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IMPACT OF CORPORATE GOVERNANCE ON FINTECH DISCLOSURE INDEX: EVIDENCE FROM PAKISTANI BANKS

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Abstract

Rapid digital transformation and technological progress have made Financial Technology (FinTech) an essential component of a contemporary banking industry. This study's primary objective is to investigate how Pakistani banks' FinTech Disclosure Index (FDI) is affected by corporate governance and firm-specific factors. The study looks into the impact of board meetings, foreign directors, firm size, return on assets (ROA), market-to-book ratio (MTBR), dividend per share (DPS), and capital ratio (CAP) on FinTech disclosure practices. Secondary data were acquired from the yearly reports of ten major Pakistani commercial banks for the period 2015-2024, resulting in 100 observations. The study used panel data analysis by using a Fixed Effect Model to analyse the relationships among the variables. The empirical findings reveal that Foreign Directors, Firm Size, and ROA have a positive and significant impact on the FinTech Disclosure Index, while DPS and CAP have a negative and significant relationship with the FinTech Disclosure Index. However, the impact of Board Meetings and MTBR on FinTech disclosure was found to be insignificant. According to the report, corporate governance and firm-specific features are useful in improving transparency and FinTech-related disclosure practices in the Pakistani banking sector. The findings offer valuable information to the policymakers and regulators and banking institutions on the significance of governance quality and digital reporting practices in fostering transparency and technological development.

Keywords: FinTech Disclosure Index (FDI), Corporate Governance, Commercial Banks, Financial Performance

1. Introduction

1.1 Background of the Study

Financial technology is the most imperative innovation in the sector of financial services which had changed the way traditional banking systems work with the help of advanced technologies like mobile banking, digital payments, artificial intelligence, and blockchain technology (Shehadeh et al., 2024).

The financial crisis of 2008 was a major turning point in the financial sector that exposed the shortcomings of traditional banking systems and highlighted the need for more efficient, transparent, and technology-driven financial solutions. In response, financial institutions increasingly turned to technological innovations to improve risk management, operational efficiency, and customer service. This change has created the foundation for the fast-paced expansion and evolution of FinTech in the upcoming years (Busta, 2010; Buchetti & Santoni, 2022).

The importance has accelerated further during the COVID-19 pandemic (2020-2021) as it significantly disrupted traditional bank operations and increased reliance on digital financial services. The lockdowns and social distancing measures compelled both consumers and financial institutions to move towards digital platforms, leading to significant growth of online banking, digital payments, and remote financial services. Thus, FinTech became a significant part of business continuity, operational resilience, and financial inclusion during this period (Ozili, 2020; Fu & Mishra, 2022).

With banks adopting FinTech solutions at an increasing rate, the disclosure of technological advances is becoming more and more important. FinTech disclosure is the reporting of innovations related to digital initiatives, technological innovations, and digital transformation strategies in banks' annual reports and corporate disclosures (Shehadeh et al., 2024). These disclosures enhance transparency, reduce information asymmetry, and enable stakeholders, investors, regulators, and customers to better assess a bank's technological capabilities and future growth prospects (Healy & Palepu, 2001).

Additionally, the importance of corporate governance in affecting disclosure practices in organizations is also discussed. Prior research indicates that robust corporate governance strongly encourages transparency and voluntary disclosure, especially in developing regions such as FinTech disclosure (Forker, 1992; Eng & Mak, 2003).

FinTech disclosure is becoming more important, but there is minimal empirical evidence of FinTech disclosure procedures in the banking industry of developing economies, especially in Pakistan. Driven by these insights, our research explores how governance frameworks and specific bank attributes shape the FinTech Disclosure Index across Pakistan's banking sector (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024).

1.2 Problem Statement

The fast progress of FinTech has transformed the banking industry by refining efficiency, transparency, and availability of financial services (Ferilli et al., 2024). FinTech disclosures have become more important because banks have increased their use of digital technologies and they can provide relevant information to stakeholders about technological advances and strategic initiatives. Despite this importance, the level and determinants of FinTech disclosure are still not sufficiently studied, particularly in developing countries (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024).

The role of corporate administration within disclosure practices has been emphasized by recent research. For example, Shehadeh et al. (2024) examined the relation between corporate governance and FinTech disclosure in Jordanian banks and discovered that governance tools such as board size, meetings, audit quality, and foreign directors significantly enhance the level of disclosure. However, as these findings are limited to the Jordanian context, they may not be relevant to other nations due to variations in institutional frameworks, regulatory environments, and levels of technological adoption.

The banking sector in Pakistan has undergone important digital transformation in recent years, aided by regulatory initiatives by the State Bank of Pakistan and increased adoption of digital financial services. However, the empirical evidence on FinTech services and its relationship with corporate governance in Pakistan is lacking. It remains unclear whether governance characteristics play a similar role in affecting FinTech-related services in Pakistan.

This research seeks to investigate how corporate governance affects FinTech disclosure in the commercial banks of Pakistan. By applying a well-established methodology to a different institutional situation, this research contributes to the body of literature already in existence and sheds light on the role that governance plays in encouraging accuracy and digital reporting in the banking industry.

1.3 Research Objectives

The study's main objective is to examine FinTech transparency and corporate governance in Pakistan's banking industry.

The following are the research objectives:

1. To investigate the effect of board meetings on FinTech disclosure in Pakistani banks.
2. To investigate the effect of foreign directors on FinTech disclosure.
3. To examine the relationship between FinTech disclosure and firm size.
4. To examine the effect of profitability (ROA) on FinTech disclosure.
5. To investigate the effect of market-to-book ratio on FinTech disclosure.
6. To examine the effect of dividend per share on FinTech disclosure.
7. To examine the relationship between the capital ratio and FinTech disclosure.

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1.4 Research Questions

In light of the above-mentioned literature, the following research questions have been developed:

1. Is there any influence of board meetings on FinTech disclosure of Pakistani banks?
2. What is the influence of foreign directors on FinTech disclosure practices?
3. Does the size of a bank really determine how much it discloses about FinTech?
4. What is the relation of profitability (ROA) with FinTech disclosure?
5. Is FinTech disclosure significantly impacted by the market-to-book ratio?
6. What is the effect of dividend per share on FinTech disclosure practices?
7. Does the capital ratio significantly impact FinTech disclosure in Pakistani banks?

1.5 Significance of the Study

This research extends the literature and enhances the existing knowledge base on FinTech disclosures to the specific economic landscape of Pakistan. It adds empirical evidence on the impact of corporate governance mechanisms on transparency and digital reporting in the banking industry.

The study's findings, which emphasize the importance of corporate governance in enhancing FinTech disclosure standards, will be helpful to bank management. The findings might also help regulators, such as the State Bank of Pakistan, create rules and regulations that promote more openness in FinTech-related reporting.

Additionally, these insights provide a strategic road map for future inquiries centred on corporate oversight and digital financial disclosures across emerging economies.

1.6 Gap Analysis

Although the prominence of FinTech in the global banking sector is increasing, the determinants of FinTech practices are still relatively under-explored in the current literature, particularly in developing economies (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024). Most prior research has mainly focused on traditional corporate disclosure, sustainability disclosure, financial performance, or the adoption of FinTech technologies, while relatively little focus has been given to FinTech disclosure practices in the banking industry (Healy & Palepu, 2001; Shehadeh et al., 2024).

So far, studies on FinTech have mainly examined the impacts of technological innovation on profitability, operational efficiency, customer satisfaction, financial inclusion, and bank performance (Ferilli et al., 2024; Bhatti, 2025). While a handful of recent papers explore how corporate governance connects with FinTech initiatives, solid empirical data on what actually drives FinTech disclosure remains scarce.

The majority of recent studies on FinTech disclosure and corporate governance focus on Middle Eastern countries like Jordan and Saudi Arabia. For instance, recent studies by Shehadeh et al. (2024) and Almubarak and Aljughaiman (2024) looked at banks in those regions. However, we still do not have a detailed study that looks directly at the FinTech Disclosure Index (FDI) in Pakistan's banking sector. Because Pakistan has different regulations, economic conditions, and banking environments, we cannot just apply the findings from Middle Eastern countries here.

In recent years, the banking sector in Pakistan has witnessed rapid digital transformation owing to increased uptake of digital banking, branchless banking, mobile banking, online payment systems, and other financial technology services (SBP, 2023). The banks in Pakistan are investing more in technological innovations and digital transformation to improve operational efficiency and customer services (SBP, 2023; Almubarak & Aljughaiman, 2024; Ferilli et al., 2024). However, empirical study on FinTech disclosure practices of Pakistani banks is limited (Shehadeh et al., 2024).

Moreover, little empirical study has been done on the effects of governance and firm-specific variables such as board meetings, foreign directors, firm size, profitability, market-to-book ratio, dividend per share, and capital ratio on the FinTech disclosure practices of the Pakistani banking industry. Most of the existing studies were conducted in different institutional settings and their results may not be able to explain the disclosure behaviour of Pakistani banks (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024; AlHares & AlBaker, 2023).

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Another limitation of previous literature is that few studies have used recent panel data analysis to examine FinTech disclosure practices over a longer period in emerging banking markets (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024). Considering the rapid development of financial technology and digital reporting practices in Pakistan (SBP, 2023), there is a need for fresh empirical evidence to better understand the determinants of FinTech disclosure by Pakistani banks.

2. Literature Review

2.1 Studies Related to Corporate Governance and Disclosure

Carter et al. (2003) investigated the connection between firm value and board diversity in US-listed corporations. The study underlined the importance of diverse board composition for enhancing governance effectiveness and disclosure quality. The outcomes revealed that the performance of firms with higher board diversity is better due to the wider knowledge, expertise, and perspectives of directors for organizational decision-making. The researchers claimed that diverse boards can improve monitoring efficiency and encourage transparent reporting practices. The study became very important in governance literature because it established a link between board diversity and organizational transparency.

Barako et al. (2006) investigated corporate disclosure procedures in Kenyan enterprises focusing on characteristics of board and ownership structure. Based on annual reports of listed companies, the research work found significant influence of board size, foreign ownership, and independent directors on voluntary disclosure practices. Larger boards, the researchers concluded, provide stronger monitoring and greater expertise that increase the quality of disclosures.

Allegrini and Greco (2013) investigated the impact of board composition and governance quality on voluntary disclosure behaviour in their study of Italian companies' sustainability disclosure policies and governance procedures. The results showed that firms with good governance structures disclose more sustainability information and have higher transparency levels. According to the study's results, the standard of governance has a favourable impact on the corporate reporting procedures and the communication among stakeholders.

Ntim et al. (2013) investigated governance and disclosure practices in South African firms, and their study emphasized the significance of governance quality in enhancing the organization's voluntary disclosure policies and openness. The outcomes of regression analysis indicated that board independence and governance effectiveness have a positive impact on disclosure quality. The study found that better governance systems increase investor trust and reduce asymmetric information in organizations.

2.2 Studies Related to Banking Sector Governance

In the Jordanian banking sector, Tomar and Bino (2012) investigated the association between corporate governance and bank performance. The study found that improved governance structures reduce agency conflicts, enhance transparency, and improve accountability of management in banks. The researchers also emphasized that sound governance mechanisms are helpful to improve disclosure practices and enhance investor confidence in the banking industry.

Adams and Mehran (2012) studied the corporate governance practices in banking firms and compared their practices with non-financial firms. The results suggest that bigger boards and more robust governance mechanisms positively affect bank performance and monitoring efficiency. Because of the nature of banking and the regulatory requirements, the authors found that the governance structures in banking organizations are different from those in non-financial enterprises.

Pathan and Faff (2013) explored the link between bank performance and board structure by looking at the governance mechanism in banks. The study highlighted the impact of board independence and governance quality on risk-taking behaviour and performance of banks. The study indicated that efficient corporate governance procedures promote accuracy, accountability, and operational performance in the banking sector.

Zagorchev and Gao (2015) examined the impact of corporate governance on bank performance in the U.S. banking industry. The study outcomes indicate that strong quality of governance has a favourable effect on market confidence and operational efficiency of banks. The study concluded that banking firms with a robust governance framework had sustainable financial performance.

In their analysis of the function of corporate governance in the banking industry, Buchetti and Santoni (2022) emphasized the significance of corporate governance in enhancing risk management, accountability, and transparency in organizations. The researchers also found that good governance helps banks to maintain financial stability and better regulatory compliance.

Corporate governance's effect on banks' market value across various nations was investigated by Komath et al. (2023). The research paper determined the effect of governance indicators namely, quality of management, shareholders' rights, and CSR strategies on market performance. The study's results showed that good governance practices affect the market value and investor confidence in banks significantly. Governance quality increases transparency and improves organizational credibility in the banking sector.

2.3 Studies Related to Corporate Governance and FinTech Disclosure

AlHares and AlBaker (2023) examined the impact of corporate governance on financial innovation in the Gulf Cooperation Council (GCC) banking industry by examining 30 commercial banks over a period of 2013-2021. The researchers found that governance variables such as directors' attendance rate, board independence, directors' educational level, and directors with financial or accounting backgrounds have a favorrable impact on banks' financial innovation operations. The findings also showed that banks with better governance structures provide more advanced digital financial services and improve organizational performance.

Almubarak and Aljughaiman (2024) studied the impact of corporate governance on FinTech innovation in Saudi banks, using data of 12 listed banks over the period 2014-2019, and they examined the effect of board size and board independence on FinTech services and quality of innovation. Findings from the panel data analysis showed that board qualities significantly determine the adoption of FinTech and innovation practices in banks. The researchers also added that good governance structures increase innovation capabilities, technological advancement, and organizational competitiveness in banking institutions.

One of the important studies in the field of corporate governance and FinTech disclosure in Jordanian banks was conducted by Shehadeh et al. (2024), as they covered 15 Islamic and conventional banks during 2015-2022. The research developed a FinTech Disclosure Index (FDI) based on available content. The results reveal that board size, board meetings, and audit quality have a positive substantial effect on the level of FinTech disclosure. The survey also found Islamic banks to provide more FinTech-related information due to their strong governance frameworks and ethical principles.

In their study, Ferilli et al. (2024) also investigated the association between corporate governance structure and organizational performance of FinTech enterprises with special emphasis on the effect of board features on profitability, financial stability, and transparency. The researchers also argued that firms with stronger governance structures have better transparency and disclosure practices as the quality of governance encourages reliable reporting and effective strategic decision-making. This study concluded that corporate governance is an essential factor in supporting technological innovation, improving disclosure quality, and ensuring sustainable growth and competitiveness in firms of FinTech.

Bhatti (2025) examined the effect of governance quality, FinTech adoption, and banking performance in Saudi Arabian banks by examining the moderating function of technology infrastructure and corporate governance. Their research employed longitudinal panel data analysis and found that FinTech adoption has a significant impact on bank performance, operational efficiency, and digital service quality. The research paper shows that robust corporate governance mechanisms improve monitoring efficiency, transparency, and accountability in banks, thereby magnifying the positive effect of FinTech adoption on banking performance.

2.4 Studies Related to Board Meetings

Board meetings reveal the extent of monitoring activities directors have undertaken. Researchers say regular board meetings improve governance efficiency and organizational transparency. Active boards are important to improve the decision-making processes and the quality of governance in organizations through regular meetings and effective oversight activities, argued Lipton and Lorsch (1992). The study showed that the effectiveness of the board depends on directors' active participation, communication, and oversight. Regular board meetings allow directors to discuss strategic issues, keep an eye on the performance of management, and ensure transparency of the organization's operations. The authors claimed that effective boards are enhancing corporate governance by reducing agency problems and increasing accountability. Board monitoring also enhances disclosure practices and helps achieve better organizational performance.

Elgattani and Hussainey (2020) explored the determinants of governance disclosure in Islamic banks and considered board meeting frequency as one of the corporate governance characteristics. The number of board meetings did not have a significant impact on governance disclosure. This implies that more board meetings do not always lead to more disclosure, while the effectiveness of board actions can be more dependent on the quality of monitoring, discussions, and decisions made during these meetings.

2.5 Studies Related to Foreign Directors

Researchers say that the international exposure of directors improves the quality of governance and disclosures. Ali et al. (2022) studied the impact of foreign directors on corporate social responsibility disclosure in the Pakistani banking sector. The study indicated that the presence of foreign directors on the board had a beneficial influence on the practices of disclosure of CSR. Foreign directors can contribute international expertise, professional experience, and diverse perspectives, which may enhance the quality and transparency of corporate disclosure.

Khan et al. (2013) investigated the effect of foreign ownership on disclosure practices in emerging economies. The study indicated that foreign ownership has a positive impact on the quality of transparency and corporate disclosure. The findings implied that foreign investors induce firms to adopt better governance and reporting practices in line with international standards. Moreover, foreign ownership was associated with greater transparency and corporate disclosure. The study concluded that foreign ownership matters for reducing information asymmetry and improving disclosure practices of firms in emerging markets.

2.6 Studies Related to Return on Assets

The Return on Assets (ROA) is a frequently used indicator of financial performance and profitability. It demonstrates how well a bank is managing its assets to earn income. Higher ROA generally reflects better financial performance and managerial efficiency. Profitability is also expected to influence corporate disclosure practices, while stronger firms are financially better able to afford and incentivize providing transparent information to stakeholders.

Aljifri and Moustafa (2007) found that more profitable firms tend to provide greater financial and non-financial disclosure, as stronger financial performance can enhance stakeholder confidence and reduce information asymmetry. Similarly, Szegedi et al. (2020) state that there is a positive and statistically significant association between ROA and CSR disclosure among Pakistani listed banks. In the context of FinTech disclosure, more profitable banks may have more resources to invest in digital technologies, cybersecurity, and reporting systems, thereby encouraging greater disclosure of FinTech-related information. Thus, a positive link is expected between ROA and FinTech disclosure.

2.7 Studies Related to Firm Size

Size of the firm is a key element of corporate disclosure and organizational performance. It usually refers to the size of the company's operations and is commonly expressed as a percentage of total assets, total sales, or market capitalization. Larger firms tend to have more financial resources, operational capacity, and technology infrastructure than smaller firms. Academic literature consistently shows a positive link between how big a firm is and the quality of its disclosures.

Back in 1987, Chow and Wong-Boren pointed out that larger companies usually share more details because they face heavier public scrutiny, political pressure, and constant demands from their stakeholders. Along the same lines, Meek, Roberts, and Grey (1995) noted that massive multinational organizations tend to maintain higher standards for voluntary reporting. They do this mainly to boost transparency, keep investors confident, and build strong organizational credibility. Generally, firm size acts as a positive driver for disclosure setups simply because larger companies have both the wealth of resources and the right incentives to invest in clear, open reporting frameworks.

In the same vein, Hossain et al. (1995) found that business size had a favourable influence on corporate disclosure practices because large organizations have the resources to develop complex reporting systems and governance structures. Akhtaruddin (2005) also claimed that large corporations are more inclined to make voluntary disclosures to boost their reputation and market credibility. In the context of FinTech disclosure, larger banks are expected to have more FinTech-related disclosures as they have better financial resources and technological capabilities. Large banks are more likely to invest in digital transformation initiatives and disclose technological advancements to enhance stakeholder confidence and sustain competitive advantage.

2.8 Studies Related to Dividend per Share

The literature suggests a relation between dividend policy, organizational transparency, and reporting quality. Miller and Rock (1985) contended that dividend announcements are important information signals to investors on the firm's performance and future expectations. Similarly, La Porta et al. (2000) argued that companies with better shareholder protection and better governance structures are more likely to have stable dividend policies and highly clear reporting habits.

Al-Najjar and Kilincarslan (2016) also note that dividend policy is related to corporate governance quality and disclosure practices as dividend-paying firms seek to increase shareholders' confidence and market reputation. In the context of FinTech disclosure, higher dividend payments may reduce the amount of internally retained funds available for investment in digital transformation, technological infrastructure, and innovation. Therefore, banks that distribute a larger proportion of their earnings as dividends may have relatively fewer resources available for FinTech-related investment and reporting activities. This suggests that DPS may have a negative relationship with FinTech disclosure.

2.9 Studies Related to Market-to-Book Ratio

Market-to-book ratio (MTBR) is a key financial metric used to evaluate the market valuation of the firm against its book value. It is a reflection of what investors expect in terms of future growth opportunities, profitability, and organizational performance. A higher MTBR shows that investors think the company has good growth potential and better prospects in the future.

Prior studies have supported the association between market valuation and quality of disclosure. Lang and Lundholm (1993) observed that firms with better market performance also had better disclosure as investors' uncertainty decreases with transparency. Likewise, firms with better growth opportunities are more inclined to reveal strategic information to increase their credibility in the market and to mitigate information asymmetry (Healy & Palepu, 2001). Regarding FinTech disclosure, banks with a high market-to-book ratio are expected to disclose more FinTech-related information as investors tend to expect technologically advanced companies to be more transparent on innovation and digital transformation activities.

2.10 Studies Related to Capital Ratio

The key financial indicator used to measure the financial strength and stability of banks is the Capital Ratio (CAP), as it is the ratio between a bank's capital and its assets and liabilities, measuring the ability of the institution to absorb financial losses and effectively manage financial risks. A higher capital ratio signifies financial stability, risk management competence, and regulatory compliance in the banking industry.

Berger and Bouwman (2013) further stated that capital strength improves the stability of an organization and enhances the confidence of stakeholders in financial institutions. The study found that banks with more capital are generally more capable of maintaining operational efficiency and managing financial risks effectively. In the context of FinTech, capital ratio may influence banks' investment in technological development and related disclosure practices. Banks with stronger capital positions may have greater financial capacity to invest in technological infrastructure, digital banking systems, cybersecurity, and innovation. However, capital-related requirements may also constrain managerial flexibility and the resources available for technological investment and reporting activities.

Almubarak and Aljughaiman (2024), who examined Saudi banks, found a negative but statistically insignificant relationship between capital ratio and FinTech services. This suggests that the relationship between capital position and FinTech-related activities may vary across banking and regulatory environments. Therefore, CAP may have an important role in determining the level of FinTech disclosure in banks.

3. Research Methodology

3.1 Research Design

The present study adopts a quantitative research approach to examine the impact of corporate governance and firm-specific characteristics on FinTech disclosure in Pakistani commercial banks. Secondary data from publicly accessible annual reports and financial statements is used in the study. These sources are considered reliable as they are audited and prepared according to relevant accounting and regulatory standards.

A panel data approach is employed, combining cross-sectional data from different banks with time-series observations over several years. This method enables the study to examine differences among banks as well as changes over time. Panel regression analysis is used to assess the relationship between FinTech disclosure and the selected explanatory variables, including board meetings, foreign directors, firm size, profitability, market-to-book ratio, dividend per share, and capital ratio.

3.2 Population and Sample Selection

The population of the study is major commercial banks operating in Pakistan. The banking sector has been chosen because banks are one of the leading institutions engaged in digital transformation, technological innovation, and FinTech adoption (SBP, 2023; Ferilli et al., 2024). Pakistani banks have lately focused a lot on digital banking services, branchless banking, online payment systems, and financial technology initiatives (SBP, 2023).

However, due to restrictions such as availability, consistency, and completeness of annual reports, a sample of 10 commercial banks has been chosen for the empirical analysis. Purposive sampling was used to select firms with available financial and corporate governance data (Saunders et al., 2019).

The study spans a period of 10 years, resulting in a balanced panel dataset. Hence, the total number of observations used in the study is:

$$10 \text{ Banks} \times 10 \text{ Years} = 100 \text{ Observations}$$

The sample includes major ten commercial banks operating in Pakistan which ensures proper representation of the banking sector. The annual reports, governance disclosures, and financial data required for the study variables were available for the banks selected.

The banks selected are:

- Habib Bank Limited
- United Bank Limited
- MCB Bank Limited
- Allied Bank Limited
- Meezan Bank Limited
- Bank Alfalah Limited
- Habib Metropolitan Bank Limited
- Faysal Bank Limited
- Bank Al Habib Limited
- National Bank of Pakistan

These banks have been chosen as they are actively participating in digital banking and FinTech-related activities and provide sufficient disclosure in their annual reports regarding governance and technological initiatives.

3.3 Data Collection

This study's data is secondary in nature and has been collected from multiple reliable sources including:

- Published annual reports of selected banks
- Official websites of banks
- Corporate governance reports
- Financial statements

The FinTech Disclosure Index was systematically used to analyse the banks' annual reports in the context of a manual content analysis. The FDI consisted of a list of predefined FinTech-related keywords, and the Ctrl + F search technique was used to identify and count the frequency of the keywords in each annual report (Shehadeh et al., 2024). For each bank, an annual FinTech disclosure score was assigned based on the presence of these terms. The data collected along with governance-related variables like foreign directors and board meetings were entered in an Excel sheet. The financial variables like firm size, ROA, MTBR, DPS, and CAP were extracted from the official financial statements and annual reports for comparative and trend analysis during the study period.

3.4 Measurement of Variables

The study contains one dependent variable and seven independent variables. The selection of these variables was based on the previous literature on corporate governance, banking performance, and FinTech disclosure practices (Shehadeh et al., 2024; Almubarak & Aljughaiman, 2024; Ferilli et al., 2024).

3.4.1 Dependent Variable

FinTech Disclosure Index (FDI). The FinTech Disclosure Index (FDI) is the study's dependent variable. The score gauges how much information banks disclose on FinTech in their yearly reports.

This study utilized content analysis techniques to build the FinTech Disclosure Index, focusing specifically on reported data about digital banking, mobile banking, internet banking, online payment systems, branchless banking, cybersecurity initiatives, financial technology innovation, and digital transformation activities (Shehadeh et al., 2024).

3.4.2 Independent Variables

Board Meetings (BM). Board meetings indicate how many meetings were held overall in a given year. The directors meet more often to discuss the affairs of the company and exercise stronger control and supervision over the management (Lipton & Lorsch, 1992).

Foreign Directors (FD). The number of foreign members on the board is known as the number of foreign directors. The quality of disclosure and transparency may be enhanced by the worldwide experience, varied viewpoints, technological know-how, and improved governance practices that foreign directors can offer (Carter et al., 2003; Masulis et al., 2012).

Firm Size (SIZE). The bank's firm size is determined by taking the natural logarithm of its total assets. Large-scale banks are generally expected to disclose more because of higher regulatory pressure and stakeholder expectations (Meek et al., 1995; Akhtaruddin, 2005).

Return on Assets (ROA). Banks' operational efficiency and profitability are measured by their return on assets (ROA). It gauges how successfully a bank generates profit from its assets (Berger & Bouwman, 2013; Barth et al., 2004).

Market-to-Book Ratio (MTBR). Market-to-book ratio is the market value of a bank divided by its book value of equity. It is a reflection of the investors' expectations of future growth and performance (Lang & Lundholm, 1993; Komath et al., 2023).

Dividend per Share (DPS). Dividend per share is the amount of dividend to be given to shareholders in respect of each ordinary share in issue during the financial year (La Porta et al., 2000).

Capital Ratio (CAP). Capital ratio is an indicator of the financial strength and capital adequacy of banks. It represents the proportion of total equity financed by total assets (Berger & Bouwman, 2013).

3.5 Conceptual Framework

The conceptual framework illustrates how corporate governance and firm-specific variables affect the FinTech Disclosure Index (FDI). The framework describes the impact of independent variables like Board Meetings, Foreign Directors, Firm Size, ROA, MTBR, DPS, and Capital Ratio on the FinTech disclosure practices of Pakistani banks.

Independent Variables

- Foreign Directors
- Board Meetings
- Firm Size

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- ROA
- MTBR
- DPS
- CAP

Dependent Variable

- FinTech Disclosure Index

3.6 Research Hypotheses

Based on the current literature and the theoretical framework of this investigation, the following hypotheses are proposed:

H1: Boards with a higher number of foreign directors show a favourable and significant effect on the FinTech Disclosure Index.

H2: More board meetings significantly influence the level of FinTech disclosure in the banking sector.

H3: Larger commercial banks (Firm Size) demonstrate a significantly positive tendency toward FinTech disclosure.

H4: Higher profitability, measured through Return on Assets (ROA), is significantly linked to increased levels of FinTech disclosure.

H5: The market-to-book ratio exerts a significant impact on the extent of FinTech disclosures.

H6: Dividend per Share significantly affects the FinTech Disclosure Index.

H7: The bank's capital ratio (CAP) exerts a significant effect on the level of FinTech disclosure.

3.7 Econometric Model

The following panel data regression model is constructed to investigate how corporate governance characteristics and financial metrics influence the FinTech Disclosure Index:

$$\mathbf{FDI_t = \beta_0 + \beta_1(BM)_t + \beta_2(FD)_t + \beta_3(SIZE)_t + \beta_4(ROA)_t + \beta_5(MTBR)_t + \beta_6(DPS)_t + \beta_7(CAP)_t + \varepsilon_t}$$

Where:

- FDI = FinTech Disclosure Index
- BM = Board Meetings
- FD = Foreign Directors
- SIZE = Firm Size
- ROA = Return on Assets
- MTBR = Market-to-Book Ratio
- DPS = Dividend per Share
- CAP = Capital Ratio
- β_0 = Constant Term
- β_1–β_7 = Regression Coefficients
- ε = Error Term

3.8 Statistical Techniques

The data analysis was performed using EViews software. Data analysis and hypothesis testing made use of a variety of statistical methods.

3.8.1 Descriptive Statistics. Descriptive statistics were used to summarize the data, looking at basic measures like the average (mean), the middle point (median), the spread (standard deviation), and the highest and lowest numbers.

3.8.2 Correlation Analysis. In order to verify the interrelationships between the variables and to ensure that the data was free of multicollinearity, correlation analysis was implemented.

3.8.3 Regression Analysis. Our data collection consists of both cross-sectional (different banks) and time-series (several years) data, hence we used panel data regression analysis. The panel data is more reliable and accurate than the traditional regression as it considers the changes over both the banks and time simultaneously. For our primary analysis, the Fixed Effect Model (FEM) is applied to study the impact of corporate governance and bank-specific characteristics on the FinTech Disclosure Index (FDI). We opted for the Fixed Effect Model as it controls for individual bank characteristics and is interested in changes of banks over time, which makes our results much more consistent.

4. Results and Findings

4.1 Descriptive Statistics

Table 4.1

Descriptive Statistics

Variables	Mean	Median	Standard Deviation	Minimum	Maximum
FDI	42.92	27.00	65.68	2.00	487.00
BM	6.56	6.00	2.77	4.00	15.00
FD	1.89	1.00	2.09	0.00	7.00
ROA	1.18	1.02	0.48	0.30	2.80
MTBR	1.18	1.02	0.61	0.17	2.67
FS	28.13	28.09	0.66	26.78	29.71
DPS	8.86	7.00	8.59	0.00	44.00
CAP	7.03	6.78	1.99	3.92	13.72

Table 4.1 gives the descriptive statistics for the core variables analysed in this study. Beginning with the dependent variable, the FinTech Disclosure Index (FDI) mean value is 42.92 and median value is 27.00, which indicates that banks disclose a moderate level of FinTech-related information on average. However, the index ranges significantly from a minimum of 2 to a maximum of 487. This shows that there is wide variation in disclosure practices among the sampled banks. The high variability in FinTech disclosure is further confirmed by a standard deviation of 65.68.

4.2 Correlation Analysis

Table 4.2

Correlation Analysis

	FDI	BM	FD	ROA	MTBR	FS	DPS	CAP
FDI	1.00000							
BM	-0.01430	1.00000						
	0.8877							
FD	0.25367	-0.38603	1.00000					
	0.0109	0.0001						
ROA	0.20593	-0.38241	0.20016	1.00000				
	0.0398	0.0001	0.0459					
MTBR	-0.19468	-0.45106	0.20792	0.28050	1.00000			
	0.0523	0.0000	0.0379	0.0047				
FS	0.41059	0.37755	-0.28865	0.04631	-0.34506	1.00000		
	0.0000	0.0001	0.0036	0.6473	0.0004			
DPS	0.18426	-0.21241	-0.12862	0.50927	0.18618	0.44644	1.00000	
	0.0665	0.0339	0.2022	0.0000	0.0636	0.000		
CAP	-0.25434	0.13436	-0.25783	0.35268	0.03107	-0.12364	0.21526	1.00000
	0.0107	0.1826	0.0096	0.0003	0.7589	0.2203	0.0315	

The correlation matrix and probability values for all variables are displayed in Table 4.2. These findings show that the independent variables share both positive and negative associations with the dependent variable. The dependent variable FinTech Disclosure Index (FDI) demonstrates a weak yet statistically significant positive correlation with Foreign Directors ($r = 0.253$, $p = 0.0109$), indicating that banks with a higher proportion of foreign directors tend to have higher levels of FinTech disclosure. Similarly, Firm Size exhibits a robust highly significant positive link with FDI ($r = 0.410$, $p = 0.0000$), meaning that larger firms have a higher FinTech Disclosure Index. Furthermore, Return on Assets also shares a weak but statistically

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significant positive association with FDI (r = 0.206, p = 0.0398). Dividend Per Share trends positively with the disclosure index (r = 0.184, p = 0.0665) but the probability value is greater than 0.05 indicating that the relationship is statistically insignificant. The Capital Adequacy Ratio CAP moves inversely to FDI, showing a weak but significant negative correlation (r = -0.254, p = 0.0107). This means that as CAP increases, FDI decreases. Board Meetings display a weak negative and highly insignificant relationship with FDI (r = -0.014, p = 0.8877). Market-to-Book ratio is also negatively weakly correlated with FDI (r = -0.194, p = 0.0523) but statistically insignificant at the 5% level of significance. The strongest positive relationship between independent variables is between ROA and Dividend Per Share (r = 0.509, p = 0.0000) which is a moderate positive significant association. On the other hand, Board Meetings and Market-to-Book ratio has the most negative relationship (r = -0.451, p = 0.0000) which reflects a moderate negative significant association. All correlation coefficients are less than 0.80, indicating that multicollinearity is not a concern here. Therefore, we can safely proceed with the panel regression analysis.

4.3 Regression Analysis

Table 4.3

Fixed Effect Model

Variables	**Coefficient**	**Prob**
Board Meetings	4.193	0.319
Foreign Directors	24.23	0.0466
Firm Size	52.678	0.0051
ROA	61.026	0.0006
MTBR	2.756	0.8339
DPS	-2.757	0.0185
CAP	-19.251	0.003
C	-1428.24	0.0101
R-squared	0.5694	
Adjusted R-squared	0.4864	
Durbin-Watson stat	1.539	
Prob (F-statistic)	0	

Based on the fixed-effects regression results in Table 4.3, the model evaluates the impact of firm-specific variables and corporate governance procedures on the FinTech Disclosure Index (FDI). The framework provides an R-squared value of 0.5694. Thus, the selected explanatory factors explain around 56.94% of the variation in FDI. Additionally, the adjusted R-squared is 0.4864. This indicates that the independent variables continue to have a strong 48.64% explanatory power over the variation of the dependent variable. The Prob (F-statistic) value of 0.00 validates the model's overall statistical significance, confirming the reliability of the combined independent variables to predict the outcome. Also, the Durbin-Watson statistic is recorded at 1.539. Since the result is in an acceptable range, it suggests that there are no significant autocorrelation issues with the dataset.

Among the explanatory variables, Foreign Directors have a positive and statistically significant impact on the FinTech Disclosure Index (FDI) ($\beta = 24.23$, $p = 0.0466$). Thus, it appears that a higher number of foreign directors contributes positively to the improvement of FinTech-related disclosure practices because of international expertise, different perspectives, and better governance quality. Firm Size is also positive and highly significant to the FinTech Disclosure Index (FDI) ($\beta = 52.678$, $p = 0.0051$). This indicates that bigger banks tend to disclose FinTech-related information more due to their greater financial resources, stronger technological capabilities, higher regulatory pressure, and better market credibility. Moreover, Higher ROA is significantly associated with greater levels of FinTech Disclosure Index (FDI) ($\beta = 61.026$, $p = 0.0006$). Thus, banks with better profitability tend to provide more information related to FinTech. One possible reason is that profitable banks have better financial resources to adopt digital technologies and improve their FinTech-related reporting. Board Meetings have a positive and statistically insignificant relationship with the

FinTech Disclosure Index (FDI) ($\beta = 4.193$, $p = 0.3190$), implying that the number of board meetings has no meaningful impact on the FinTech disclosure policies of the selected banks. Thus, an increase in the number of board meetings may not always lead to an improvement in transparency or FinTech-related disclosure activities in the absence of adequate governance quality and decision-making.

The MTBR has a positive effect on the FinTech Disclosure Index but is not statistically significant as given ($\beta = 2.756$, $p = 0.8339$), meaning that market valuation does not have a significant influence on the FinTech disclosure practices of the sampled banks, which indicates that the market value variation is not significantly related to the level of FinTech-related disclosure in this model. The Dividend Per Share (DPS) also has a negative but significant relationship with the FinTech Disclosure Index (FDI) having ($\beta = -2.757$, $p = 0.0185$), which means that banks that pay out higher dividends may have fewer financial resources to spend on tech development, digital transformation, and disclosure activities related to FinTech. Thus, higher dividend payments are linked with lower levels of FinTech disclosure practices of sampled banks. CAP has a significant negative effect on FDI ($\beta = -19.251$, $p = 0.0030$), indicating that an increase in CAP is associated with a decrease in FinTech disclosure practices. This may mean that banks with higher capital levels spend fewer resources on technological innovation and reporting activities related to FinTech.

4.4 Hypotheses Testing

The study's hypotheses are evaluated by the empirical method of the fixed-effects model. The study used a conventional significance level of 5% ($p < 0.05$) to decide whether to accept or reject each hypothesis. Thus, any variable that satisfies this condition is statistically significant in explaining the outcome.

H1: Boards with a higher number of foreign directors show a favourable and statistically significant effect on the FinTech Disclosure Index.

The hypothesis is supported, as Foreign Directors have a positive and statistically significant relationship with FinTech Disclosure ($\beta = 24.23$, $p = 0.0466$), which implies that firms having more foreign directors tend to provide more FinTech-related disclosures because of their diverse expertise, international exposure, and better governance practices. This result suggests that foreign directors improve transparency and motivate firms to disclose more information concerning financial activities.

Decision: H1 is Accepted

H2: More board meetings significantly influence the level of FinTech disclosure in the banking sector.

The data suggest that an increase in the number of board meetings is associated with an increase in FinTech disclosures although the association is not significant ($\beta = 4.193$, $p = 0.3190$). In simple terms, the frequency of a bank's board meetings has no meaningful impact on the volume of FinTech information they disclose. The insignificant relationship might suggest that increasing the number of meetings alone is not enough to improve disclosure practices without good governance quality.

Decision: H2 is Rejected

H3: Larger commercial banks (Firm Size) demonstrate a significantly positive tendency toward FinTech disclosure.

The results are strong support of this hypothesis because larger commercial banks (Firm Size) exert a positive and significant impact on the FinTech Disclosure Index ($\beta = 52.678$, $p = 0.0051$). This indicates that bigger banks are more likely to reveal FinTech-related information because of stronger regulatory pressure, higher stakeholder expectations, and stronger technological resources.

Decision: H3 is Accepted

H4: Higher profitability, measured through Return on Assets (ROA), is significantly linked to increased levels of FinTech disclosure.

The empirical results show that ROA has a positive and highly significant correlation with the FinTech Disclosure Index ($\beta = 61.026$, $p = 0.0006$). This implies that banks with high profitability disclose more FinTech-related information as profitable firms are financially stronger and more capable of investing in digital technologies and reporting practices.

Decision: H4 is Accepted

H5: The market-to-book ratio exerts a significant impact on the extent of FinTech disclosures.

The results show a positive but statistically insignificant effect of the Market-to-Book Ratio (MTBR) on FinTech Disclosure (β = 2.756, p = 0.8339). This shows that the sampled banks' FinTech disclosure practices are not significantly influenced by market valuation. Contrary to what past theories suggest, the actual data in this study doesn't show that higher-value firms share more information with their investors. In other words, a company's market worth doesn't seem to drive its disclosure habits.

Decision: H5 is Rejected

H6: Dividend Per Share significantly affects the FinTech Disclosure Index.

The regression study shows that the link between Dividend Per Share (DPS) and the FinTech Disclosure Index is negative and significant (β = -2.757, p = 0.0185). This means that banks paying greater dividends might dedicate fewer resources to technological development and disclosure activities, resulting in lower levels of FinTech disclosure. The result indicates that companies more focused on dividend distribution might pay less emphasis to FinTech reporting and transparency.

Decision: H6 is Accepted

H7: The bank's capital ratio (CAP) exerts a significant effect on the level of FinTech disclosure.

Capital Ratio (CAP) has a negative and statistically significant relationship with FinTech Disclosure (β = -19.251, p = 0.0030). This indicates that banks with higher capital ratios tend to disclose less FinTech information.

Decision: H7 is Accepted

Hypothesis Testing Table

Hypothesis	Variables	Result	Decision
H1	Foreign Directors	Positive & Significant	Accepted
H2	Board Meetings	Positive but Insignificant	Rejected
H3	Firm Size	Positive & Significant	Accepted
H4	ROA	Positive & Significant	Accepted
H5	MTBR	Positive but Insignificant	Rejected
H6	DPS	Negative & Significant	Accepted
H7	CAP	Negative & Significant	Accepted

5. Conclusion and Recommendations

5.1 Conclusion

The purpose of the research is to examine the influence of corporate governance and firm-specific characteristics on the FinTech Disclosure Index (FDI) of the banking sector of Pakistan. The study specifically captures the effect of variables such as Foreign Directors, Meetings frequency, Firm Size, Profitability (ROA), Market valuation (MTBR), Dividend Per Share (DPS), and CAP on the FinTech disclosure practices of Pakistani banks. For this purpose, the fixed-effects model framework is designed for robust panel data estimation. This study provides insight into what genuinely motivates FinTech disclosure practices in Pakistani banks. The entire regression model is very dependable, which means that the independent factors are working together to directly shape the FinTech Disclosure Index. Additionally, the R-squared value reveals that these selected parameters explain a significant part of the variations and discrepancies observed in the way banks communicate their FinTech data. The empirical data indicate that Foreign Directors positively and significantly affect the FinTech Disclosure Index.

The findings show that banks are more likely to disclose FinTech information when they have more foreign directors. Foreign directors have international expertise, awareness of technology, and improved governance procedures that enhance transparency and disclosure quality. Hence, board internationalization is important to enhance digital reporting and disclosure procedures in the banking industry. Similarly, Firm Size was discovered to be highly significantly and positively correlated with the FinTech Disclosure Index. Larger banks, with their greater financial resources, higher visibility to the public, and greater regulatory pressure, are better positioned to adopt more sophisticated technologies and to sustain higher standards of disclosure. Larger companies are likewise more apt to be transparent as they want to build investor confidence and corporate reputation. Thus, firm size is an important variable in FinTech disclosure practices of Pakistani banks.

The results also suggest that ROA has a positive and extremely significant impact on the FinTech Disclosure Index. This finding points to profitable banks disclosing more FinTech-related information due to strong financial companies' greater capacity to invest in digital technologies, innovation, and reporting systems. Profitable companies generally have more transparent operations and reporting practices to preserve the trust of stakeholders and credibility in the market. The Market-to-Book Ratio (MTBR) also showed a positive and insignificant association with the FinTech Disclosure Index. This implies that market valuation has no substantial influence on the level of FinTech disclosures by Pakistani banks. While higher market value firms are generally expected to have better disclosure standards, the empirical evidence of this study does not support a meaningful relationship between MTBR and FinTech disclosure practices. The FinTech Disclosure Index was negatively and statistically significantly related to Dividend Per Share (DPS). The results imply that banks with higher dividend payouts could be allocating fewer resources to technology development and disclosure activities. Firms with a higher focus on dividend distribution might pay less attention to investments in FinTech-related reporting and transparency practices. Similarly, CAP had a highly significant and negative impact on the FinTech Disclosure Index. The negative association indicates that higher levels of CAP may increase financial pressure and reduce managerial flexibility that may ultimately inhibit investment in technological disclosure and reporting systems. Thus, banks with higher capital-related burdens may exhibit lower FinTech disclosure practices.

5.2 Recommendations

The study's findings provide a basis for several recommendations to banks, policymakers, regulators, and other stakeholders to improve the disclosure practices of FinTech in the banking industry of Pakistan.

Firstly, banks should promote board diversity by recruiting more foreign directors with international experience and technological know-how. The results suggest that foreign directors have a positive effect on FinTech disclosure practices by improving governance quality and increasing transparency. Therefore, banks are recommended to improve board internationalization to meet higher disclosure standards and digital reporting practices.

Secondly, banks should invest more in technology development and digital reporting systems. The positive association between profitability and FinTech disclosure implies that banks in a strong financial position are better positioned to adopt advanced technologies and thus are likely to uphold higher disclosure standards. Therefore, banks need to make sure they invest enough resources in FinTech innovation, cybersecurity systems, digital platforms, and transparent reporting mechanisms.

Thirdly, large banks should keep up their good disclosure procedures, and smaller banks should improve their transparency standards. Regulators and policymakers should encourage smaller banks to use common FinTech disclosure frameworks in an effort to ensure consistency and transparency throughout the banking system.

Besides, the management should consider not only the frequency of the board meetings but also the efficiency and quality of governance decisions. The results show that just increasing the number of meetings does not significantly improve FinTech disclosure practices. Therefore, boards should focus on strategic decision-making, technological awareness, and effective monitoring mechanisms to enhance disclosure quality.

The study also advises that banks need to balance dividend distribution with technology investment, as an overemphasis on dividends may limit the funds available for digital transformation and FinTech-related efforts. Banks should also conduct training and awareness programs for directors and management on the importance of FinTech disclosure, digital transformation, and technological governance practices, as this would help improve understanding of emerging technology risks and opportunities in the financial sector.

5.3 Policy Implications

The findings of this investigation have substantial implications for investors, banks, and governments. It is imperative that policymakers enhance the transparency of technology and corporate governance in the

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banking sector. To boost investor trust and the quality of reporting, regulatory authorities may implement uniform disclosure requirements for FinTech activities.

The study offers useful insights for investors regarding the governance and financial characteristics that affect FinTech disclosure practices. Investors should consider governance quality, profitability, and disclosure transparency while making investment decisions in the banking sector.

The findings overall support the necessity of a more robust regulatory framework for FinTech disclosure in Pakistan. The State Bank of Pakistan should consider adopting standard FinTech disclosure rules that outline the minimal information banks should report about digital financial services, technological investments, cybersecurity precautions, innovation plans, and digital risk management. These regulations would lead to openness, eliminate information asymmetry, build investor confidence, and help in sustainable digital transformation of Pakistan's banking system.

5.4 Limitations of the Study

The study has interesting findings, although it also has certain drawbacks. First, the investigation is restricted to a sample of ten commercial banks functioning in Pakistan. Although these banks include a large share of the banking sector, the results may not be entirely generalizable to all financial institutions such as Islamic banks, microfinance banks, and non-bank financial firms.

Second, the study is related to the measurement of the FinTech Disclosure Index (FDI). The index was developed through content analysis by searching predefined FinTech-related keywords in the annual reports of the sampled banks. Although this approach provides a systematic and consistent method for measuring disclosure, it may not capture all FinTech-related information if banks use different terminology or describe similar initiatives without using the selected keywords. Consequently, some relevant disclosures may have been overlooked, which could affect the comprehensiveness of the FinTech Disclosure Index.

Third, the study used a limited set of explanatory factors related to corporate governance and firm-specific features. Other key aspects like ownership structure, audit committee characteristics, technology infrastructure, and macroeconomic variables are not taken into account in the investigation. Lastly, the study was constrained in time period and sample size due to the limitations of data availability. A bigger sample and longer time horizon may lead to more comprehensive results.

Moreover, the research was primarily based on secondary data from annual reports, which might have the limitation of the quality of disclosure and reporting consistency.

5.5 Future Research Directions

The results of the present study offer a number of options for further investigation. Firstly, future research could increase the sample size by including Islamic banks, microfinance banks, and non-banking financial institutions to increase the generalizability of the results and to offer a comprehensive perspective on FinTech disclosure practices in the financial sector.

Secondly, more corporate governance variables may be included in future research, such as board independence, board diversity, audit committee characteristics, ownership structure, CEO duality, institutional ownership, technology committees, directors' IT knowledge, and ESG governance practices. The inclusion of these variables may help to offer a more comprehensive understanding of the governance aspects influencing FinTech disclosure.

Thirdly, future researchers may adopt alternative approaches for measuring the FinTech Disclosure Index. Instead of relying solely on predefined FinTech-related keywords in annual reports, future studies may include information disclosed through sustainability reports, integrated reports, corporate websites, investor presentations, digital platforms, and other corporate communications. Advanced text-mining techniques, natural language processing (NLP), or artificial intelligence-based content analysis may also improve the accuracy and comprehensiveness of FinTech disclosure measurement.

Lastly, future studies may employ advanced econometric techniques, such as dynamic panel models, generalized method of moments (GMM), or structural equation modelling (SEM), to address potential endogeneity issues and provide more robust evidence concerning the causal connection between corporate governance and FinTech disclosure. Qualitative or mixed-method approaches, including interviews with board members, regulators, and banking professionals, may also provide deeper insights into the governance practices that promote greater transparency in FinTech disclosures.

Author Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

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Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. Due to privacy and confidentiality considerations, raw financial data may not be publicly distributed but can be accessed through the corresponding author with appropriate data use agreements and institutional approvals. The authors are committed to transparency and will provide detailed methodological information, model specifications, and analysis protocols upon request.

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