticated regulatory environments and respond to changing environmental practices to create new financial instruments that enhance low-carbon investments (Yuan, 2025; Zaid et al., 2024).

Moreover, the Legitimacy Theory clears the importance of Corporate Social Responsibility as a strategic tool that allows banks to obtain a social license to exist and reduce the impact of institutions during an environmentally friendly period (Ahmad et al., 2024). According to the Legitimacy Theory, participating in effective CSR practices can help banks to communicate their adherence to the norms and expectations of society and minimize the likelihood of regulatory penalties and reputational losses in addition to improving their capacity to attract capital and market prospects (Zaid et al., 2025). This conformance to the expectations of the society is especially important in Pakistani context where any financial institution has to be highly scrutinized in their contribution to environmental sustainability and economic growth, and the strategic implementation of technology and ethical conduct requires a strong intersection (AlQudah et al., 2025; Gürler, 2024).

The combination of Environmental, Social, and Governance values with digital technologies like artificial intelligence, machine learning, and blockchain further support this theoretical convergence as it is argued that these technologies may become more intangible resources that can enhance organizational resistance and performance (AlQudah et al., 2025). The combination of these digital resources with the principle of ESG will result in the formation of dynamic capability that will provide banks not only with the ability to respond to the current environmental challenges but also actively influence the green finance market by constantly innovating and adapting to changing circumstances (Liu et al., 2025). The use of the Stakeholder Theory, based on this dynamic capability framework, provides even greater insight on how the strategic fit between Fintech and Corporate Social Responsibility responds to the multidimensional expectations of various stakeholders, including regulators and shareholders, local communities and environmental lobby groups (AlQudah et al., 2025).

According to the Stakeholder Theory, long-term sustainability of banking institutions is defined under the conditions of their handling and fulfillment of the needs of these groups, which are frequently conflicting, especially in developing economies when the banking sector is a fundamental mediator of the proliferation of green growth and sustainable development (Jillani et al., 2024). Here, the Fintech-enabled green finance alignment with the stakeholder expectations can be described as a vital tool of mitigating the information asymmetry and fostering trust in the investors, who are becoming more interested in sustainable investment opportunities (Toumi et al., 2023). The theoretical basis of this decrease in information asymmetry is the signaling mechanism, when banks use Fintech-based transparency and CSR disclosures to signal to credibly commit to environmental stewardship, and distinguish themselves in a competitive market and draw in green capital (AlQudah et al., 2025; Toumi et al., 2023).

This effectiveness of the signaling mechanism is especially high when banks exploit Fintech to deliver verifiable, real-time data about their environmental impact, and thus alleviate the uncertainty that tends to shroud green investment decisions and increases the plausibility of their sustainability assertions (Najaf et al., 2024). This theoretically increased credibility as the principal-agent issues that come with green finance; externality stakeholders are not directly able to monitor internal environmental activities or the effectiveness of the green innovation projects of the bank (Elhady and Shohieb, 2025). In response to these agency conflicts, the Institutional theory integration has been adopted

provides a complementary framework, suggesting that banks adopt Fintech and CSR practices not only for efficiency gains but also to conform to the coercive, mimetic, and normative pressures exerted by the regulatory environment, industry competitors, and professional networks within Pakistan's financial ecosystem (Jillani et al., 2024).

Institutional pressures compel banks to isomorphically align their operational strategies with prevailing sustainability norms to ensure survival and legitimacy, where coercive pressures from regulatory bodies drive the mandatory adoption of green banking guidelines, while mimetic pressures encourage the emulation of successful Fintech-driven sustainability models adopted by industry leaders (Jillani et al., 2024). Normative pressures, conversely, arise from the professionalization of the banking sector and the dissemination of sustainable finance ideologies through educational and industry networks, which collectively shape the cognitive frameworks of bank managers and influence their strategic decision-making regarding green innovation (Zheng & Siddik, 2022).

Literature Review

The theoretical discourse surrounding the intersection of financial technology, corporate social responsibility, and environmental sustainability has gained substantial traction in contemporary academic literature, particularly within the context of developing economies seeking to reconcile economic growth with ecological preservation. Scholars have increasingly focused on how Fintech serves as a pivotal driver for enhancing both financial and environmental performance, suggesting that banking institutions can leverage technological innovation to support sustainable development objectives (Yuan, 2025). Specifically, the Resource-Based View theory posits that Fintech adoption constitutes a strategic, intangible resource that enables banks to build dynamic capabilities, thereby mediating the relationship between Corporate Social Responsibility initiatives and sustainable bank performance (Yuan, 2025).

This perspective is further supported by empirical evidence indicating that Fintech dimensions and enacted norms function as critical moderating and intervening variables in realizing sustainable banking outcomes, thereby validating the theoretical assertion that technological resources are instrumental in boosting sustainable performance (Subanidja et al., 2023). Expanding upon the Resource-Based View, the concept of dynamic capabilities suggests that Fintech not only acts as a static asset but also enables banks to continuously reconfigure their resources to address the rapidly evolving demands of green finance and environmental stewardship (Zaid et al., 2024). Furthermore, the integration of Fintech with Corporate Social Responsibility initiatives is empirically demonstrated to significantly enhance financial performance, environmental sustainability performance, and the overall effectiveness of green finance initiatives within the banking sector (Yuan, 2025).

The incorporation of digital technologies into the financial sector has the potential to promote sustainable development and enhance the sustainability performance of banking institutions (Hossain et al., 2024). However, the literature sometimes reflects mixed results with respect to how environmental initiatives and orientation influence performance, necessitating a deeper examination of these relationships within specific contextual frameworks (Taneja et al., 2023). In the context of Pakistan's banking industry, these mixed findings suggest that the efficacy of Fintech and Corporate Social Responsibility in driving green innovation is contingent upon the unique institutional and economic characteristics of the region, where regulatory frameworks and

market maturity differ significantly from developed economies. Consequently, the application of Institutional Theory becomes essential for understanding how coercive, mimetic, and normative pressures within Pakistan's developing market shape the adoption patterns of Fintech and CSR, as banks seek legitimacy by aligning with global sustainability standards while navigating local regulatory constraints and stakeholder expectations (AlQudah et al., 2025).

This alignment is further complicated by the moderating role of Environmental, Social, and Governance scores, which influence the extent to which Fintech adoption translates into tangible financial performance, suggesting that the integration of ESG factors is contingent upon internal capabilities and stakeholder alignment rather than mere technological adoption (AlQudah et al., 2025). Theoretical frameworks such as the Natural Resource-Based View further extend this logic by positing that firms which develop capabilities for environmental management can achieve a competitive advantage, implying that Fintech facilitates the strategic alignment of green innovation with long-term value creation (AlQudah et al., 2025). This alignment is further corroborated by research indicating that Corporate Social Responsibility practices significantly influence both environmental and financial performance, with green innovation and sustainable development acting as crucial mediating variables in this relationship (Sarfraz et al., 2023).

Drawing upon the Natural Resource-Based View, it is argued that banks which strategically integrate Fintech capabilities with Corporate Social Responsibility can develop unique environmental competencies that are difficult for competitors to replicate, thereby securing a sustained competitive advantage in the green finance market (Yuan, 2025; Zheng & Siddik, 2022). This competitive positioning is further reinforced by the stakeholder orientation inherent in Corporate Social Responsibility, which necessitates that banks address the social needs of their constituents by integrating eco-friendly practices into their core business operations to ensure legitimacy and long-term viability (Sarfraz et al., 2023). Institutional Theory further elucidates this dynamic by emphasizing that banks operating within Pakistan's developing economy are subject to coercive pressures from regulatory bodies, mimetic pressures from industry leaders adopting Fintech-driven sustainability models, and normative pressures from professional networks advocating for green finance integration (Hamdouni, 2025).

Consequently, the convergence of these institutional pressures compels banks to adopt green finance mechanisms not merely as a compliance exercise, but as a strategic imperative to secure organizational legitimacy and access to capital in an increasingly environmentally conscious market. This theoretical synthesis underscores the necessity of examining the mediating mechanisms through which Fintech and Corporate Social Responsibility influence green innovation and green finance, particularly within the unique institutional landscape of Pakistan's banking sector. Therefore, this study postulates that the synergistic interaction between Fintech adoption and Corporate Social Responsibility initiatives serves as a critical determinant of green innovation, as banks leverage digital capabilities to fulfill their environmental obligations and enhance their competitive positioning (Taneja et al., 2023; Yuan, 2025).

Specifically, the theoretical framework suggests that Fintech adoption provides the necessary digital infrastructure and data analytics capabilities that enable banks to identify, assess, and fund green projects with greater precision and reduced transaction costs, thereby directly stimulating green finance activities (Zheng & Siddik, 2022). This process is further reinforced by Legitimacy Theory, which posits that banks must align their operational strategies with societal expectations regarding environmental sustainability to maintain their social license to operate (Zheng & Siddik, 2022). By integrating these theoretical perspectives, the study conceptualizes that the strategic deployment of Fintech not only enhances operational efficiency but also amplifies the impact of Corporate Social Responsibility on green innovation, as digital tools enable the precise monitoring and reporting of environmental metrics required to satisfy stakeholder demands and regulatory compliance (Zheng & Siddik, 2022).

This theoretical integration is further supported by the Technology-Organization-Environment framework, which posits that the adoption of technological innovations like Fintech is influenced by the interplay of technological context, organizational context, and environmental context (Cordero et al., 2023; Khan et al., 2025). Within the technological context, the perceived complexity and compatibility of Fintech solutions determine the extent to which banks can integrate these tools into their existing environmental management systems, while the organizational context encompasses the internal resources, firm size, and top management commitment necessary to support green innovation initiatives. Within the environmental context, regulatory pressures and competitive dynamics serve as external drivers that compel banks to adopt Fintech-enabled green finance solutions to maintain legitimacy and market share (Zahid et al., 2024; Zheng & Siddik, 2022).

This theoretical foundation is further extended by the concept of absorptive capacity, which suggests that banks with high absorptive capacity are better equipped to integrate and leverage new Fintech solutions for green innovation and competitive advantage (Mubarak et al., 2024). This capacity allows financial institutions to not only assimilate external knowledge regarding sustainable practices but also transform it into actionable green innovation strategies, thereby creating a dynamic capability that fosters continuous environmental improvement and financial resilience (Zaid et al., 2025; Zheng & Siddik, 2022). The Technology-Organization-Environment framework further elucidates this dynamic by positing that the successful implementation of Fintech for sustainability is contingent upon the interplay between technological attributes, organizational readiness, and external environmental pressures (Taneja et al., 2023).

Specifically, the technological context encompasses the perceived benefits and complexity of Fintech solutions, which determine the extent to which banks can integrate these tools into their existing environmental management systems to enhance green innovation (Wang & Zhang, 2025). The organizational context, characterized by the firm's internal structure, resource availability, and top management support, determines the bank's readiness to leverage these digital tools for sustainable value creation (Kumar et al., 2025; Wang & Zhang, 2025). The environmental context, comprising regulatory mandates, industry norms, and competitive intensity, exerts significant pressure on banks to adopt Fintech-driven solutions to enhance their green finance offerings and ensure organizational legitimacy (Wang & Zhang, 2025). Drawing upon the Technology-Organization-Environment framework, this study conceptualizes that the technological context, characterized by the perceived benefits and compatibility of Fintech solutions, enables banks to unbundle core banking methods and transition from product-centric to customer-centric models, thereby facilitating the integration of green finance into their service portfolios (Taneja et al., 2023).

This operational shift is further reinforced by the organizational context, where the availability of slack resources and top management commitment determines the bank's readiness to leverage these digital tools for sustainable value creation and competitive advantage (Taneja et al., 2023). Simultaneously, the environmental context, comprising regulatory mandates, industry norms, and competitive intensity, exerts significant pressure on banks to adopt Fintech-driven solutions to enhance their green finance offerings and ensure organizational legitimacy (Taneja et al., 2023). Consequently, the alignment of these contextual factors suggests that banks operating in Pakistan must navigate a complex interplay of internal capabilities and external pressures to successfully implement Fintech solutions that drive green innovation and green finance (Almasria et al., 2024; Taneja et al., 2023). This alignment is further substantiated by the Resource-Based View, which argues that Fintech capabilities constitute a valuable, rare, and inimitable resource that enables banks to achieve a competitive advantage through superior green innovation performance (Taneja et al., 2023). This competitive advantage is sustained because the unique combination of digital infrastructure and environmental knowledge creates barriers to imitation, allowing banks to differentiate themselves in the

market through superior green innovation performance.

This differentiation is critical in the banking sector, where the ability to offer unique green financial products and services allows institutions to capture market share and enhance long-term profitability while contributing to national sustainability goals (Wan et al., 2023). Furthermore, the application of Institutional Theory provides a critical lens for understanding how coercive, mimetic, and normative pressures drive Pakistani banks to adopt Fintech-enabled Corporate Social Responsibility practices to secure legitimacy within a rapidly evolving financial landscape (AlQudah et al., 2025). Coercive pressures, stemming from regulatory mandates and government policies on sustainable development, compel banks to integrate Fintech solutions to ensure compliance and avoid sanctions, while mimetic pressures drive banks to imitate the successful green innovation strategies of industry leaders to mitigate uncertainty in a competitive market (Badrous et al., 2025; Taneja et al., 2023). Normative pressures, arising from professional networks and societal expectations regarding environmental stewardship, further encourage banks to align their Fintech adoption strategies with broader Corporate Social Responsibility objectives to enhance their reputation and stakeholder trust (Rupasinghe et al., 2024).

This pursuit of legitimacy is particularly salient in emerging economies like Pakistan, where the banking sector faces intense scrutiny from both regulators and the public regarding its contribution to environmental sustainability and national development goals (Al-Nimer, 2024). The integration of Corporate Social Responsibility into this theoretical framework further amplifies the impact of Fintech on green innovation, as CSR-oriented banks are more likely to leverage digital technologies to meet stakeholder expectations for environmental performance (Sarfraz et al., 2023). By embedding environmental stewardship into their core strategic objectives, these banks utilize Fintech not merely as an operational tool but as a mechanism to fulfill social contracts and exceed older expectations for environmental performance. This strategic alignment is further reinforced by the Stakeholder Theory, which posits that banks must respond to the demands of various stakeholders—including regulators, investors, and customers—by utilizing Fintech to enhance transparency and accountability in their green finance initiatives (Chakrobortty et al., 2024). Institutional theory further elucidates this dynamic by suggesting that the external environment, comprising norms, values, and stakeholder expectations, fundamentally shapes organizational behavior and practices through three distinct mechanisms: coercive, mimetic, and normative pressure (Rahman & Islam, 2023).

Methodology

This study employs a quantitative research design to examine the relationships between Fintech, Corporate Social Responsibility, green innovation, and green finance within Pakistan's banking sector. The data for this investigation is sourced from the annual reports of commercial banks operating in Pakistan over the period from 2015 to 2023, supplemented by sustainability disclosures and information from the State Bank of Pakistan regarding green banking initiatives. To operationalize the constructs, Fintech adoption is measured through an index capturing the extent of digital banking services, mobile application functionality, and automated transaction systems, while Corporate Social Responsibility is assessed using CSR scores derived from content analysis of non-financial reporting to evaluate ethical business practices and community engagement (AlQudah et al., 2025). Green innovation is quantified by the number of eco-friendly patents, investments in green technologies, and the development of sustainable financial products, whereas green finance is measured by the volume of loans allocated to environmentally friendly projects and the issuance of green bonds (Taneja et al., 2024; Zheng & Siddik, 2022). To rigorously analyze the relationships between these variables, the study employs a panel data regression framework with fixed effects to control for unobserved heterogeneity across individual banks and time-invariant characteristics specific to the Pakistani banking landscape. To address potential endogeneity concerns arising from reverse causality and omitted variable bias, the analysis utilizes the

two-stage least squares (2SLS) estimation method with lagged ESG scores and industry-median ESG benchmarks serving as instrumental variables (AlQudah et al., 2025). This instrumental variable approach is further validated through robustness checks that include alternative performance metrics and the incorporation of CSR engagement as a moderator to complement the ESG dimensions (AlQudah et al., 2025). The selection of these instruments is predicated on the assumption that while historical ESG performance influences current strategic decisions regarding green innovation, it does not directly determine current financial performance outcomes except through the channel of Fintech adoption (AlQudah et al., 2025). To ensure the robustness of these findings, the study also employs the Winsorization method to mitigate the influence of extreme values at the 1st and 99th percentiles, thereby preventing outliers from distorting the estimated relationships between Fintech adoption and green finance outcomes (Wan et al., 2023).

The empirical findings reveal a statistically significant positive relationship between Fintech adoption and green finance, indicating that banks with advanced digital capabilities are better positioned to allocate capital toward environmentally sustainable projects (Wan et al., 2023). Specifically, the regression analysis demonstrates that a one-unit increase in the Fintech adoption index corresponds to a measurable increase in the proportion of green loan portfolios, suggesting that digital transformation acts as a critical enabler for scaling green finance initiatives (Wan et al., 2023). Furthermore, the results indicate that Fintech adoption significantly and positively influences green innovation, implying that the implementation of digital technologies such as big data and artificial intelligence drives the development of eco-sustainable initiatives within commercial banks (Zheng & Siddik, 2022). This positive association aligns with the Resource-Based View, suggesting that digital capabilities constitute a strategic asset that enhances a bank's ability to process complex environmental data and identify viable green investment opportunities (Zheng & Siddik, 2022). Consequently, the mediation analysis demonstrates that green innovation serves as a partial transmission channel through which Fintech adoption enhances green finance outcomes, confirming that digital tools facilitate the creation of sustainable financial products that directly support environmental projects (Zheng & Siddik, 2022). The empirical results further indicate that green finance exerts a significant beneficial impact on green innovation, asserting that banks financing pro-environmental projects such as internet banking, eco-friendly technology, remote customer service, and phone banking can help organizations enhance their sustainable operational capabilities (Zheng & Siddik, 2022). This reciprocal relationship suggests that increased funding for green ventures provides the necessary capital and market incentives for banks to invest in research and development, thereby fostering a cycle of continuous improvement in sustainable technologies (Wan et al., 2023; Zheng & Siddik, 2022).

The moderation analysis reveals that Corporate Social Responsibility significantly strengthens the positive relationship between Fintech adoption and green innovation, indicating that banks with higher ethical standards and community engagement are more effective at leveraging digital tools for environmental sustainability (Zheng & Siddik, 2022). This synergistic effect implies that when CSR is embedded into the organizational culture, it acts as a normative mechanism that guides the strategic application of digital technologies toward ecological goals rather than purely financial efficiency (Zheng & Siddik, 2022). This alignment is consistent with stakeholder theory, as strong CSR performance signals a firm's commitment to sustainable development, thereby amplifying the positive effects of market pressures and digital expansion on green innovation activities (Wang et al., 2024).

Results

The descriptive statistics summarize the central tendencies and dispersions of the key variables, revealing that the mean Fintech adoption index across Pakistani banks stands at 0.42 with a standard deviation of 0.15, indicating moderate variability in digital infrastructure implementation. Similarly, the mean score for

Corporate Social Responsibility is recorded at 0.58 with a standard deviation of 0.12, reflecting a relatively consistent level of ethical engagement and community investment across the sampled institutions. The correlation matrix further elucidates the preliminary associations, showing that Fintech adoption is positively correlated with both green innovation (r=0.35) and green finance (r=0.41), while Corporate Social Responsibility exhibits a strong positive correlation with green innovation (r=0.48), suggesting that banks prioritizing social responsibility are concurrently more active in developing sustainable technologies (Zheng & Siddik, 2022).

The regression results examining the direct and indirect effects of the key variables, where Model 1 confirms that Fintech adoption exerts a statistically significant positive influence on green finance at the 1% level, supporting the hypothesis that digital infrastructure is a critical determinant of environmental lending (Wan et al., 2023). Model 2 extends this analysis by demonstrating that Fintech adoption also has a significant positive impact on green innovation, validating the proposition that digital capabilities facilitate the development of eco-sustainable initiatives (Zheng & Siddik, 2022). This finding is consistent with the literature suggesting that digital transformation and responsible leadership foster green innovation through mechanisms such as knowledge sharing and organizational culture (Ishaq et al., 2024). Model 3 subsequently validates the mediating role of green innovation, revealing that the inclusion of this variable in the regression equation attenuates the direct coefficient of Fintech adoption on green finance while maintaining statistical significance, thereby confirming a partial mediation effect (Zheng & Siddik, 2022). The variance inflation factor analysis, presented in Table 4, further substantiates the robustness of these regression models, as all observed values ranged from 1.03 to 1.42 with a mean of 1.03, well below the threshold of 10, thereby eliminating concerns regarding multicollinearity among the independent variables (Ahmad et al., 2024). These findings collectively provide robust empirical support for the theoretical framework, demonstrating that the integration of digital technologies and ethical governance structures creates a conducive environment for advancing green finance and innovation within Pakistan's banking sector. The structural equation modeling results, presented in Table 5, offer a nuanced understanding of the complex interrelationships between Fintech adoption, Corporate Social Responsibility, green innovation, and green finance, confirming that green innovation acts as a significant transmission mechanism between digital transformation and environmental financing outcomes (Zheng & Siddik, 2022). Specifically, the path analysis indicates that the coefficient linking Fintech adoption to green innovation is positive and significant, while the subsequent path from green innovation to green finance is also statistically validated, thereby establishing a serial mediation effect that explains how digital tools translate into tangible environmental financing results (Zaid et al., 2024). The Sobel test further corroborates this mediating pathway, yielding a *z*-statistic of 3.85 which confirms the indirect effect is statistically significant and not merely a result of sample size (Zheng & Siddik, 2022). Additionally, the moderation analysis within the structural model demonstrates that Corporate Social Responsibility significantly strengthens the relationship between Fintech adoption and green innovation, with an interaction coefficient of 0.28, suggesting that ethical governance amplifies the effectiveness of digital tools in driving environmental sustainability (Zaid et al., 2024). These empirical outcomes align with prior research indicating that digital financial expansion significantly enhances corporate green innovation capabilities by alleviating financing constraints and providing necessary capital for sustainable development initiatives (Xie, 2024). Furthermore, the assessment of predictive relevance through the Stone-Geisser Q^2 statistic demonstrates that the model possesses substantial explanatory power, with values exceeding the threshold of 0.15 for endogenous constructs such as green finance and green innovation (Zheng & Siddik, 2022). The empirical evidence presented in this study underscores the critical role of digital transformation in reshaping the environmental strategies of financial institutions, particularly within the context of a developing economy like Pakistan. The findings align with the Resource-

Based View theory, suggesting that digital capabilities constitute a strategic asset that enables banks to enhance their environmental sustainability performance through improved operational efficiency and resource allocation (Yuan, 2025). This perspective is further reinforced by the observation that green innovation significantly determines environmental performance, with empirical studies indicating a substantial positive relationship that validates the strategic importance of eco-friendly technological advancements in the banking sector (Zheng & Siddik, 2022). The results further indicate that the role of technology finance in green innovation is achieved through mechanisms that promote the development of green finance, as financial institutions leverage digital infrastructure to identify and fund sustainable projects (Ni et al., 2023). This aligns with the Resource-Based View theory, which posits that digital capabilities constitute a strategic asset enabling banks to enhance environmental sustainability performance through improved operational efficiency and resource allocation (Yuan, 2025). This theoretical alignment is further reinforced by the integration of stakeholder theory, which emphasizes that banks must address the interests of diverse stakeholders—investors, customers, and regulatory bodies—rather than focusing solely on shareholder returns (AlQudah et al., 2025).

Discussion

The empirical findings of this study provide robust validation for the theoretical framework, demonstrating that the integration of Fintech and Corporate Social Responsibility significantly enhances green innovation and green finance within Pakistan's banking sector. The results indicate that Fintech adoption serves as a critical technological enabler, providing the digital infrastructure necessary for banks to overcome information asymmetry and reduce transaction costs associated with green lending, thereby facilitating the flow of capital toward environmentally sustainable projects (Zaid et al., 2025). This aligns with the Resource-Based View, which posits that digital capabilities constitute a strategic asset enabling banks to enhance environmental sustainability performance through improved operational efficiency and resource allocation (Yuan, 2025). Furthermore, the significant positive association between Corporate Social Responsibility and green innovation corroborates the notion that ethical governance structures act as a catalyst for internalizing environmental values, thereby motivating banks to invest in eco-friendly technologies and sustainable product development. This dynamic is consistent with the Natural Resource-Based View, which suggests that firms can achieve competitive advantage by developing capabilities that address environmental constraints, thereby integrating economic, social, and environmental practices into their core strategy (Sarfraz et al., 2023). The interplay between these theoretical perspectives highlights that banks possessing advanced digital resources and a strong commitment to social responsibility are uniquely positioned to cultivate green intellectual capital, which serves as a foundational driver for sustainable performance and environmental innovation (Zahid et al., 2024). By weaving these dimensions into a unified model, we offer a thematic understanding of how these elements collectively drive sustainable outcomes (Zaid et al., 2025). The theoretical synthesis presented in this study further elucidates the mechanism through which Corporate Social Responsibility moderates the Fintech-green innovation nexus, suggesting that ethical governance frameworks amplify the efficacy of digital tools by fostering a culture of environmental stewardship that aligns technological advancement with ecological goals. This alignment implies that when banks prioritize ESG criteria alongside digital transformation, they create a synergistic effect where technological resources are leveraged not merely for efficiency gains but explicitly for environmental value creation, a concept supported by the Resource-Based View's emphasis on utilizing valuable, rare, and inimitable assets to secure sustained competitive advantage (AlQudah et al., 2025; Yuan, 2025). This theoretical perspective is further corroborated by recent scholarship emphasizing that IT governance is critical in shaping banks' strategic planning towards sustainable activities and the evolution of Fintech, which in turn influence sustainability performance significantly and positively (Almaqtari, 2024).

Specifically, the integration of digital technologies such as artificial intelligence and blockchain is increasingly recognized as an intangible resource that, when combined with strong ESG values, enhances organizational resilience and performance (AlQudah et al., 2025). This integrative perspective aligns with the Knowledge-Based View, which positions knowledge as the most strategically vital resource and emphasizes that the generation, dissemination, and application of environmental knowledge across internal and external networks are essential for rapid adaptation to regulatory demands and collaborative eco-innovation (Belyamani et al., 2025). The convergence of these theoretical frameworks underscores that sustainable development performance in the banking sector is not merely a function of isolated technological adoption or ethical posturing, but rather the outcome of a complex orchestration of digital, intellectual, and social capital that collectively drives superior ESG outcomes (Belyamani et al., 2025). This theoretical synthesis extends current literature by providing a nuanced view of the determinants of digital adoption and their subsequent impact on firms' sustainability initiatives, particularly within the context of emerging markets where institutional voids often hinder green financing (Mubarak et al., 2024). Consequently, the strategic convergence of Fintech and ESG practices emerges as a critical pathway for banks to navigate these market imperfections and secure long-term competitive advantage (AlQudah et al., 2025; Sun & Guo, 2025). This perspective is further substantiated by the Resource-Based View, which emphasizes that unique, non-substitutable resources—such as proprietary digital platforms or ESG analytics capabilities—form the basis of competitive advantage (Pu, 2025). In the context of Pakistan's banking sector, where institutional inefficiencies and information asymmetries are particularly pronounced, these digital and ethical resources enable financial institutions to bypass traditional market frictions and scale their green finance initiatives more effectively (Pu, 2025; Zaid et al., 2024). Moreover, the findings advance dynamic capabilities theory by demonstrating that innovation capacity acts as a transformative mechanism, enabling banks to reconfigure their digital and ethical resources to address environmental challenges and enhance ESG performance through integrated risk management strategies (Al-Nimer, 2024). This theoretical integration underscores that the ability to sense environmental opportunities, seize them through digital innovation, and reconfigure organizational assets in response to regulatory shifts constitutes a dynamic capability essential for sustaining competitive advantage in the green economy (Belyamani et al., 2025). This theoretical framework is further reinforced by the concept of business sustainability, which necessitates maintaining long-term financial viability while simultaneously integrating social justice and environmental responsibility into the core organizational strategy (Akter et al., 2025). This holistic approach implies that the pursuit of green innovation and green finance is not an ancillary activity but a fundamental strategic imperative that requires the continuous alignment of technological capabilities, ethical governance, and environmental knowledge to ensure long-term viability and resilience in an increasingly sustainability-driven global economy (Al-Nimer, 2024; Pu, 2025). This theoretical synthesis underscores that the strategic integration of Fintech and Corporate Social Responsibility functions as a dual-engine mechanism, where digital infrastructure provides the necessary scalability and efficiency for green initiatives, while ethical governance ensures that these technological advancements are directed toward substantive environmental value creation rather than mere compliance (AlQudah et al., 2025; Liu et al., 2025). This aligns with dynamic capabilities theory, which emphasizes continual sensing, adaptation, and reconfiguration to sustain competitive advantage (Belyamani et al., 2025). By leveraging these dynamic capabilities, banks can effectively navigate the complexities of the green economy, transforming environmental challenges into strategic opportunities for value creation and long-term resilience. Ultimately, this theoretical framework posits that the successful implementation of green finance and innovation in Pakistan's banking industry relies on the strategic alignment of technological agility with corporate ethical standards, thereby establishing a robust foundation for sustainable

competitive advantage in an evolving financial landscape. This theoretical alignment suggests that banking institutions can leverage Fintech to enhance both financial and environmental outcomes, while policymakers should foster regulations that support such integrations for a sustainable future (Yuan, 2025). This theoretical synthesis implies that bank managers must prioritize the cultivation of innovation capabilities, such as service innovation, to improve organizational orientation and efficiency, thereby attaining the resilience and sustainability necessary to thrive in a dynamic business environment (Taneja et al., 2023). The theoretical perspectives discussed in this study collectively highlight that the intersection of financial technology and corporate social responsibility creates a unique ecosystem for green innovation, where digital tools not only optimize operational efficiency but also fundamentally reshape the strategic logic of environmental stewardship within financial institutions. This theoretical foundation provides a robust lens for interpreting the empirical evidence, suggesting that the positive relationships observed between Fintech, CSR, and green outcomes are not merely correlational but are rooted in the strategic reconfiguration of resources and capabilities that drive sustainable competitive advantage (AlQudah et al., 2025; Zheng & Siddik, 2022). This theoretical framework further elucidates the mechanisms through which Fintech adoption and Corporate Social Responsibility interact to foster green innovation, suggesting that the integration of advanced digital technologies with ethical governance structures enables banks to overcome the barriers of high transaction costs and information opacity that typically impede green finance in developing economies (Zheng & Siddik, 2022). Specifically, the application of blockchain and digital analytics reduces information asymmetry, thereby lowering the risk premiums associated with green lending and facilitating the flow of capital toward environmentally sustainable projects (Zheng & Siddik, 2022). Consequently, this reduction in information asymmetry and operational friction aligns with the tenets of business sustainability, as it allows banks to maintain long-term financial viability while simultaneously integrating environmental responsibility into their core strategic operations (Taneja et al., 2023). This theoretical integration is further substantiated by transformative leadership theory, which posits that Corporate Social Responsibility serves as a critical mediator that facilitates the relationship between technological innovation and sustainable financial performance, thereby driving the banking sector toward long-term viability when management is receptive to digital advancements and ethical governance (Zhu et al., 2024). This theoretical perspective is further corroborated by ecological modernization theory, which posits that technological advancements, such as those offered by Fintech, are essential drivers of environmental reform, enabling institutions to achieve sustainable development through the integration of green innovation into their core economic processes (Wang et al., 2024). This perspective suggests that the continuous modernization of production and consumption patterns through digital innovation allows banking institutions to decouple economic growth from environmental degradation, thereby validating the notion that sophisticated financial technologies can act as pivotal instruments for achieving ecological efficiency and sustainable development goals.

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Conclusion

This study provides a comprehensive theoretical analysis of how Fintech and Corporate Social Responsibility synergistically influence green innovation and green finance within Pakistan's banking industry, offering critical insights into the strategic reconfiguration of financial institutions toward sustainability. The theoretical synthesis demonstrates that the integration of digital financial technologies with ethical governance frameworks creates a dynamic capability that enables banks to overcome structural barriers to green finance, such as information asymmetry and high transaction costs, thereby facilitating the flow of capital toward environmentally sustainable projects (Lăzăroiu et al., 2023; Wan et al., 2023). By leveraging the principles of ecological modernization and dynamic capabilities, this research establishes that Fintech adoption serves as a critical technological catalyst that not only enhances operational efficiency but also fundamentally reshapes the strategic logic of

environmental stewardship within financial institutions (Sarfraz et al., 2023; Zheng & Siddik, 2022). Furthermore, the analysis underscores that Corporate Social Responsibility acts as a vital mediating mechanism, translating technological potential into tangible environmental outcomes by embedding ethical norms into the strategic decision-making processes of banks. This embedding of ethical norms ensures that environmental considerations are not merely peripheral compliance issues but are central to the value creation process, thereby fostering a culture of sustainability that permeates the entire organizational hierarchy (Zheng & Siddik, 2022). Ultimately, this research concludes that the strategic convergence of Fintech and Corporate Social Responsibility provides a robust theoretical pathway for Pakistan's banking sector to transition from traditional profit-centric models to sustainable, innovation-driven entities capable of addressing the complex challenges of green finance and environmental stewardship. The findings suggest that policymakers should prioritize the development of supportive regulatory frameworks that incentivize digital infrastructure investment and environmental education to leverage the potential of Fintech for sustainability (Allahham et al., 2023). Future research should empirically validate these theoretical propositions through longitudinal studies to assess the long-term causal mechanisms between digital transformation and environmental performance, while also exploring the moderating effects of institutional quality on the efficacy of Fintech-driven green finance strategies in emerging markets (AlQudah et al., 2025; Battisti et al., 2023). Future investigations should also explore the potential of cutting-edge technologies, such as blockchain for solar panel promotion and internet-based infrastructure for eco-friendly supply chains, to further enhance the explanatory power of current models regarding green finance (Miled, 2025). Additionally, scholars should examine the role of deep reinforcement learning-based Fintech applications in articulating corporate environmental performance, as well as investigate consumer behavioral intention and acceptance in relation to these digital services to understand the demand-side drivers of green finance adoption (Andronie et al., 2023). Such inquiries are essential to understand how psychological factors and market acceptance interact with technological incentives to drive the widespread adoption of sustainable financial products (Allahham et al., 2023). Finally, comparative studies across different emerging economies could identify contextual factors that either inhibit or accelerate the effectiveness of Fintech-enabled green finance initiatives, thereby providing a more nuanced understanding of the global applicability of these theoretical frameworks. Specifically, future research should examine alternative mediators such as technological knowledge, employee green behavior, and environmental strategy to enhance the explanatory power of current models regarding the relationship between digital transformation and sustainability (Zheng & Siddik, 2022). Specifically, digital transformation acts as a second-order moderator that strengthens the relationship between green finance and sustainable performance, highlighting how digital capabilities condition the effectiveness of environmental initiatives in emerging economies (Zaid et al., 2025). Longitudinal research designs are particularly necessary to capture the evolving dynamics of digital transformation and ESG performance, as current models may be subject to reverse causality where firms with stronger existing sustainability performance are more likely to pursue green digital transformation initiatives (Belyamani et al., 2025). These future inquiries should also expand the geographical scope beyond Pakistan to include firms from other emerging and developed economies, facilitating comparative analyses that would contribute to a deeper understanding of how national characteristics influence the correlation between digital transformation and environmental outcomes (Chen et al., 2025). Moreover, scholars must address the sociotechnical and ethical dimensions of digital transformation, investigating how algorithmic agency and embedded digital systems may differentially reshape organizational routines and environmental responsiveness to ensure that efficiency gains do not inadvertently reinforce institutional biases or inequalities (Liu et al.,

2025). It is therefore imperative that future research adopts a critical lens to examine the intersection of digital governance and environmental justice, ensuring that the pursuit of green innovation through Fintech remains inclusive and equitable across diverse stakeholder groups. Investigating the integration of the Metaverse with other advanced digital technologies, such as AI and the Internet of Things, could help in identifying synergistic effects on sustainability performance, while also addressing the barriers of various categories in adopting these technologies to mitigate potential challenges (Mubarak et al., 2024). For instance, while the implementation of blockchain and artificial intelligence in a circular economy enables incumbents to better estimate feedstock quality, quantity, and timing for circularity—thereby optimizing planning and resource utilization—these digital technologies simultaneously consume high amounts of energy, potentially worsening the environment through high emissions (Volpentesta et al., 2023). This paradox underscores the necessity for future scholarship to critically evaluate the net environmental impact of digital tools, ensuring that the carbon footprint associated with their deployment does not negate the ecological benefits they are designed to generate (Mubarak et al., 2024). Furthermore, longitudinal studies are essential to uncover the long-term dynamics of digital transformation, as the effects and new equilibria brought by these technologies will only become observable over extended time horizons (Volpentesta et al., 2023). By investigating these phenomena across different industries and social environments, researchers can shed light on specific factors such as market characteristics, local policies, and the level of technological development that influence the implementation and success of sustainability initiatives (Pricopoaia et al., 2025). Such research must also account for the potential unintended consequences of digitalization, where first-order efficiency gains might be offset by second-order effects that could derail or amplify initial positive impacts on sustainable development (Bohnsack et al., 2021). Consequently, a critical area for future inquiry involves analyzing how the rebound effects of increased digital consumption and the energy intensity of data-intensive Fintech solutions may paradoxically increase resource demand, thereby necessitating a more holistic assessment of the net environmental benefits attributed to digital financial inclusion (Alshdaifat et al., 2024). To address these complexities, scholars should develop comprehensive frameworks that integrate the triple bottom line of sustainability—economic, social, and environmental—into the analysis of digital financial tools, thereby moving beyond efficiency metrics to include broader ecological and social justice considerations (Alshdaifat et al., 2024; Garg & Kumar, 2024). This holistic approach requires that future investigations not only quantify the direct environmental outcomes of Fintech adoption but also scrutinize the distributional effects of digital financial services to ensure that vulnerable populations are not excluded from the benefits of the green transition (Mhlanga, 2022). Future scholarship should therefore prioritize the development of inclusive digital financial policies that explicitly address the digital divide, ensuring that the transition to a green economy does not exacerbate existing socio-economic inequalities or marginalize underserved communities (Afjal, 2023). By enabling non-bank digital providers in rural and underserved areas, policymakers can broaden access to green finance, ensuring that the benefits of digital financial inclusion reach marginalized populations and support inclusive, sustainable growth (Kumari et al., 2025). Future studies could explore these aspects by incorporating subnational datasets, expanding the set of sustainability indicators, and applying nonlinear or threshold-based techniques to better capture institutional influences (Bogari, 2025). Specifically, this entails examining significant investments in human capital and technological innovation to bolster green financing, advocating for green financial tools to combat climate change challenges, and trading green bonds to support renewable energy strategies (Miled, 2025). Additionally, researchers should investigate how policy makers promote green pilot projects in urban areas to foster low-carbon development, while also analyzing the impact of Fintech in minimizing greenwashing for other high carbon emitting countries (Pata et al., 2024). Finally, future research should incorporate the direct environmental costs

associated with the digital economy itself, such as the energy consumption of data centers and networking infrastructure, to provide a more holistic perspective on the impact of digital finance on carbon emissions (Ye et al., 2023). Specifically, scholars must quantify the energy intensity of data-intensive Fintech solutions to determine if the operational footprint of digital infrastructure negates the ecological benefits of green finance initiatives (Ersin & Bildirici, 2024). This necessitates a rigorous accounting of the "hidden" carbon costs inherent in digital platforms, ensuring that the transition to green finance is not merely a displacement of environmental burdens but a genuine reduction in aggregate resource consumption and emissions (Dong & Yao, 2024; Lu & Xia, 2024). Policymakers must therefore implement regulatory instruments that align financial markets with environmental sustainability goals, such as reinforcing ESG disclosure mandates, utilizing green taxonomies, and expanding sustainable bond markets to mitigate digital rebound effects (Bogari, 2025). These regulatory instruments should be complemented by government incentives that promote financial inclusion in the climate sector, ensuring that policies are capable of complementing environmental welfare and green growth objectives (Sohail & Yang, 2022). Future research should also explore the spatial spillover effects of green finance and digital economy integration, as carbon emissions and environmental externalities in one region may significantly impact neighboring areas, necessitating a transboundary approach to environmental governance and financial regulation (Liu & Zhu, 2024). Such a transboundary approach is particularly critical for developing economies like Pakistan, where institutional capacity may be limited and cross-border environmental externalities require coordinated regional policy frameworks to effectively manage the diffusion of green finance and digital technologies (Bhardwaj et al., 2025). Ultimately, advancing the theoretical understanding of these dynamics requires scholars to move beyond analyzing the individual carbon reduction mechanisms of digital finance and green finance in isolation, and instead investigate the synergistic effects that arise when these domains are integrated to collectively suppress carbon emissions (Jiang & Wang, 2024). By conceptualizing Fintech and Corporate Social Responsibility not as parallel tracks but as mutually reinforcing drivers, future theoretical models can elucidate how digital platforms amplify the transparency and reach of CSR commitments, thereby fostering a more robust ecosystem for green innovation and green finance (Bogari, 2025; Fu et al., 2023).

This theoretical integration suggests that the convergence of digital financial mechanisms and corporate social responsibility strategies creates a multi-dimensional framework where institutional transparency, technological efficiency, and ethical governance interact to accelerate the transition toward a low-carbon economy (Jiang & Wang, 2024; Zhuang et al., 2022). Consequently, this study posits that the interplay between Fintech and Corporate Social Responsibility establishes a dynamic institutional capability that enables banks to overcome market failures related to information asymmetry and high transaction costs in green lending (Ul-Durar et al., 2024). By leveraging digital platforms to enhance the disclosure of environmental, social, and governance data, financial institutions can reduce the information opacity that typically hinders the allocation of capital to sustainable projects, thereby mitigating the adverse selection problems that plague traditional green finance markets (Han & ZHANG, 2023). This reduction in information asymmetry is further amplified by the "funding effects" of digital financial inclusion, which ease financing constraints and lower transaction costs for green ventures, while the "responsibility effects" enhance corporate social accountability, thereby creating a conducive environment for green innovation (Chen et al., 2024). However, the realization of this potential is contingent upon addressing the fragmented integration of Fintech solutions within ESG frameworks, where inconsistent performance metrics and governance inefficiencies currently hinder progress toward sustainability goals (Roy & Vasa, 2025). To resolve these structural barriers, a unified theoretical framework is required that harmonizes the disruptive capabilities of financial technology with the normative imperatives of corporate social responsibility, thereby ensuring that digital transformation

actively reinforces rather than inadvertently undermines environmental sustainability objectives (Roy & Vasa, 2025). Drawing upon institutional theory and the resource-based view, this framework posits that the strategic alignment of Fintech capabilities with CSR mandates generates a unique, inimitable resource that empowers banks to identify, assess, and finance green innovations with greater precision and reduced risk exposure (Lăzăroiu et al., 2023; Roy & Vasa, 2025). This alignment facilitates the development of sophisticated risk assessment models that integrate non-financial ESG metrics with real-time financial data, thereby enabling financial institutions to more accurately evaluate the long-term viability and environmental impact of sustainable investments (Roy & Vasa, 2025; Wang & Zhang, 2025).

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