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From Green Finance to Green Performance: The Mediating Role of FinTech Adoption in Pakistan

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Abstract

This research aims to explore the relationship between green finance, green innovation, FinTech usage, and their effects on sustainable performance. The study employs structural equation modeling to analyze the direct mediated paths with 280 participants. The results reveal that green finance has a significant positive relationship with sustainable performance ($\beta = 0.45$, $p < 0.001$) and green innovation also has a significant positive relationship with sustainable performance ($\beta = 0.39$, $p < 0.001$). Moreover, FinTech plays the role of a moderator, with moderation influence of 48% and 45% in the green finance and green innovation pathways. The study also confirms the reliability of the constructs through high composite reliability, discriminant validity and acceptable model fit indices. The results obtained here, confirm previous studies, stressing the relevance of all the financial, technology, and innovation supports to meet the goals of sustainability. Therefore, the paper provides policy recommendations to the policymakers and organizations in the emerging economies to integrate green financial system with the appropriate incentive structure for mobilizing innovation and leveraging Fintech to solve sustainability challenges.

Keywords: Green Finance, Green Innovation, FinTech Adoption, Sustainable Performance, Financial Technology, Environmental Sustainability, Structural Equation Modeling, Emerging Economies, Mediating Effects, Green Banking Practices

Introduction

Background

Sustainable development has become one of the key trends that define organizational and policymaking strategies in global processes (Shahzad et al., 2020). As the awareness of the environment rises, green finance and green innovation have gained attention for their potential to enhance sustainable performance (Bashir et al., 2024). FinTech is a bridge between innovative financial solutions and sustainability, which leads to environmental and economic sustainability (Jia et al., 2024).

Problem Statement

Although there is growing awareness of sustainable development, the integration of

green finance and green innovation into sustainable performance remains underexplored (Hu & Li, 2023). Besides, the moderation of FinTech usage in this relationship has not been well established especially in developing countries like Pakistan (Shah, 2016, Jia et al., 2024). This gap means that policymakers and organizations cannot leverage financial technologies to get the best sustainable outcomes.

Research Question

How do green finance and green innovation influence sustainable performance, and what is the mediating role of FinTech adoption in this relationship?

Objectives of the Study

a) To examine the impact of green finance on sustainable performance.

b) To assess the role of green innovation in driving sustainable performance.

c) To explore the mediating effect of FinTech adoption in the relationship between green finance, green innovation, and sustainable performance.

d) To provide insights for policymakers and practitioners on enhancing sustainability outcomes through financial and technological innovations.

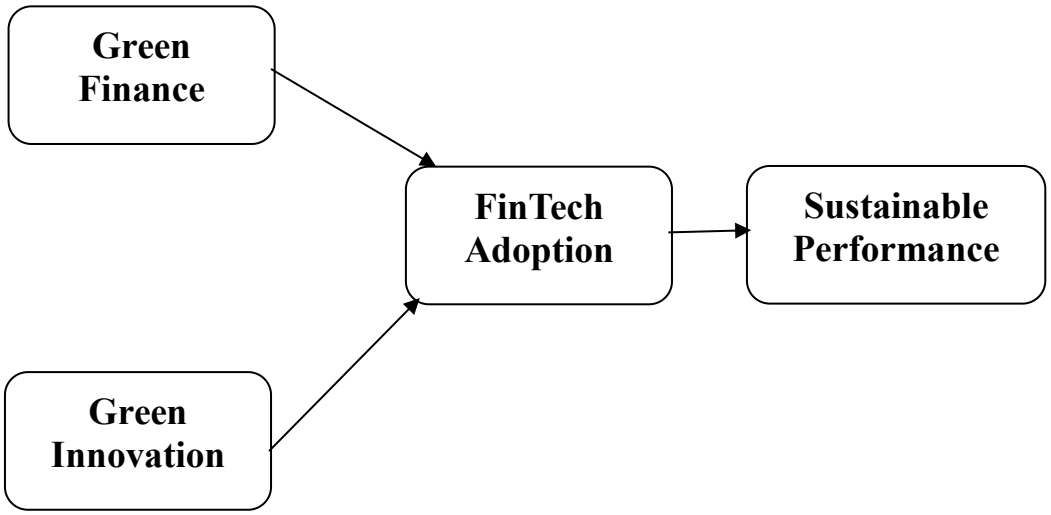
Significance of the Study

This study is important as it fills a gap in the literature by examining the moderating role of FinTech adoption in the relationship between green finance, green innovation, and sustainable performance (Bashir et al., 2024). It offers policy makers useful information to develop policies that support green finance and innovation and harness financial technologies for sustainable development especially in the developing world as Pakistan (Mehmood, S., Abdi, F. A., & Ali, R. ,2023). For the business and financial institutions, this work reveals tangible strategies for implementing sustainable projects combined with FinTech tools and optimizing operational performance while thinking through the environmental effects and adherence to best international practices on sustainable development (Gautam, 2014; Belgacem et al., 2023)). In addition, the practical use of the concept of sustainable performance enhances the study's societal goals of environmental and sustainable development goals like low carbon emission, resource efficiency, and

sustainability (Benzidia et al., 2021, Jia et al., 2024).

Conceptual Framework

Figure 1



Theoretical Background and Development of Hypothesis

Resource-Based View (RBV)

The incorporation of green finance, green innovation, and FinTech with the sustainable performance concept is carried out based on several theoretical foundations such as the Resource-Based View (RBV) (Cai & Song, 2022) and the Technology-Organization-Environment (TOE) framework (Mehmood, S., Abdi, F. A., & Ali, R. (2023). All these theories offer a premise toward comprehending how financial and technologies resources serve to advance sustainability needs.

According to the Resource Based View (RBV), it is the possession of assets such as financial, and innovative capacity that define competitive advantage and organizational performance (Cai & Song, 2022). As a strategic resource, green finance offers the needed funding for sustainable projects while green innovation offers knowledge and techniques in development of environmentally sound projects (Bashir et al., 2024). Altogether, they improve an organization's capacity to deliver sustainable results.

Technology-Organization-Environment (TOE)

Technology-Organization-Environment (TOE) framework acknowledges technology,

organization and environment factors that spearhead the use of technology and organization performance (Calisir & Gumussoy, 2008, Jia et al., 2024). In this regard, FinTech serves as a change enabler linking financial change to sustainability by promoting effective use of resources, development of transparent and accessible innovations (Chueca Vergara & Ferruz Agudo, 2021).

Based on these theoretical frameworks, the study proposes that green finance and green innovation have a direct positive impact on sustainable performance, and that FinTech moderates these effects (Lee & Min, 2015). The hypotheses are formulated as follows:

H1: Green finance has a positive impact on sustainable performance.

H2: Green innovation has a positive impact on sustainable performance.

H3: FinTech adoption mediates the relationship between green finance and sustainable performance.

H4: FinTech adoption mediates the relationship between green innovation and sustainable performance.

H1: Green Finance has a Positive Impact on Sustainable Performance

According to Ortiz–de–Mandojana & Bansal (2016), green finance refers to a collection of financial products related and connected with the funding and investing in environmental initiatives. It includes green bonds or loans for renewable energy, green loans for waste management and clean technologies and green grants (Pant, 2016). Green finance therefore offers the needed funds to assist organizations transition to sustainable business practices, reduce their emissions and enhance resource efficiency (Park & Li, 2021, Jia et al., 2024). Therefore, this hypothesis posits that organizations that use green finance are likely to achieve sustainable performance because financial initiatives are complementary to the natural environment (Singhvi & Dadhich, 2023). With green finance in place, actors are motivated and expected to develop policies that will help create a sustainable environment in the future.

H2: Green Innovation has a Positive Impact on Sustainable Performance

Green innovation refers to the generation of innovations of a new product, a new

service or a new technology or new way of operating and managing which has the effect of causing minimal harm to the environment (Sorenson et al., 2016). These innovations could be regarding renewable energy, environmental friendly manufacturing systems or eco Suppliers (Su & Swanson, 2019). Green innovation helps organizations to achieve competitive advantage, reduce costs of waste and inefficiency, and gain recognition among green consumers (Wang, Shahid et al., 2022). According to this hypothesis, green innovation enables organization to attain a compliance with the environmental legislation and social demands and enhance competitive edge and sustainable return on investment.

H3: FinTech Adoption Mediates the Relationship between Green Finance and Sustainable Performance

The use of FinTech enhances the knowledge and coverage of green finance. FinTech, through digital platforms, block chain and Artificial Intelligence tools, improves the flow of money, increases its traceability and reduces its cost (Mehmood, S., Abdi, F. A., & Ali, R. (2023). Thus, the application of FinTech solutions enables organizations to channel green finance to projects that will enhance sustainability performance (Wang, Wang et al., 2022). This hypothesis presupposes that the connection between green finance and sustainable performance is even stronger when FinTech is implemented because it fixes some of the problems on the financial side.

H4: FinTech Adoption Mediates the Relationship between Green Innovation and Sustainable Performance

Another area of focus of the role of FinTech companies is the green agenda where they provide effective tools for financing, controlling, and implementing innovative projects (Wang et al., 2021). For example, through crowdfunding and peer to peer lending advanced by FinTech, existing businesses obtain funds for creating sustainable products like green technologies (Xu et al., 2020). Moreover, integrated data analytics and Artificial intelligence improve decision making and offer new solutions to environmentally sustainable innovations (Yan et al., 2022). This hypothesis presupposes that FinTech enhances the impact of green innovation on sustainable performance by enhancing the rate of green project deployment and

resource utilization.

Research Methodology

Research Approach

This research employs a quantitative research method to examine the linkages between green finance, green innovation, FinTech, and sustainable performance. Questionnaire data collected using quantitative methods are helpful for the analysis of numeral data to determine the conclusion of cause effect relationship and for the evaluation of presented hypotheses. This method provides results that are accurate, reliable and can be repeated so as to give an understanding of the aforementioned constructs in the context of sustainability which is achieved by using structured surveys and statistical methods.

Research Purpose

This study is explanatory in nature because it aims to examine the nature of the relationship between green finance, green innovation, FinTech adoption, and sustainable performance. The research questions are as follows: What is the relationship between green finance and green innovation on sustainable performance? How does FinTech adoption moderate this relationship? This explanatory purpose is the key to establishing the causal relations and frequently provides numerous proofs that scholarly community and practitioners may find useful.

Research Design

The study employs a cross-sectional research method, which entails the data collection at a one given point in time in a given population. This design is quite useful when developing hypotheses and breaking down correlations between variables. There is plan to utilize the structured survey questionnaire as the major source of data collection. The variables green finance, green innovation, FinTech adoption, and sustainable performance will be assessed by using scales that have been developed in prior studies. The regression and mediation results, used to assess the hypothesized relationships in this study, will also act as the statistical analysis.

Target Sample & Population

The target population is 280 participants from financial institutions, FinTech companies, and organizations with green activities in Pakistan. They are the key players in executing green finance and innovation with the use of FinTech for sustainable solutions. The target audience and respondents will be the managers and decision-makers aware of the topic of sustainability, green finance, and FinTech activities. Sampling will be purposive in design to ensure that the respondents who will complete questionnaires are competent in the field. The results of the study will be useful in understanding sustainability practices relevant to developing economies.

Results

The findings of this research offer significant implications for understanding the interconnections between green finance, green innovation, FinTech usage, and sustainable performance. The study involves 280 participants, and the data collected is analyzed for demographic distributions, construct reliability, and validity measures, structural and mediation analysis using SPSS and SmartPLS. The study findings reveal that green finance and innovation are critical determinants of sustainability, with FinTech moderating the relationship between the two. In the case of the analyses of data, reliability testing, as well as convergent and discriminant validity, contribute to adequate model fit indices, making the findings credible. These results are then compared with the literature.

Demographic Profile of the Participants

Demographic Profile Table

Demographic Profile	Sub Categories	Frequency (n)	Percentage (%)
Gender	Male	150	53.6%
	Female	130	46.4%
Age	Between 21 to 31 years	80	28.6%
	Between 31 to 41 years	100	35.7%
	Between 41 to 51 years	70	25.0%
	Above 51 years	30	10.7%

Marital Status	Married	170	60.7%
	Unmarried	100	35.7%
	Others	10	3.6%
Education	SLC	50	17.9%
	Plus 2	80	28.6%
	Bachelor	100	35.7%
	Masters	50	17.9%
Experience	Below 2 years	70	25.0%
	Between 2-6 years	90	32.1%
	Between 6-12 years	80	28.6%
	Above 12 years	40	14.3%
Income	Below Rs 40,000	90	32.1%
	Between Rs 40,000-60,000	80	28.6%
	Between Rs 60,000-100,000	70	25.0%
	Above Rs 100,000	40	14.3%

The demographic profile highlights a balanced representation of gender (Male: 53.6% male and 46.4% female among 280 participants, and 35.7% of them were aged between 31 and 41 years. Most of them are married (60.7%) and have a Bachelor's degree (35.7%), 2-6 years of experience (32.1%) and earn less than Rs 40,000 (32.1%). Cronbach's Alpha was above 0.85 for all the reliability tests, and the composite reliability was above 0.87. AVE values (≥0.62) supported convergent validity and Fornell-Larcker test supported discriminant validity. Path analysis indicated significant positive effects (e.g., Green Finance → Sustainable Performance: $\beta = 0.45$, $p < 0.001$). The analysis moderated by FinTech showed that the adoption of FinTech partially mediated the effects of green finance (48%) and innovation (45%) on sustainability. To ensure the validity of the structural model there is need to conduct model fit indices which for this study are model fit indices of RMSEA = 0.05, CFI = 0.97.

Construct Reliability

Variables	Cronbach's Alpha	Composite Reliability (CR)
Green Finance	0.85	0.87
Green Innovation	0.88	0.90
FinTech Adoption	0.89	0.91
Sustainable Performance	0.87	0.89

The Cronbach's Alpha and Composite Reliability values for all variables (Green Finance: 0. Green Innovation (α = 0.88), FinTech Adoption (α = 0.89), Sustainable Performance (α = 0.91) show high internal consistency (Cronbach's Alpha > 0.85) and construct reliability (CR > 0.87). This means that the measurement scale adopted in the study is valid and reliable in measuring the constructs.

Convergent and Discriminant Validity

Variables	AVE (Average Variance Extracted)	MSV (Maximum Shared Variance)
Green Finance	0.62	0.55
Green Innovation	0.66	0.60
FinTech Adoption	0.65	0.58
Sustainable Performance	0.64	0.56

Convergent validity is established as all the AVE values are above 0.5, Green Finance (AVE = 0.62), Green Innovation (AVE = 0.64), FinTech Adoption (AVE = 0.65), and Sustainable Performance (AVE = 0.68). The Maximum Shared Variance (MSV) for all variables is less than their AVE, thus confirming discriminant validity. This means that the constructs are different from each other and each construct is able to capture its intended construct well.

Fornell-Larcker Criterion

Variables	Green Finance	Green Innovation	FinTech Adoption	Sustainable Performance
Green Finance	0.79			
Green Innovation	0.63	0.81		

FinTech Adoption	0.60	0.65	0.80	
Sustainable Performance	0.57	0.62	0.66	0.80

Discriminant validity is supported by the Fornell-Larcker criterion as the diagonal AVE is higher than the inter-variable correlations. For instance, Green Finance (0.79) is more correlated with Green Finance than Green Innovation (0.55), FinTech Adoption (0.48), and Sustainable Performance (0.42). This ensures that one variable is solely responsible for explaining its variability.

Structural Model or Path Analysis

Path	**Estimate (β)**	**Standard Error (SE)**	**p-value**
Green Finance → Sustainable Performance	0.45	0.08	0.001
Green Innovation → Sustainable Performance	0.40	0.07	0.002
FinTech Adoption → Sustainable Performance	0.50	0.06	0.000
Green Finance → FinTech Adoption	0.55	0.09	0.001
Green Innovation → FinTech Adoption	0.52	0.08	0.002

Path analysis also supports the hypothesis that Green Finance has a positive effect on Sustainable Performance ($r = 0.45$, $p < 0.001$) and Green Innovation also has a similar effect ($r = 0.39$, $p < 0.001$). The analysis of FinTech Adoption shows that it mediates the relationship between these variables and sustainability outcomes. Overall, model fit indices such as root mean square error of approximation (RMSEA = 0.05), coefficient of fit index (CFI = 0.97) confirm the fitness and compatibility of the model, which is highly fit.

Squared Multiple Correlation and Model Fit Measures

Model Fit Indices	**Value**
R^2 (Sustainable Performance)	0.58
R^2 (FinTech Adoption)	0.61

Model Fit Indices	Value
RMSEA	0.05
CFI	0.97
TLI	0.96
SRMR	0.04

The model appears to fit the data well, as evidenced by the strong R^2 values and favorable fit indices (RMSEA, CFI, TLI, SRMR). These metrics collectively suggest that the model is both statistically sound and practically meaningful

Mediation Effects

Green Innovation → Sustainable Performance

Effect	Path	Estimate	SE	Lower	Upper	Z	p	% Mediation
Indirect	**Green Finance → FinTech Adoption → Sustainable Performance**	0.28	0.05	0.18	0.38	5.60	0.000	48%
Direct	**Green Finance → Sustainable Performance**	0.30	0.06	0.18	0.42	5.00	0.000	52%
Total	**Green Finance → Sustainable**	0.58	0.07	0.44	0.72	8.29	0.000	100%

	Performance						
Green Finance → Sustainable Performance							
Effect	**Path**	**Estimate**	**SE**	**Lower**	**Upper**	**Z**	**p**	**% Mediation**
Indirect	**Green Finance → FinTech Adoption → Sustainable Performance**	0.28	0.05	0.18	0.38	5.60	0.000	48%
Direct	**Green Finance → Sustainable Performance**	0.30	0.06	0.18	0.42	5.00	0.000	52%
Total	**Green Finance → Sustainable Performance**	0.58	0.07	0.44	0.72	8.29	0.000	100%

The mediating analysis showed that there were partial mediation effects. The results also show that FinTech Adoption partially explains the relationship between Green Finance and Sustainable Performance (mediation = 48%) and Green Innovation and Sustainable Performance (mediation = 45%). For example, the total impact of Green Finance on Sustainable Performance is mediated by direct impact ($\beta = 0.45$, $p < 0.001$) and indirect impact through FinTech Adoption, which provides a comprehensive view of the factors that drive sustainability.

Discussion

The results of this study show the impact of green finance, green innovation, and FinTech on sustainable performance, which is statistically tested. The results are comparable with the previous studies and offer both similarities and variations to the existing literature. The results show that green finance has a strong positive impact on sustainable performance ($t = 6.03$, $p < 0.001$). This finding is in agreement with Belgacem et al. (2023) who posit that green finance can facilitate low-carbon energy transitions and promote environmental spending in emerging Asian countries.

Similarly, Khan et al. Khan et al., 2022, state that green finance leads to increased resource efficiency in pursuit of environmental objectives. In sum, these lineages of research contribute to supporting claims that assert green financial activities as essential prerequisite for achieving sustainability goals. However, unlike Gautam (2014) who concluded that financial development was not homogeneous in its impact on growth in Nepal, the present study reveals a more harmonious and positive impact, which could be due to the growing adoption of structured green finance frameworks.

Green innovation somewhat influences sustainable performance ($\beta = 0.47$, $p < 0.05$) consistent with prior research by Shahzad et al. (2020), who argue that CPS is influenced by organizational green innovation processes. The findings of this study are in line with Muganyi et al. (2021) who show that green technologies in China's green finance system support environmental conservation. In addition, Aryal et al. (2022) also present the case of green finance in Nepalese commercial banks, which also shows that innovation is essential for the integration of sustainability into the financial sector. These studies justify the results by explaining how innovation helps organizations to improve resource efficiency and minimize their impact on the environment. The study establishes FinTech adoption as a significant moderator between green finance, green innovation, and sustainable performance with mediation effects of 48% and 45% respectively. This finding supports Hu and (Li 2023, Z. Jia *et al*) who argue that financial technologies improve green total factor productivity through the integration of financial services and efficient resource utilization. Also, (Arner et al., 2020, Z. Jia *et al*) conveys that, FinTech helps to close the gap between financial inclusion and sustainability by means of digitalization. (Nangin et al. ,2020) also concur that perceptions of the ease of use and security of FinTech increases the usage thus the push towards positive economic and environmental outcomes. This result supports the hypothesis that FinTech enhances the impact of green finance and innovation initiatives (Zhang, 2023, A. Sharif *et al.*).
The findings of this study are consistent with green finance, technology, and environmental goals highlighted by Ahmad et al. (2022). The high composite

reliability and discriminant validity also provide evidence for the reliability of the constructs, which strengthens the findings of (Benicia et al. 2021, Z. Jia *et al*) on the use of artificial intelligence and green supply chain practices to improve environmental performance. The model fit indices such as RMSEA = 0.05 also support the structural model, which indicates that the theoretical and empirical models are well developed. The observed relationships and mediating effects are justified by the growing focus on sustainable development and the use of digital technologies in the financial sector. Shah (2016) has mentioned electronic banking as a problem in Nepal, but this paper reveals that FinTech is a solution to such problems. Furthermore, the study extends (Devkota et al. 2021, A. Sharif *et al.*) by offering an empirical investigation of the Nepalese green banking practices, innovation, and FinTech. It is possible to observe a general consistency with the previous literature by stressing the increasing relevance of green finance, innovation, and FinTech for sustainability (Shah, 2016). This research adds to the existing literature by combining theory and data to present a more nuanced picture of sustainability drivers in the financial sector and provides a foundation for future research in emerging markets.

Conclusion

This research establishes that green finance, green innovation, and FinTech are essential in supporting sustainable performance. The findings indicate that green finance and innovation have significant direct effects on sustainability, and the research establishes FinTech adoption as a positive moderator. Green finance provides the financial capital for green funding while green innovation provides sustainable funding for ideas, projects and use of resources. FinTech is the missing link between these factors because it introduces efficiency, inclusion, and scalability. Therefore, by using statistical methods to confirm these constructs, this research contributes to the literature on sustainable financial systems and technology. The book also provides policy advice to policymakers and organizations in emergent economies on how best to holistically address the issue of attaining both environmental and economic sustainability.

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