

The Nexus Between FinTech Adoption, Corporate Governance, and Carbon Emission Reduction: A PLS-SEM Analysis

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Abstract

This paper investigates the interrelation among the three constructs of this study; corporate governance, fintech adoption, and carbon emission reduction in the banking sector of Saudi Arabia, with fintech serving as both a direct and mediating variable. The data was collected from 403 officials in the banking industry using a convenience random sampling technique. PLS-SEM was applied to test the hypotheses. The findings reveal that both corporate governance and fintech adoption exert significant and positive influence on carbon emission reduction ($\beta = 0.606$; $\beta = 0.167$, $p < 0.05$). The results further show that corporate governance significantly influences fintech adoption ($\beta = 0.555$, $p < 0.05$). The study also highlights the role of fintech in mediating the relationship between corporate governance and carbon emission reduction ($\beta = 0.093$, $p < 0.05$). The study emphasizes the need to implement effective governance frameworks and promote digital innovation to achieve sustainable environmental objectives.

Keywords: Financial technology, carbon emission reduction, corporate governance, sustainable development, Saudi Arabia, partial least square method.

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1. Introduction

Global policymakers and academics have raised serious concerns about the environmental impact of carbon emission. Technological innovation, corporate investment decisions, and sustainable initiatives have been identified as key factors to reduce emissions. Science and technological advancement are increasingly recognized as key enablers of global low-carbon innovation (Sanni et al., 2026). This encompasses the integration of digital and smart-grid solutions, including technologies such as artificial intelligence and blockchain, which enhance system efficiency, support real-time energy management, and facilitate the transition toward cleaner and more sustainable energy systems (Sanni et al., 2026, Akinwale, 2024a). In this instance, financial technology (fintech) has altered the way financial transactions are conducted by enhancing transparency, efficiency, and market accessibility. Fintech such as digital payments, blockchain, and data analytics, reduces environmental footprints and channels capital into sustainable investment (Attia & BinEid, 2025). At the same time, many scholars have argued that corporate governance mechanisms play pivotal roles in achieving decarbonization and environmental sustainability (Haque and Ntim, 2018; Oyewo et al., 2022; Fareed, et al., 2025). While both fintech and corporate governance have independently been linked to improved environmental outcomes, their combined and interactive effects remain insufficiently explored, particularly in emerging economies.

As a resource-dependent economy, Saudi Arabia faces challenges of reducing carbon emissions. The country has a robust financial system predominantly operating Islamic banking which support economic growth of the country (Oladapo et al. 2024). Therefore, the interconnection between fintech and corporate governance is particularly relevant to the country's sustainability and economic diversification agenda under Vision 2030 (Oladapo, 2025). Although it has been established that fintech and governance systems positively impact emissions reduction, limited attention has been paid to an integrated framework that simultaneously links fintech, corporate governance, and carbon emissions reduction. Furthermore, studies investigating environmental outcomes in Saudi Arabia have largely focused on financial development and governance as moderating factors (Omri et al., 2021), or on fintech investments as independent drivers of environmental performance (Alshahrani et al., 2026). The mediating mechanisms through which fintech influences the relationship between corporate governance and environmental outcomes also remain underexplored, particularly in emerging markets. This lack of integration between corporate decarbonization strategies and technological transformation could hinder the

achievement of lower emission targets.

To address the identified gap in the literature, this paper proposes an integrated model that analyses the effects of fintech adoption and the corporate governance framework on carbon emissions reduction, with a specific focus on the mediating role of fintech adoption in the governance–emissions reduction relationship. This integrated model will extend extant studies by providing a deeper understanding of the linkages among digital innovation, governance mechanisms, and sustainable outcomes. The findings are expected to shed further light on how regulators, policymakers, business managers, and financial institutions in Saudi Arabia can leverage technological advancements to achieve sustainability objectives aligned with Vision 2030. The remaining sections of this research paper review the past literature linking the variables of concern in section 2, present the methodology and result discussion in sections 3 and 4, while section 5 concludes the study.

2. Literature Review

Financial technology (Fintech) has transformed the traditional ways in which financial products and services are delivered (Oladapo et al., 2022; Akinwale and Kyari, 2022). Digital and financial technologies have been attributed to low carbon emission among the small and medium enterprises in Saudi Arabia (Akinwale, 2024a). It has created new business models and growth opportunities in the financial markets through emerging technologies such as big data, cloud computing, blockchain, and artificial intelligence. Besides evolving into one of the main disruptors of the financial markets, fintech also helps reduce carbon emissions. Many studies have explored the influence of fintech on carbon-emission reduction and sustainable development (Zhang, 2024; Akinwale, 2024b; Deng et al., 2019). The empirical findings of some of these studies are presented below.

Zhang et al. (2024) applied dynamic panel models, mediation effect models, and dynamic spatial Durbin models to examine the direct influence of fintech on carbon-emission efficiency and the transmission channels of green technological innovation and green finance, using city panel data from 2007 to 2019. The study finds that fintech significantly improves carbon-emission efficiency, with the long-term spillover effect smaller than the short-term spillover effect. Similarly, Anwar, Waheed, and Aziz (2024) conducted a study in Australia using data from 2000 to 2022. The study examines how FinTech will influence the nation's environmental future. They demonstrated that FinTech enables carbon reduction through green finance. In the same vein, Chena, Wanga, & Ye (2024) analyzed the impact of financial technology on carbon emissions reduction across Chinese provincial regions using annual data from 2011 to 2021. The study highlights the significant and positive effect of fintech on carbon emissions reductions in all the provinces. However, the impact is much stronger in high-carbon provinces than in low-carbon provinces.

Furthermore, Mangi (2025) examined the relationship between fintech adoption, environmental innovation, and CO₂ emissions in developed countries using 10 years panel data. The study noted that both fintech adoption and environmental innovation exhibit a significant negative correlation with CO₂ emissions, indicating the importance of integrating technological advancements and the digitalization of financial activities to accelerate carbon reduction. Extending this line of inquiry, Coffie et al. (2025) investigated the relationship between fintech and CO₂ reduction in sub-Saharan Africa using a panel data set from 2009 to 2020. The findings suggest a significantly negative relationship between financial technology and carbon emissions in these countries. However, domestic credit to the private sector showed no statistically significant relationship with carbon emissions during the same period. More recently, Belgacem and Alaskar (2026) evaluated the impact of FinTech, blockchain, green finance, and financial inclusion on sustainable development in Saudi Arabia and the Gulf Cooperation Council (GCC) using a mixed-methods approach. They highlighted that FinTech and blockchain can effectively enhance sustainable performance, especially when combined, and green finance and financial innovation mediate and strengthen the effect.

Complementing fintech's role in reducing carbon emissions, corporate governance has also emerged as a critical institutional factor influencing environmental performance. Oyewo (2023) examined the influence of corporate governance factors on carbon emissions among 336 multinational firms across 32 countries using 15 years of data. The study provides evidence on a negative relationship between board gender diversity, CEO duality, and ESG committees and carbon emissions outcomes, while board independence and ESG-based compensation are associated with higher emissions in carbon-intensive industries. In a similar vein, Muktadir-Al-Mukit and Bhaiyat (2023) further investigated the role of corporate governance mechanisms, gender diversity, board independence, and board size in influencing carbon emissions. The findings offer additional insights into how governance structures shape a firm's environmental performance. However, the results revealed that larger board sizes are associated with poorer environmental performance for the firm. Likewise, Yustina et al. (2024) explored

how governance-related determinants affect carbon-emission disclosure, emphasizing the influence of ownership structure and firm-specific characteristics; board diversity, audit reputation, firm size, audit quality, leverage, and return on assets on carbon-emission disclosure using panel data analysis on 120 firm-year observations of state-owned enterprises that have published sustainability reports between 2012 and 2021. The results highlight the evolving nature of governance practices in emission control. More recently, Lasmia et al. (2025) investigated the impact of corporate governance mechanisms on carbon-emission disclosure among listed companies on the Indonesia Stock Exchange from 2020 to 2023. The results reinforce prior findings while introducing multiple linear regression and the Newey-West method, thereby advancing the empirical understanding of this relationship.

Recent studies provide empirical evidence on both the direct and mediated effects of fintech on carbon-emission reduction (Anwar et al. 2024). Wang and Zhang (2025) similarly suggest that fintech may influence corporate governance, both directly and indirectly, through supply chain finance. In parallel, the literature highlights the importance of corporate governance mechanisms, particularly board size, board meetings, and “Big4” audit firms, in enhancing fintech disclosure and practice (Shehadeh et al., 2024), as well as improving the performance of fintech companies (Seraj et al., 2024). In a similar vein, specific governance attributes, such as board size, board independence, board meetings, board experience, and fintech, are found to have a significant relationship with corporate performance (Al-Matari et al., 2022), reinforcing the critical role of governance in shaping firm outcomes. While many papers have provided valuable insights, only a limited number of studies have investigated how both fintech adoption and corporate governance act as catalysts for reducing carbon emissions, or how fintech facilitates the relationship between governance structures and environmental outcomes, especially in Saudi Arabia. Therefore, this study examines how fintech mediates the relationship between corporate governance and carbon-emission reduction. This will provide an in-depth understanding of the indirect relationship.

3. Methodology

3.1 Sample size

This study utilized a quantitative research approach to determine the relationships among fintech adoption, corporate governance practices, and carbon-emission reduction in the Saudi banking industry. The data were collected using a structured questionnaire instrument. A five-point Likert scale was used to measure each study construct.

Before data collection, the Institutional Review Board (IRB) of Imam Abdulrahman bin Faisal University granted ethical approval to conduct this research (IRB Reference No: IRB-2024-14-330). This was to ensure that research ethical standards were adhered to and to maintain the confidentiality and voluntary nature of respondents' participation. The purpose of the study and how the data will be used were explicitly explained to the respondents. The respondents provided their written informed consent before participating in the study.

The study sample comprises bank professionals, retirees, the unemployed, and other stakeholders familiar with the workings of the Saudi banking system. A convenience random sampling method was used to gather data from the respondents. It is a common technique used in business, information technology, and sustainability research (Chen et al., 2024; Hashed et al., 2025; Memon et al., 2025). This technique makes data collection efficient at a reduced cost. Social media, email lists, contact persons, and WhatsApp groups were used to share the questionnaire. This is to allow for a wider geographic coverage. The data was collected between August 2024 and February 2025. The expected number of respondents was 500, however, 403 valid responses were received. This represents 80.6% response rate, exceeding the acceptable minimum threshold in social science research (Bryman, 2016).

3.2 Instrument development

Item measurement is fundamental to scientific research. The items used to measure the constructs of this paper were adapted from previous empirical studies. The items used to measure fintech adoption were derived from the fintech acceptance framework developed by Abedin et al. (2019) and the fintech integration model by Al-Mubarak and Al-Kahtani (2024). For corporate governance, the items were adapted from the study conducted by Alotaibi and Hussainey (2022). Items measuring carbon-emission reduction were drawn from studies by Kaur and Sahu (2023) on sustainability and ESG-related banking, and by Hasan et al. (2024) on environmental performance metrics.

Prior to the main data collection, a preliminary test was conducted. This was to ascertain that the questionnaire

developed is appropriate to measure the constructs of this study and that the questions are clear and reliable. To ensure the validity and reliability of the instrument. One senior environmental compliance officer from a national regulatory body, two fintech executives from leading Saudi banks, and two experts in corporate governance and sustainable finance in Saudi universities participated in the pilot study. Based on feedback from the reviewers, the wording of the questionnaire items was improved and ambiguous statements were removed. The revised questionnaire was subsequently used for data collection.

4. Results

4.1 Respondent demographics

Table 1 presents the demographic characteristics of the 403 respondents who participated in the survey. Male respondents are the predominant group, representing 69% of the sample. The age distribution shows that 81% of the respondents were between 26 and 45 years old. Most of the survey participants (93%) held a minimum of bachelor's degree. This suggests that mid-level professionals were overrepresented in the sample.

Many of the respondents (67%) had over 10 years of relationship with their respective banks, reinforcing their familiarity and practical exposure to banking policies and operations. Seventy-seven per cent of the sample are actively employed, indicating a greater likelihood of providing useful and reliable information for the study due to their direct involvement in banking activities.

Table 1: Demographic Profile of Respondents

	Frequency	Percent
Gender		
Male	280	69
Female	123	31
Age		
18-25	45	11
26-35	153	38
36-45	175	43
46-55	22	5
56 and above	8	2
Education level		
PhD	34	8
Masters	140	35
Bachelor	202	50
Diploma	27	7
Years with the bank		
Less than 5	47	12
5-10	87	22
11-15	104	26
16-20	86	21
20 and above	79	20
Employment status		
Employed	309	77
Unemployed	41	10
Retired	15	4
Others	38	9

4.2 Reliability and convergent validity assessment

To establish the validity and reliability of the constructs, fintech adoption (FT), corporate governance (CG), and carbon-emission reduction (CER), the study evaluated the measurement model by testing for convergent validity, internal consistency, and collinearity (Hair et al., 2022; Becker et al., 2023). All latent variables exhibited strong internal consistency, with rho_A values above 0.70. Notably, CER recorded 0.919, while CG and FT reported 0.888 and 0.825 respectively. These values validate that the items accurately measure their underlying latent constructs (Nunnally & Bernstein, 1994; Wong, 2016). Also, Cronbach's alpha (α) demonstrated acceptable internal reliability (CER α : 0.915; CG α : 0.887; FT α : 0.818).

The Average Variance Extracted (AVE) was calculated to determine convergent validity for each construct in the model. The AVE values which ranged from 0.577 to 0.702 exceeded the recommended threshold of 0.50. Hence, the measurement model established satisfactory convergent validity (Fornell & Larcker, 1981; Henseler et al., 2015; AlSharahni et al., 2026). These values indicate that the items explained over 50% of the variance in each construct.

To test for multicollinearity, Variance Inflation Factors (VIF) were calculated. All constructs demonstrated the absence of multicollinearity, with VIF values ranging from 1.240 to 1.447 (Kock & Lynn, 2012; Becker et al., 2015). The results provide strong justification for including these constructs in the structural model.

Table 2: Convergent Validity

Constructs	Items	Loadings	Alpha (α)	rho_A	AVE
Carbon Emission Reduction	CER1	0.857	0.915	0.919	0.702
	CER2	0.845			
	CER3	0.838			
	CER4	0.855			
	CER5	0.860			
	CER6	0.767			
Corporate Governance	CG1	0.758	0.887	0.888	0.596
	CG2	0.771			
	CG3	0.766			
	CG4	0.808			
	CG5	0.772			
	CG7	0.761			
FinTech	CG8	0.767			
	FT3	0.774	0.818	0.825	0.577
	FT4	0.718			
	FT5	0.733			
	FT6	0.796			
	FT7	0.774			

The heterotrait-Monotrait (HTMT) ratio was used to test discriminant validity of the latent variables. The HTMT ratio is a recommended statistical measure for structural equation modeling (Voorhees et al., 2016; Franke & Sarstedt, 2019). It has been described as more effective than other traditional approaches, including the Fornell-Larcker criterion, for determining discriminant validity in a conceptual framework (Kline, 2023; Hair et al., 2022). It determines whether the latent variables in a model are truly distinct.

The HTMT values for the three constructs in this study meet the proposed threshold (see Table 3), with each construct below 0.85 (Henseler et al., 2015). The results show that the constructs are empirically distinct, with strong divergence. Therefore, theoretical precision and mutual independence of the constructs in this study are well established.

Table 3: Discriminant Validity (HTMT)

Constructs	CER	CG	FT
Carbon Emission Reduction	0.838		
Corporate Governance	0.697	0.772	
FinTech	0.502	0.553	0.760

4.3 Hypothesis testing and structural model results

Table 4 presents the outcomes of the structural model analysis testing the hypothesized relationships among corporate governance (CG), fintech adoption (FT), and carbon-emission reduction (CER). Statistical evidence supports the study's propositions at the 1% significance level, validating the model's assumptions.

Corporate governance exhibits a significant effect on carbon emission reduction ($\beta = 0.606$, $t = 15.298$, $p = 0.000$), indicating the highest path coefficient. This positions it as the strongest predictor in the model. The finding empirically supports the hypothesis (H_1) that more rigorous corporate governance standards directly contribute to lower carbon footprints in the banking sector. Also, corporate governance was positively and significantly associated with fintech adoption ($\beta = 0.555$, $t = 12.633$, $p = 0.000$), thereby validating H_2 . The result implies that the digital revolution and cutting-edge technological innovation could be achieved when banks implement the highest governance standards.

The significant and positive impact of Fintech adoption on carbon emissions reduction confirms H_3 ($\beta = 0.167$, $t = 3.161$, $p = 0.002$). Although the path coefficient is modest, it demonstrates that the carbon-emissions challenge can be addressed through the use of financial technologies and data-driven emissions tracking. As expected, fintech adoption positively and significantly exerts an indirect effect ($\beta = 0.093$, $t = 3.110$, $p = 0.002$) on the corporate governance-carbon-emission reduction relationship, thus validating H_4 . The result signifies that the positive effect of governance frameworks on carbon-emission reduction is amplified for banks that also integrate financial technology.

Table 4: Result of hypothesis testing

Relationships	Std. Beta	Std. Error	t-values	p-values	Result
Corporate Governance -> Carbon Emission Reduction	0.606	0.040	15.298	0.000	Supported
Corporate Governance -> FinTech	0.555	0.044	12.633	0.000	Supported
FinTech -> Carbon Emission Reduction	0.167	0.053	3.161	0.002	Supported
Corporate Governance -> FinTech -> Carbon Emission Reduction	0.093	0.030	3.110	0.002	Supported

The structural equation model demonstrates moderate explanatory power and acceptable model fit. Corporate governance demonstrated moderate explanatory power. It explains about 31% of the variance in financial technology ($R^2 = 0.306$), while the relatively high R^2 of 0.51 indicates that fintech adoption and corporate governance collectively explain a substantial percentage of the variance ($R^2 = 0.506$) in emission reduction. These values suggest that the predictors substantially explain the model, and moderately explain the mediator (Hair et al., 2021).

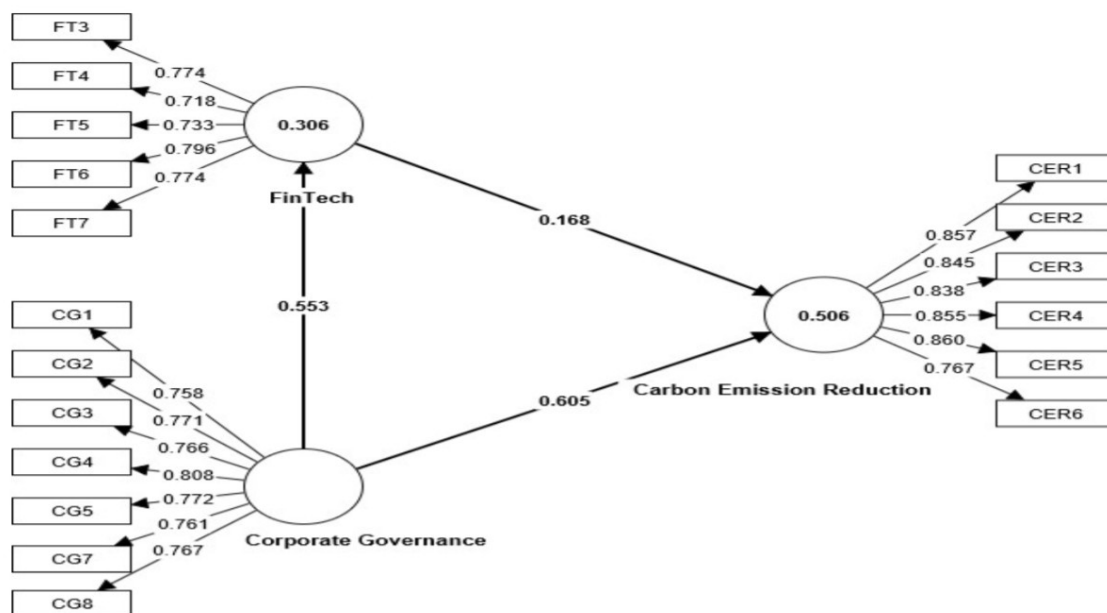


Figure 1: Structural Model

The standardized root mean square residual (SRMR) was used to estimate the model fit. The SRMR value was 0.076. This is below the suggested cut-off point of 0.08 (Hu and Bentler, 1999; Henseler et al., 2016), reflecting good model fit. This result corroborates the appropriateness of the structural model.

5. Discussion

This paper develops a unique model that examines the interrelationship among three constructs: fintech adoption, corporate governance, and carbon emission reduction. The study contributes to the growing discussion on a clean sustainable environment with a specific focus on the banking industry in Saudi Arabia. The empirical analyses support the proposed model for this study.

The result shows that corporate governance has the strongest direct impact on carbon emission reduction (Table 4). This corroborates previous research on the relationship between governance structures and reduction in emissions (Yustina et al., 2024; Lasmia et al., 2025). It implies that banking institutions that practice effective governance are more likely to be committed to reducing carbon emission. That is, when banks place high importance on emission reduction, they will provide the necessary support. Likewise, corporate governance shows a significant influence on fintech adoption. This suggests that sound governance system largely drives the adoption and promotion of innovative financial technologies in the banking industry. The findings align with the opinion that corporate governance mechanisms such as board size and board meetings improve fintech disclosure and performance (Shehadeh et al., 2024; Seraj et al., 2024). This implies that when banks embrace good governance, they will strategically enhance the way they evaluate innovative ideas, which ultimately facilitates the adoption of financial technologies.

Furthermore, the study establishes through the structural model, that fintech adoption is significantly linked to lower carbon emissions. The finding underscores the importance of financial technology in promoting waste-reducing initiatives, supporting green financing, improving operational efficiency, and enhancing sustainable environment. Moreover, fintech adoption has reduced the time and the distance people travel to physically engage in financial transaction which previously increases the rate at which carbon dioxide is emitted onto the earth surface from fossil-fueled vehicles and other carriers. With the level of fintech adoption in Saudi Arabia, this has significantly reduced carbon emission in the country. The finding is consistent with prior studies which argued that advanced technologies and financial innovation should encourage green investment to improve carbon emission efficiency (Zhang et al. 2024; Mangi, 2025; Belgacem and Alaskar, 2026; Sanni et al., 2026).

Beyond its direct effect, fintech also indirectly mediates the relationship between corporate governance and

emission reduction, serving as an important transmission channel for the variables. This implies that simply implementing financial technology is not enough to achieve environment targets; rather, governance credibility and the effectiveness with which these technologies are applied play a significant role. Therefore, fintech provides a strategic channel for connecting corporate governance with environmental sustainability. The finding aligns with prior research on the direct and mediated effects of fintech on carbon emission reduction (Anwar et al. 2024; Wang and Zhang, 2025).

6. Conclusion

This study highlights that integrating corporate governance with fintech adoption has a significant positive impact on carbon emissions reduction in the banking sector in Saudi Arabia. The study demonstrates that while corporate governance promotes emissions reduction, the impact will be more obvious when effective governance frameworks are developed and implemented. The significant direct effect of fintech adoption on carbon-emission reduction, and its combination with corporate governance, show that technology-driven policies are central to providing a clear direction for the banking industry toward a sustainable environment.

More importantly, fintech significantly mediates the relationship between corporate governance and carbon-emission reduction. This suggests that digital transformation provides a channel through which corporate governance can enhance lower carbon emissions. Therefore, the banking industry should maintain governance standards that promote effective fintech integration to achieve carbon reduction goals.

Future research could extend this study by exploring cross-country analyses in MENA and Asia using longitudinal data. This will provide further insights into the temporal changes and dynamic relationships among the variables. In addition, further studies can examine the moderating roles of green innovation, artificial intelligence, and environmental regulation.

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