

The impact of corporate governance on bank risk-taking: evidence from an emerging market

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Abstract

Purpose – This paper examines the impact of gender diversity and the number of highly educated managers on the risk-taking of Islamic banks. Particularly, this paper aims to investigate how the existence of females and PhD holders influences bank risk.

Design/methodology/approach – The authors use a range of econometric estimators to ensure the robustness and reliability of the analysis. Initially, pooled ordinary least squares is used to estimate a single equation across multiple cross-sectional units. To address potential endogeneity concerns arising from unobserved heterogeneity and simultaneity bias, this study further uses the system-generalized method of moments, which is particularly suitable for dynamic panel data and the control of endogenous regressors. In addition, a random effects model is used to account for within-entity variation over time and to provide further validation of the robustness of the findings. The dependent variables in the analysis include capital adequacy, the ratio of common equity to total assets and several distinct indicators of credit risk.

Findings – The empirical results of this study reveal that the presence of females in departmental management is significantly associated with a reduction in bank risk. In addition, findings on the influence of highly educated individuals show a positive association between the shares of PhD holders in top management positions at both the departmental manager's level and the board of directors, on the one hand, and the capital-to-assets ratio and equity-to-assets ratio, on the other hand. Additionally, the results demonstrate that highly educated senior managers and the board of directors have a significantly negative influence on credit risk when it is assessed by loan loss provision to total loans and loan loss provision to total assets.

Research limitations/implications – It is recommended that Islamic banks appoint highly educated senior managers at both the departmental and board of directors levels, as this enhances managers' decision-making capabilities and risk management strategies. Moreover, banks are encouraged to increase gender diversity in managerial positions to enhance their resilience against unforeseen losses.

Originality/value – The influence of diversity on banks' risk-taking behavior remains an important yet insufficiently explored area, especially in the realm of Islamic finance. Although existing literature has addressed several attributes of board composition, there is a noticeable lack of focus on how diversity functions within Islamic banking institutions (Jabari and Muhamad, 2022). This research aims to address that shortfall by examining the link between diversity at the leadership level and risk-taking tendencies in Islamic banks. The study concentrates on two underexamined facets of diversity – gender representation and educational heterogeneity – within both the Board of Directors and senior executive teams. By analyzing these dimensions within the distinctive operational and ethical parameters of Islamic finance, this study endeavors to generate new insights into how leadership diversity may influence strategic risk decisions. Ultimately, the findings are



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expected to enhance our understanding of governance practices in Islamic financial institutions and contribute to broader debates surrounding inclusive leadership in the Islamic banking sector.

Keywords Bank risk, Gender diversity, Education, Islamic banks

Paper type Research paper

1. Introduction

The global financial crisis underscored the profound implications that banks' risk-taking behaviors can have on both institutional stability and broader economic health. This event has drawn renewed attention to the need for understanding the drivers behind banks' risk profiles (Ashik-Uz-Zaman *et al.*, 2025; Skala and Weill, 2015). Risk-taking is inherent to banking operations, yet when banks assume risks that exceed optimal thresholds, the consequences can destabilize the financial system. One potential safeguard against excessive risk is a competent board of directors, which bears the ultimate responsibility for cultivating and maintaining a sound risk culture within the organization. Within this framework, an extensive body of research has sought to identify the mechanisms that lead bank executives to pursue risky strategies. One stream of literature investigates bank-specific and macro-level variables that shape managerial risk preferences (Nguyen, 2021; Leo *et al.*, 2019; Berger *et al.*, 2009; Boyd and De Nicolo, 2005; Berger and DeYoung, 1997). A second stream concentrates on the influence of executive incentives and compensation policies on managerial risk behavior (Luo *et al.*, 2023; Fahlenbrach and Stulz, 2011). More recent inquiries extend this line of inquiry by exploring how behavioral aspects of corporate governance – particularly the personal characteristics of decision-makers – affect financial outcomes. This includes traits such as age, education and gender, which have been linked to variations in banks' performance metrics (Liu *et al.*, 2023).

Several studies have highlighted the significant role of executives' individual attributes in shaping bank outcomes (e.g. Elgadi and Ghardallou, 2022; Birindelli *et al.*, 2019; Barber and Odean, 2001; Campbell and Vera, 2007; Pathan *et al.*, 2012). In particular, gender diversity has received growing scholarly attention (Elgadi and Ghardallou, 2022; Birindelli *et al.*, 2019). However, other dimensions of diversity remain underexplored. Jabari and Muhamad (2022) note that gender has dominated the discourse, often to the exclusion of other relevant forms of heterogeneity. In this regard, Khatib *et al.* (2021) call for broader investigations into board diversity that move beyond gender alone. Responding to this gap, the present study examines the effects of both gender and educational diversity among board members and senior executives on banks' risk-taking behaviors. By extending the focus to educational background, this research offers a more comprehensive perspective on how leadership composition may influence risk governance within financial institutions.

The relationship between diversity and risk-taking behavior in the banking sector continues to attract scholarly attention. Although prior research has considered various characteristics of boards of directors, there remains a notable deficiency in studies focusing specifically on diversity within Islamic financial institutions (Shaheen *et al.*, 2024; Jabari and Muhamad, 2022). This study aims to address this gap by exploring how diversity manifests and influences risk behavior within the unique institutional framework of Islamic banking. The analysis centers on two key dimensions of leadership diversity, gender and educational qualifications, across both the board of directors and senior management levels. Despite their relevance, these aspects have been largely overlooked in the context of Islamic banks. By focusing on the Sudanese Islamic banking sector, this paper investigates whether the presence of female executives and highly educated individuals, particularly those holding doctoral degrees, influences institutional risk levels. More specifically, the study examines whether gender representation and advanced

academic qualifications correlate positively, negatively, or neutrally with banks' risk profiles. Through this approach, the research aims to generate empirical evidence that contributes to a deeper understanding of the governance mechanisms influencing risk performance in Islamic banking. The findings are expected to offer novel insights into how two of the most widely discussed elements in the corporate governance literature, gender diversity and educational attainment, impact the risk behavior of Sudanese Islamic banks.

This study contributes to the existing body of literature by examining the relationship between diversity and risk-taking behavior through a novel lens. First, it analyzes how the composition of boards and managerial teams – including both male and female members – affects the propensity of Islamic banks to engage in risk. Gender diversity remains a highly debated issue in the field of corporate governance, offering potential advantages as well as certain challenges (Martínez and Rambaud, 2019). Empirical studies indicate that female participation in boardrooms can influence a firm's risk appetite, a dynamic that holds particular relevance for shareholders, who ultimately bear the financial consequences of risk-laden strategic decisions. Second, the research investigates the influence of educational diversity among board and management members on banks' risk behavior. Educational background serves as a proxy for the cognitive abilities, technical knowledge and analytical frameworks that shape an individual's approach to complex decision-making. By considering this dimension, the study highlights how varied educational profiles within leadership can contribute to differences in institutional risk preferences. Third, the study addresses a critical limitation in the current literature: the predominance of research focused on publicly listed banks. These institutions, while more accessible in terms of data, constitute only a small segment of the banking sector in many economies. To address this gap, the present research examines the risk-taking behavior of Islamic banks operating in Sudan, thereby expanding the empirical scope and offering insights into a less-studied segment of the financial industry. Sudan offers a uniquely relevant case for exploring governance and risk-taking in fully Shariah-compliant banking environments. Unlike many dual-banking jurisdictions, Sudan operates under a fully Islamic financial system (IMF, 2020; Aljughaiman *et al.*, 2023), where all banks must comply with Islamic principles. This setting provides a rare opportunity to examine governance dynamics within an environment that is not influenced or diluted by conventional banking practices. As such, Sudan serves as an illustrative and theoretically significant case for understanding how Islamic governance structures function in their purest institutional form. Moreover, insights drawn from Sudanese Islamic banks contribute to the broader literature by highlighting governance mechanisms and risk behaviors in jurisdictions where Shariah compliance is deeply embedded in both regulatory and organizational practice. These findings can inform theory-building and offer comparative insights for countries with dual systems or emerging Islamic finance sectors.

The structure of the paper is organized as follows. The following section provides a comprehensive overview of the theoretical underpinnings and synthesizes prior empirical findings concerning how gender diversity and educational qualifications influence risk-taking behavior. The methodology applied in this study is then elaborated in Section 3. Section 4 presents the analysis of the results, while Section 5 offers various robustness checks to ensure the reliability of the findings. The final section, Section 6, summarizes the study's key insights and discusses its broader implications.

2. Literature review

2.1 Theoretical background

Various theoretical perspectives, including agency theory, resource dependence theory and upper echelons theory, have been used to examine the composition and function of corporate boards. Among these, agency theory is particularly prominent in emphasizing the board's

monitoring responsibilities (Aslam and Haron, 2021; Nguyen, 2021). From this standpoint, the board serves to align managerial actions with the interests of shareholders by mitigating conflicts that may arise when executives prioritize personal goals over the firm's sustained value creation (Fama, 1980).

Agency theory also serves as a valuable framework for exploring how gender diversity influences board dynamics, particularly regarding oversight, risk evaluation and ethical considerations. Emerging research suggests that women tend to exhibit heightened ethical awareness and are generally more sensitive to moral issues compared to their male counterparts (Jain and Zaman, 2020). This heightened ethical orientation often translates into more prudent and deliberate decision-making, thereby reducing the likelihood of actions that may negatively affect shareholder value. Furthermore, female leaders are frequently associated with collaborative and empathetic leadership styles, in contrast to the more authoritative and control-focused approaches typically attributed to male leaders (Carli and Eagly, 2007). Such distinctions in leadership behavior position female directors as stabilizing agents within boardrooms, particularly when decisions involve substantial risk. Their generally cautious stance on risk-taking can serve to temper aggressive financial strategies, fostering more balanced and sustainable corporate decisions (Belaounia *et al.*, 2020).

In addition to their contributions to ethical standards and risk management, women serving on corporate boards have been found to enhance governance effectiveness by engaging more actively in oversight responsibilities. Their involvement strengthens internal control systems, curtails managerial opportunism and contributes to reducing agency-related inefficiencies (Chen *et al.*, 2017). These positive effects are particularly notable in firms with relatively weak governance frameworks, where female directors play a crucial role in elevating overall corporate performance. Not only are women capable of exercising diligent oversight, but they also tend to approach these responsibilities with a strong sense of accountability and commitment (Nekhili *et al.*, 2021). Their influence extends to pivotal areas of governance, including the structuring of executive compensation, the decision to replace chief executive officers and potentially the formulation of dividend distribution policies (Cardillo *et al.*, 2020). Post and Byron (2015) argue that the distinct monitoring approaches and skill sets that women bring to the boardroom underscore gender-based differences in governance behavior. In banks, female board members are associated with policies that reduce agency costs, such as advocating for higher dividend payouts. These distributions act as a governance tool by limiting the availability of excess free cash flow, thereby restraining managers from engaging in unproductive or excessively risky investments, and better aligning executive actions with shareholder interests.

The upper echelons theory suggests that the presence of female directors can enhance the quality of board-level discussions by broadening strategic considerations to encompass a more diverse range of stakeholder perspectives (Karim, 2021). Hambrick and Mason (1984) emphasized that diversity in board members' educational and professional backgrounds equips them to better address market complexities and to interpret strategic information more effectively. This theoretical framework has been extensively applied to examine how directors' personal and professional attributes, such as their demographics, education, career trajectories and social background, affect the strategic orientation of firms (Abatecola and Cristofaro, 2018). A central tenet of this approach is that individual cognitive inputs from board members play a critical role in shaping the nature and effectiveness of corporate decision-making processes (Hambrick and Mason, 1984; John *et al.*, 2020). Within this context, the qualifications and expertise of female board members stand out. Those with advanced academic credentials tend to demonstrate greater openness to diverse viewpoints,

higher levels of cognitive flexibility and superior analytical capabilities, all of which contribute to a more nuanced and thorough evaluation of strategic choices (John *et al.*, 2020).

Resource dependence theory posits that firms in an open system, require constant interaction with the external environment to obtain the resources and knowledge necessary to achieve their objectives (Terjesen *et al.*, 2009). Within this framework, the board of directors plays a critical role by helping firms secure strategic resources, establish institutional legitimacy and enhance their public image through diverse insights (Hsu *et al.*, 2019). The diversity present within a board is often indicative of the range and depth of resources accessible to the organization. In particular, female board members contribute by expanding the firm's financial and commercial networks, while also offering distinctive viewpoints that enrich strategic deliberations (Fan *et al.*, 2019). Furthermore, their relational capital and communication approach can lower transaction costs linked to environmental volatility, as they help ensure prompt and effective access to crucial external information (Hillman and Dalziel, 2003).

Despite the increasing recognition of gender representation as an indicator of governance quality, limited attention has been given to its role within dual banking systems, particularly regarding the comparative dynamics of Islamic and conventional banks. Islamic financial institutions are structurally and functionally distinct from their conventional counterparts, notably in their use of equity-based arrangements such as profit-and-loss sharing (PLS) contracts with depositors (Mollah *et al.*, 2017). Moreover, whereas conventional banks typically operate under a single-tier governance system managed by a board of directors, Islamic banks follow a two-tier model. This includes both a conventional board and a Shariah Supervisory Board (SSB), the latter of which plays a vital role in ensuring compliance with Islamic financial principles (Mollah and Zaman, 2015). The strategic decisions made by the board of directors are subject to the oversight of the SSB, which functions as a regulatory body to ensure that financial products align with Shariah mandates. This distinctive governance configuration raises important questions about how gender diversity may interact with the dual oversight mechanisms present in Islamic banks. The inclusion of both corporate and Shariah boards introduces a layered governance model that may alter the influence of board-level attributes on institutional risk-taking. Islamic banks operate under religious principles that prohibit interest, speculative behavior and excessive uncertainty, necessitating a cautious and ethically anchored approach to financial practices. This framework may inherently moderate the institution's risk profile. From the perspective of agency theory, conflicts between shareholders and managers stem from differences in information access and risk tolerance. In the Islamic banking context, these agency issues are further complicated by the presence of multiple stakeholders, including depositors whose funds are allocated under PLS contracts. Such arrangements heighten the importance of robust governance systems. Greater board diversity, especially in gender and educational qualifications, can improve monitoring capacity and constrain managerial latitude in making high-risk decisions. Gender-diverse boards tend to exhibit more cautious risk behavior, while directors with advanced or specialized education are typically better equipped to assess and manage complex financial exposures. Consequently, the role of female directors in shaping risk outcomes may differ within Islamic banks, given their distinctive regulatory and operational environments. These complexities underscore the need for heightened accountability mechanisms from both depositors and investors, as the associated agency costs are often more pronounced than in conventional banking systems. Overall, these theoretical insights substantiate the focus on Islamic banks and support the proposition that the effects of board characteristics on risk-taking may diverge across banking models.

2.2 Hypothesis development

2.2.1 Gender and risk-taking decisions. Empirical studies have consistently identified a notable association between female participation in investment decision-making and a

tendency toward risk-averse behavior (see [Jianakoplos and Bernasek, 1998](#); [Agnew et al., 2003](#); [Byder et al., 2019](#)). According to [Skała and Weill \(2016\)](#), the general assumption that women exhibit greater risk aversion than men is grounded in observed patterns of their risk-related behaviors.

[Barber and Odean, \(2001\)](#) justify females' risk-averse behavior by their personality characteristics, as they are known to be less overconfident than males. [Berger et al.](#) define overconfidence as a very low-risk assessment. [Barber and Odean, \(2001\)](#) justify the difference between humans' perceptions of risk by the variation in their overconfidence about their capabilities, knowledge and future expectations. In the same context, [Goel and Thakor \(2008\)](#) report that overconfident managers underestimate the importance of information acquisition and therefore invest less in this aspect, which, in consequence, leads to poorer investment decisions. [Barber and Odean, \(2001\)](#) added that such overconfidence has been seen in areas such as finance and the banking industry. They also associate overconfidence with greater trading and lower expected profits. [Barber and Odean, \(2001\)](#) also report that realistic and rational investors accept to invest in certain transactions only if they see potential profit in the transaction. However, they added, overconfident investors misread the information precision and therefore overestimate the expected gains, which, in consequence, makes them decide to invest in transactions with very low profits or even losses.

In the same vein, [Goel and Thakor \(2008\)](#) state that overconfidence also influences the quantity and quality of the information delivered by the CEO to the board of directors, which in consequence results in poor corporate investment decisions. [Barber and Odean, \(2001\)](#) compare males and females in this characteristic, stating that women are less overconfident than men; therefore, women will accomplish their jobs better than men. A different judgment is given by , who argue that compared to men, women may encounter informational disadvantages in evaluating investment projects, potentially affecting their investment choices.

Alternative perspectives on risk-taking behavior at the executive level have been offered by [Malmendier et al. \(2011\)](#) and [Skała and Weill \(2016\)](#), who argue that gender characteristics are not inherently linked to risk propensity. Instead, they attribute variations in risk-taking primarily to individual personality traits of decision-makers. [Malmendier et al. \(2011\)](#) present evidence suggesting that executives who have experienced severe depression tend to adopt more risk-averse attitudes, thereby avoiding risky decisions. Conversely, [Skała and Weill \(2016\)](#) find that managers with military backgrounds are more inclined to pursue aggressive corporate strategies. Research focusing specifically on gender differences in risk-taking and investment decisions includes contributions from [Barsky et al. \(1997\)](#), [Jianakoplos and Bernasek \(1998\)](#), [Barber and Odean, \(2001\)](#), [Agnew et al. \(2003\)](#). A related and expanding body of literature examines the influence of gender within corporate governance structures, as seen in studies by [Berger et al. \(2014\)](#), [Skała and Weill \(2015\)](#) and [Zaid et al. \(2020\)](#).

2.2.2 Education and risk-taking decisions. The existing research exploring the connection between risk-taking behavior and the educational background of senior management remains limited. Findings are diverse, with some studies reporting a positive association, others indicating a negative correlation, and yet some finding no significant relationship between these variables. Notable investigations into this relationship include the works of [Grable \(2000\)](#), [Christiansen et al. \(2008\)](#), [Ahern and Dittmar \(2011\)](#) and [Calthorpe et al. \(2020\)](#).

[Ahern and Dittmar \(2011\)](#) suggest that the level of individual education and degree of professional experience of board members can highly influence top management policy and

ability to perform their work. In the same vein, note that to improve corporate governance performance, educational requirements for bank top managers have been recommended as an approach that can lead to improved performance. Nevertheless, exploring studies on the impact of the existence of highly educated people at the top level of management on bank risk is still needed.

In the same context, report that some international efforts aim to reduce banks' risk-taking by encouraging the banks to employ managers with adequate banking experience, which, according to this opinion, leads to more effective governance. However, report that defining work experience in this context is different as highly educated CEOs, for example, a PhD holder, have fewer years of work experience than CEOs who do not have a PhD holder.

Studies that posit a positive relationship between educational background and risk-taking behavior can be seen in [Grable \(2000\)](#), [Bertrand and Schoar \(2003\)](#) and [Christiansen et al. \(2008\)](#). [Grable \(2000\)](#) suggests that higher educational attainment creates an individual's tendency to make risky financial decisions. In the same line, [Christiansen et al. \(2008\)](#) state that in stock market investments, highly educated managers develop risk-taking behavior in terms of participation. This opinion is also supported by the findings of [Bertrand and Schoar \(2003\)](#), who argue that executives with MBAs are more aggressive and tend to permit more risky policies.

In contrast, [Graham and Harvey \(2001\)](#) show evidence that the education of CEOs impacts firm financing policies. They state that when CEOs with MBAs evaluate their cost of capital, they use sophisticated project evaluation techniques more than CEOs without MBA degrees. Thus, they claim that using more of these techniques should eventually reduce firm risk. In this context, [Berger et al. \(2014\)](#) state that the use of sophisticated tools in decision-making in the banking sector is not certainly linked to a highly educated manager because these methods already exist. However, they added that education influences managers' understanding of these techniques and assists them in using these techniques in making successful management decisions.

Finally, [Buccioli and Miniaci \(2011\)](#) report no significant link between educational attainment and risk attitudes based on their analysis of US households. [Rose \(2007\)](#) explains this weak association by suggesting that corporate governance roles do not require specialized educational qualifications beyond a university degree or equivalent practical experience gained through extensive business involvement.

2.2.3 Empirical evidence on the impact of gender diversity and education on risk. [Barsky et al. \(1997\)](#) used survey data to study risk tolerance between men and women within the health-care sector, concluding that women have higher risk aversion than men. Subsequently, [Barber and Odean, \(2001\)](#) analyzed accounting records from over 35,000 US households engaged with discount brokerage firms during 1991–1997. They found that, contrary to common assumptions, women demonstrated significantly lower risk aversion in trading behaviors, which Barber and Odean attribute to differences in levels of overconfidence. This lower risk aversion corresponded with higher investment returns for female investors compared to their male counterparts.

These results align with [Farrell and Hersch \(2005\)](#), who documented a negative correlation between business risk and female board representation in a sample of US companies in 1990. Similarly, [Croson and Gneezy \(2009\)](#) and [Charness and Gneezy \(2012\)](#) provide cross-national evidence from 15 countries supporting the assertion that women generally display more risk-averse tendencies. Additional research on gender-related risk differences in banking includes the work of [Gulamhussen and Santa \(2010\)](#), who assessed data from 461 major banks across Norway, Sweden, Spain and France. They found that women on boards increase risk within the company. In a related vein, [Agarwal and Wang](#)

(2009), Beck *et al.* (2009) and Bellucci *et al.* (2010) focused on the loan evaluation process within banks, finding that loans reviewed and approved by female officers showed lower default rates than those processed by male officers. These findings reinforce the view that women tend to be more risk-averse, partly because of lower levels of overconfidence.

Adams and Funk (2012) used survey-based data to assess how gender diversity among board members influences risk preferences in Swedish firms. Their findings indicate that female board members exhibit marginally lower levels of risk aversion compared to their male counterparts. Similarly, Atkinson *et al.* (2003) examined investment behavior and performance across male and female mutual fund managers specializing in fixed-income portfolios. While their results revealed behavioral distinctions in fund management styles between genders, these differences were statistically insignificant. The authors attribute the observed variation to disparities in financial knowledge and wealth constraints between men and women.

Skała and Weill (2016) explore the influence of CEO gender on risk-taking in the banking sector by analyzing a sample of 347 Polish cooperative banks. They assess bank risk using indicators such as loan loss provisions and levels of non-performing loans. Their results show that institutions led by female CEOs tend to be less risky when assessed through capital adequacy and equity-to-assets ratios. However, they find no significant effect of female CEO presence on credit risk. Importantly, they reject the notion that these higher capital buffers were a result of appointing female executives in banks that were either problematic or already operating with conservative risk profiles.

Further insights into the role of gender and educational qualifications on risk behavior are offered by, who investigated the risk-taking practices of German banks between 1994 and 2010. They measured risk through the proportion of risk-weighted assets to total assets. Their analysis demonstrates that female CEOs increase risk exposure, particularly among younger female executives, suggesting a nuanced relationship between gender, age and managerial risk preferences. Moreover, they identify a negative effect of executive team members holding doctoral degrees and the overall risk level. Interestingly, they report that female CEOs with PhDs tend to have less professional experience than those without doctoral qualifications, which may partially explain the variations in risk behavior.

Rose (2007) explores the relationship between board composition – specifically gender and educational background – and firm performance. His analysis reveals that the educational attainment of board members does not exert a measurable influence on corporate outcomes. In a related context, Prete and Stefani (2013) examine governance practices within Italian banks and uncover a negative correlation between educational levels and the proportion of women on corporate boards. They interpret this finding as indicative of tokenism, implying that female representation may be symbolic rather than substantive. Moreover, their results demonstrate no statistically significant association between gender diversity and risk performance in the banking sector. Their study also notes that individuals with prolonged board tenure are more likely to be selected for executive roles, suggesting that experiential expertise outweighs formal education in governance appointments. Additionally, they report that candidates holding only a bachelor's degree face reduced prospects for promotion to senior executive roles, whereas educational qualifications tend to be lower at middle management levels relative to top leadership positions.

Within the Islamic banking sector, the literature examining the interplay of gender, education and risk behavior remains relatively limited. Al-Tamimi *et al.* (2013) assess customer perceptions of Islamic banks in the UAE by considering differences in gender and educational background. Their findings indicate that these demographic factors significantly influence how customers perceive the image and operations of Islamic financial institutions.

More recently, [Umar et al. \(2023\)](#) analyze data from 43 Islamic banks across 15 countries over the period 2010–2020 to evaluate how audit committee characteristics affect risk-taking behavior. Their empirical results show that neither gender diversity nor the proportion of doctorate-level qualifications among audit committee members has a significant impact on the risk profiles of the banks studied.

Building on the preceding theoretical and empirical review, a notable gap remains in the literature regarding the influence of female representation and educational background in the Islamic banking sector. This study seeks to address this shortfall by offering a novel examination of how board and executive characteristics relate to risk in Islamic banks. The first area of focus is gender diversity, specifically the inclusion of both men and women in boardroom and senior management positions, and its effect on institutional risk preferences. Gender diversity continues to be a contentious topic within corporate governance, with evidence suggesting both potential benefits and challenges ([Martínez and Rambaud, 2019](#)). Prior research has shown that female presence on boards may alter an institution's tolerance for risk, a matter of strategic concern to shareholders who are ultimately responsible for bearing the consequences of risk-related decisions.

Second, this study explores the combined effect of gender and educational diversity within management teams and its implications for risk behavior. Educational attainment is used as a proxy for cognitive capacity, analytical ability and exposure to diverse problem-solving frameworks, all of which can influence how strategic choices are approached and implemented. Third, the research aims to reconcile the fragmented and, at times, contradictory findings present in the corporate governance literature. Much of the existing scholarship has been limited to publicly listed banks because of data availability, despite such entities constituting only a fraction of the overall banking landscape in several jurisdictions. To enhance contextual relevance and address this methodological limitation, the present study centers on Sudanese Islamic banks, thereby contributing a fresh perspective to the literature and expanding the geographical and institutional boundaries of current governance debates.

In addition, this study seeks to extend the limited body of research on Islamic banking, which has predominantly focused on gender diversity and credit risk, often treating it as a singular dimension of risk while neglecting broader indicators such as insolvency risk and capital adequacy ([Kinatader et al., 2021](#); [Cardillo et al., 2020](#)). Despite substantial structural and operational differences between Islamic and conventional banks – including their financial models, investment principles and governance mechanisms – the role of female representation on boards has remained underexplored in comparative studies, particularly within Islamic financial institutions ([Elnahass et al., 2024](#)). Islamic banks operate under a unique set of constraints shaped by Shariah law, which not only influences their product offerings but also imposes additional governance responsibilities. These responsibilities include establishing effective Shariah governance frameworks and formulating policies that ensure full compliance with Islamic jurisprudence throughout all banking operations ([Elnahass et al., 2020](#)).

Given this distinct institutional landscape and the specific fiduciary relationship Islamic banks maintain with depositors, agency costs are likely to be amplified. The dual governance system, which combines traditional board oversight with Shariah Supervisory Boards (SSBs), contributes to heightened governance complexity compared to conventional banks ([Abdelsalam et al., 2016](#)). Inadequate due diligence in this context may result in elevated operational risks, stemming from unique investment models, risk-sharing arrangements and the compliance requirements of Shariah-based instruments ([Ernaningsih et al., 2023](#)). Islamic banks often encounter constraints related to the limited global supply of external

directors possessing both governance expertise and proficiency in Shariah law. The independence of SSB members is further challenged by selective appointment practices, which may diminish the potential benefits of board diversity, including gender-based diversity (Trinh *et al.*, 2020, 2021).

In response to these institutional and operational challenges, the present study contributes to the literature by conducting a focused empirical investigation of governance attributes within a uniquely Islamic financial context – specifically, using a data set consisting exclusively of Islamic banks that operate under mandatory Shariah compliance, without the overlapping influence or integration of conventional banking models (IMF, 2020; Aljughaiman *et al.*, 2023). This setting offers a distinctive opportunity to examine the effects of board composition and educational diversity on risk-taking behavior. By assessing whether systematic variations in risk exposure are associated with gender and educational attributes at the board level, this research addresses a critical gap and enhances the broader discourse on bank governance under alternative institutional paradigms. Accordingly, the following hypotheses are proposed:

- H1. A higher proportion of women serving on the board of directors is linked to a significant reduction in the risk-taking tendencies of Islamic banks.
- H2. Greater female participation at the departmental management level is significantly associated with lower risk-taking behavior in Islamic banks.
- H3. The academic qualifications of board members are inversely and significantly related to the degree of risk-taking in Islamic banks.
- H4. Islamic banks led by departmental managers with stronger educational credentials are less prone to engage in higher levels of risk-taking.

3. The methodology

3.1 Data

To achieve the aims of this research, we rely on secondary data obtained from leading Sudanese Islamic banks that made their financial statements publicly available for the period under review. Specifically, the data set comprises information from 27 Islamic banks operating in Sudan. While the Islamic banking sector in Sudan includes 36 banks, only 27 provided publicly accessible financial data for the period under investigation, 2005–2022. Data prior to 2005 are excluded because of unavailability. Where available, data were obtained either in hard copy directly from the banks' headquarters or online through their respective digital platforms. The study primarily relies on audited financial statements, including balance sheets and income statements, as the core data sources. The balance sheet data capture the structural composition of banking activities, particularly decisions related to the sources, deployment and composition of funds. Meanwhile, the profit and loss statements provide insights into managerial efficiency, particularly in terms of revenue generation and cost control.

3.2 The dependent variable

This study uses various proxies of bank risk as the dependent variables, focusing specifically on capital adequacy and loan loss provisions. These risk indicators have been widely applied in the literature, including studies by Berger and DeYoung (1997), Berger (2009), Akhtar *et al.* (2011) and Skala and Weill (2016), particularly as measures of credit risk.

Capital adequacy, assessed through the capital-to-assets ratio (CAPAD2), is selected as one of the key indicators of risk-taking behavior, given its ability to capture the bank's stance

toward either risk aversion or risk acceptance. In addition, the equity-to-assets ratio (CAPAD1) is used as a supplementary metric, providing additional insight into the extent to which a bank's capital structure relies on equity as opposed to leverage. This ratio offers a broader perspective by reflecting the institution's current policies on capital retention and its preparedness for economic downturns through conservative buffer reserves. The ratio of loan loss provisions to total loans (CREDR3) is included as another principal risk measure, especially relevant given that credit risk constitutes a primary source of risk exposure for Sudanese Islamic banks. For comparative analysis, a second credit risk measure – loan loss provisions to total assets (CREDR1) – is also used, as it may provide earlier signals about the risk implications of a bank's credit policies.

While other indicators such as the z-score and non-performing loan ratios are frequently used in risk assessment, they are not used in this study. The z-score was excluded because of the need for a longer time series to ensure reliability, and data constraints prevented the inclusion of non-performing loan information.

3.3 *The independent variables*

This paper examines gender diversity and educational background within top management positions, including in the board of directors, as key variables.

3.3.1 Gender diversity on the board of directors. Consistent with prior research (e.g. [Campbell and Vera, 2007](#); [Rose, 2007](#); [Pathan et al., 2012](#); [Jabari and Muhamad, 2022](#)), gender diversity within the board of directors is measured by the proportion of female members (FBSIZE) on the boards of the Sudanese Islamic banks included in this study.

3.3.2 Gender diversity of the departmental managers. According to [Navarro and Gallo \(2014\)](#) and [Vieito \(2012\)](#), the most restrictive definition of gender diversity in the literature considers only the proportion of female CEOs within a firm (FECOS). because of the limited number of female CEOs, some studies have broadened this definition to include vice directors and female top management members ([Smith et al., 2006](#)). Following a similar approach as [Prete and Stefani \(2013\)](#), [Alexandrina \(2011\)](#) and [Reinert et al. \(2015\)](#), this study adopts a wider conceptualization of top management that encompasses senior managers, recognizing that many Sudanese Islamic banks have a limited number of female executives and vice directors.

Using the banks' annual reports, the ratio of female senior managers to total departmental managers in each Sudanese bank is calculated to serve as a proxy for gender diversity among senior managers. To determine the gender of senior managers and board members, the authors first refer to photographs included in the banks' annual reports. In the absence of photographs, gender is inferred based on first names. Additionally, this study uses the ratios of male departmental managers and male board members to examine their impact on bank risk, enabling a comparative analysis between the influence of male and female representation.

3.3.3 The education on managerial and board positions. Following [Berger et al.](#), the ratio of board members with a PhD (bedu) and the ratio of departmental managers and CEOs with a PhD (ecoedu) are used to measure education.

3.3.4 The control variables. This paper also uses bank type (TYPE), age (AGE), specialization (Specialized), size (totass), staff expenses defined as overhead to total expenses (OVER2), assets utilization (ASSUT1), operational efficiency defined as total cost to total income (MGT1) and size of the board of directors (Bsize) as control variables ([Shaheen et al., 2024](#)). Following [Yermack \(1996\)](#), [Bhagat and Black \(2002\)](#), [Coles et al. \(2008\)](#) and [Alexandrina \(2011\)](#) studies in measuring the size of the board of directors, the authors evaluate the size of each board of directors based on the number of directors on it.

Factors that are associated only with the Islamic banking industry, which are profit and loss sharing modes of finance (PLS), non-profit and loss sharing mode of finance (MURBH) and Salam mode of finance (SLM) are also used as control variables.

3.4 The empirical specification

Building on previous research (Sendi *et al.*, 2024), this study uses the pooled regression technique, which, as described by Brooks (2008), entails estimating a single equation across multiple cross-sectional data sets. Ordinary least squares (OLS) serves as a benchmark estimation method for the models; however, the results may be vulnerable to issues such as reverse causality, omitted variables and self-selection bias. Moreover, the pooled OLS model, used here as a baseline, does not control for unobserved heterogeneity and assumes that error terms are independent assumptions that can lead to biased parameter estimates.

To better identify the causal relationship between board diversity, educational background and bank risk, the instrumental variable approach (2SLS) could be applied. Nevertheless, choosing valid instruments is often problematic. Suitable instruments need to be strongly correlated with the endogenous regressors while having no direct influence on the dependent variable. In practice, potential candidates – such as bank size or board size – often fail these requirements, particularly because they are commonly included in risk regressions (Vafaei *et al.*, 2015; Jurkus *et al.*, 2011; Brown *et al.*, 2011; Adams and Ferreira, 2009). In line with recent studies (Pham *et al.*, 2021; Yitayaw *et al.*, 2022), this analysis adopts the generalized method of moments (GMM) technique to more effectively mitigate endogeneity issues. GMM provides several benefits: it accounts for the potential endogeneity of explanatory variables, controls for unobserved heterogeneity and produces consistent and efficient estimations even when data exhibit autocorrelation and heteroskedasticity (Arellano and Bond, 1991). This method is especially suitable for dynamic panel data contexts, making it a strong choice for empirical studies focused on governance and risk.

Subsequent enhancements improved the original estimator by incorporating additional assumptions about initial conditions (Arellano and Bover, 1995; Blundell and Bond, 1998). These allow for a larger set of instruments to be used, enhancing estimation precision. Their approach, known as system-generalized method of moments (system-GMM), combines differenced and level equations, using lagged differences as instruments for the level form. This framework efficiently addresses key econometric challenges such as endogeneity, omitted variable bias, measurement error, unobserved individual effects and autocorrelation in panel data sets (Ullah *et al.*, 2018).

More specifically, we consider the following models:

$$CAPAD1_{it} = \alpha_i + \beta 0FBSIZE_{it} + \beta 1FECOS_{it} + \beta 2Ecoedu_{it} + \beta 3bedu + \beta 4Z_{it} + e_{it} \quad (1)$$

$$CAPAD2_{it} = \alpha_i + \beta 0FBSIZE_{it} + \beta 1FECOS_{it} + \beta 2Ecoedu_{it} + \beta 3bedu + \beta 4Z_{it} + e_{it} \quad (2)$$

$$CREDR1_{it} = \alpha_i + \beta 0FBSIZE_{it} + \beta 1FECOS_{it} + \beta 2Ecoedu_{it} + \beta 3bedu + \beta 4Z_{it} + e_{it} \quad (3)$$

$$CREDR3_{it} = \alpha_i + \beta 0FBSIZE_{it} + \beta 1FECOS_{it} + \beta 2Ecoedu_{it} + \beta 3bedu + \beta 4Z_{it} + e_{it} \quad (4)$$

In the model, the subscript *i* denotes individual banks, while *t* represents the time periods. The vector *Z_{it}* includes the control variables, and *e_{it}* is the error term. Several model specifications were examined sequentially. We start with a model that only includes the

control variables. Next, we add board size, the proportion of female directors and the proportion of female managers one by one in the first three models. In the fourth model, we look at board size together with female board representation, and in the fifth, we pair board size with the share of female managers. The sixth model includes both female directors and female managers, and in the seventh model, all three variables are considered together.

4. Results

4.1 Descriptive analyses

Table 1 provides insights into the descriptive statistics of all the understudy variables. It confirms that compared to other risk measures, the ratio of total equity to total assets (CPAD1) has the highest mean, standard deviation and max values. This is followed by capital-to-assets ratio (CPAD2), which proved to have the second highest score. A higher standard deviation of these two risk measures implies that large proportions of the data sets are distributed away from their mean values. On the contrary, CRDR3 has the lowest mean and standard deviation, followed by CRDR1, providing evidence that large proportions of the data set are distributed closer to their mean values.

Turning to the descriptive statistics of the independent variables, the table reveals that, when compared to Ecoedu, Bedu has an exceptionally high mean, standard deviation and max value. This suggests that, on average, there are more highly educated employees on the board of directors than there are at the departmental levels. However, the two components' standard deviations are nearly identical, suggesting that there are no variations in the distributions of both variables around their mean values.

4.2 Main estimation results

Both pooled OLS and GMM techniques are used to assess the impact of various risk determinants on the risk performance of selected Islamic banks in Sudan. Based on the

Table 1. Descriptive statistics of dependent and independent variables for Sudanese Islamic banks

Variable name	Mean	SD	Max	Min
CAPAD1	0.2658	0.2092	2.9680	0.0000
CAPAD2	0.1200	0.1468	2.1230	0.0000
CRDR1	0.0552	0.0657	0.2045	0.0000
CRDR3	0.0369	0.0174	0.1069	0.0000
AGE	7.0698	0.5331	8.0000	6.0000
TYPE	0.5288	0.4699	1.0000	0.0000
Specialised	3.1125	1.0019	5.0000	2.0000
log(Totass)	19.336	0.9706	23.669	17.134
MGT1	0.6774	0.1396	2.3933	0.0858
OVER2	0.3268	0.0756	1.0889	0.0000
ASSUT1	0.0918	0.0257	0.4012	0.0210
PLS	0.2666	0.1235	1.0000	0.0000
SLM	0.0122	0.0376	0.3075	0.0000
MURBH	0.5061	0.2944	1.0000	0.0000
Bsize	11.085	1.2630	17.000	5.0000
FBSIZE	0.0968	0.1231	0.9100	0.0000
FECOS	0.0871	0.1003	0.7766	0.0000
Ecoedu	0.0962	0.1083	0.5000	0.0000
bedu	0.2336	0.1181	0.6642	0.0000

Source(s): Table by the authors

likelihood ratio test (*F*-test) outcomes – which yielded values of 0.158 for CAPAD1, 0.526 for CAPAD2, 0.720 for CREDR1 and 0.833 for CREDR3 – it is found that including fixed effects is unnecessary. Consequently, the fixed effects model is rejected in favor of the ordinary panel least squares regression. The estimation results for the four dependent variables using the panel least squares approach are presented in Table 2. Additionally, the results of the system-GMM estimation are summarized in Table 3.

According to Table 2, the adjusted R-squared (R^2) values for CAPAD1, CAPAD2, CREDR1 and CREDR3 are 0.5150, 0.4582, 0.2678 and 0.3365, respectively. These results indicate that the variability in CAPAD1 and CAPAD2 is more strongly explained by the linear relationship with their independent variables compared to CREDR1 and CREDR3. Specifically, a 1% change in all independent variables is associated with an estimated variation of 51.50% and 45.82% in CAPAD1 and CAPAD2, respectively. In contrast, similar changes in the independent variables correspond to only 26.78% and 33.65% variation in CREDR1 and CREDR3, respectively. Table 3 presents the results obtained from applying the system-GMM estimation method to four distinct measures of bank risk. The findings reveal that the coefficients for the lagged dependent variables are statistically significant in all tested models, providing strong evidence for the use of a dynamic modeling approach. This implies that the previous period's risk level of a bank plays a crucial role in determining its current risk status. Moreover, the Hansen test yields a *p*-value greater than 0.05, which supports the validity of the chosen instruments. In addition, the AR(2) test *p*-values indicate the absence of second-order autocorrelation in the error terms for all model specifications. Examining the capital adequacy risk indicators, the findings presented in Tables 2 and 3 reveal that FECOS exerts a significantly positive effect on both CAPAD1 and CAPAD2. This implies that an increased presence of females in these positions corresponds with higher capital levels, as

Table 2. Coefficient estimates of the impact of the independent variables on risk measures of Sudanese Islamic banks using OLS

Variable name	CAPAD1	CAPAD2	CREDR1	CREDR3
Constant	1.2288** (0.3356)	1.6420*** (0.4024)	-0.3126* (0.1151)	-0.1666** (0.0651)
AGE	0.0640*** (0.0214)	0.0600* (0.0236)	-0.1065 (0.0885)	0.1006 (0.0114)
TYPE	0.0697 (0.1123)	-0.1166 (0.0667)	0.1081 (0.1852)	-0.0188 (0.0558)
Specialised	-0.1556 (0.1234)	-0.0103 (0.0213)	-0.0055 (0.0186)	0.1029 (0.1026)
log(Totass)	-0.0562** (0.2166)	-0.1659* (0.0175)	0.0518* (0.2272)	0.1030* (0.0230)
MGT1	-0.1281** (0.0632)	-0.1588** (0.1761)	0.0659 (0.0998)	0.02776* (0.0186)
OVER2	-0.0399 (0.0881)	-0.1452 (0.1033)	-0.2479 (0.0284)	-0.0666 (0.0114)
ASSUT1	-0.0332 (0.6781)	-0.2500 (0.3617)	0.0700 (0.2285)	0.1200 (0.0788)
PLS	-0.1226* (0.0805)	-0.0329* (0.0700)	0.0002 (0.0270)	-0.0163 (0.0116)
SLM	0.4522 (0.3299)	0.0306 (0.5002)	-0.0339 (0.1555)	-0.0442 (0.0320)
MURBH	-0.2001* (0.0666)	-0.0447* (0.0333)	0.0539** (0.0220)	-0.0322 (0.0584)
Bsize	0.0017 (0.0055)	0.0155* (0.0498)	0.0033 (0.2540)	0.0066 (0.2891)
FBSIZE	0.1369 (0.1225)	0.0664 (0.2770)	0.1336 (0.2306)	0.1556 (0.1327)
FECOS	0.3415*** (0.1300)	0.2277** (0.1170)	-0.1220 (0.1375)	-0.2005 (0.0667)
Ecoedu	0.3660*** (0.1150)	0.3003*** (0.0998)	0.1226 (0.0915)	-0.0999 (0.0345)
Bedu	0.2002** (0.1365)	0.3777*** (0.1325)	-0.1022** (0.0333)	-0.0551 (0.0160)
Adjusted R ²	0.5150	0.4582	0.2678	0.3365
Obs	289	289	225	207

Note(s): *Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source(s): Table by the authors

Table 3. Coefficient estimates of the impact of the independent variables on risk measures of Sudanese Islamic banks using GMM

Variable name	CAPAD1	CAPAD2	CREDR1	CREDR3
Constant	1.1255*** (0.1814)	1.1001** (0.3387)	0.2288* (0.3653)	-0.5900* (0.1388)
L.DEP	0.1489* (0.3195)	0.3368** (0.5932)	0.3624* (0.2148)	0.2825** (0.4487)
AGE	0.0235* (0.0562)	0.0587 (0.0678)	-0.0421* (0.0661)	-0.0503 (0.0294)
TYPE	0.0119* (0.0412)	0.0104 (0.0216)	0.0081 (0.0378)	0.0126 (0.0651)
Specialised	-0.0192 (0.0671)	-0.0151 (0.0345)	-0.0132 (0.0382)	-0.0587 (0.0374)
log(Totass)	-0.0218** (0.2063)	-0.0894* (0.1996)	0.0207* (0.0082)	0.0031 (0.0051)
MGT1	-0.1284** (0.0342)	-0.2012* (0.0354)	0.0351** (0.0211)	0.0314 * (0.0338)
OVER2	-0.1276** (0.0602)	-0.1359* (0.0981)	-0.0243 (0.0478)	-0.0157* (0.0312)
ASSUT1	-0.0261 (0.3687)	0.0485 (0.2823)	0.0368 (0.2521)	0.0591 (0.1526)
PLS	-0.0561* (0.0834)	-0.0352** (0.0442)	0.0448* (0.0377)	0.1265* (0.0669)
SLM	0.1524 (0.2878)	0.2529 (0.3657)	-0.1764 (0.4328)	-0.0956 (0.0322)
MURBH	-0.1540** (0.0437)	-0.1512* (0.0401)	0.0294* (0.0331)	0.0178** (0.0673)
Bsize	0.0251* (0.0335)	0.0287* (0.0458)	-0.0112 (0.0067)	0.0305 (0.0356)
FBSIZE	0.0396 (0.1578)	0.1192 (0.2102)	-0.1341 (0.0996)	0.0778 (0.0609)
FECOS	0.3114*** (0.2700)	0.1985*** (0.1395)	-0.2505*** (0.2336)	-0.1245** (0.1982)
Ecoedu	0.1231** (0.3065)	0.1049* (0.3626)	-0.1154** (0.2671)	-0.1043** (0.1067)
Bedu	0.1850** (0.2023)	0.1073** (0.2994)	-0.1296* (0.0999)	-0.09944* (0.0278)
Adjusted R ²	0.4960	0.4500	0.2365	0.1874
Obs	289	289	225	207
AR(1) p-value	0.025	0.011	0.020	0.010
AR(2) p-value	0.258	0.288	0.269	0.277
Hansen p-value	0.300	0.418	0.249	0.277
Number of instruments	11	11	12	12

Note(s): L.DEP is the lagged dependent variable. Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source(s): Table by the authors

reflected in both the capital adequacy and equity-to-assets ratios. It is important to highlight that capital acts as a vital buffer against unexpected losses incurred by banks. Moreover, capital is crucial in covering losses from non-performing loans, especially when loan loss provisions fall short. Consequently, it is reasonable to infer that female managers tend to maintain higher capital ratios, possibly because of a more conservative approach toward credit risk. This observation motivates a further investigation using credit risk indicators, specifically CREDR1 (loan loss provision to total loans) and CREDR3 (loan loss provision to total assets).

As indicated in [Table 2](#), the OLS results do not show a statistically significant association between FECOS and credit risk measures. However, when using the system-GMM estimation reported in [Table 3](#), the relationship becomes statistically significant. In particular, the coefficients for FECOS are negative and significant in relation to both CREDR1 and CREDR3. These results suggest that female departmental managers in Sudanese Islamic banks are less likely to pursue aggressive credit risk-taking policies and instead contribute to reducing credit risk exposure within their institutions.

The presence of women as departmental managers in Sudanese Islamic banks is closely linked to a conservative risk-taking approach, characterized by policies aimed at minimizing the bank's liabilities. The results suggest that female departmental managers are associated with higher capital adequacy, although their impact on credit risk appears negative and statistically insignificant. The combination of a significant positive correlation with capital adequacy and an insignificant negative correlation with credit risk measures provides robust evidence that the appointment of female departmental managers in Sudanese Islamic banks corresponds with a more cautious risk management strategy. This suggests that women in these managerial positions tend to implement policies that effectively reduce the overall risk exposure and liabilities of the banks.

Our results are in line with the findings of Skala and Weill (2016), who observed that female CEOs in Polish cooperative banks tend to strengthen capital adequacy and equity-to-assets ratios, though their presence does not appear to significantly influence credit risk. Likewise, the evidence from [Elnahass et al. \(2024\)](#) supports our conclusion that greater female representation in leadership roles contributes to a meaningful decline in bank default risk. Conversely, these outcomes differ from the evidence presented by [Berger et al. \(2014\)](#), who examined gender diversity among CEOs of Deutsche Bundesbank between 1994 and 2010 and reported that female CEOs were more likely to drive German banks toward increased risk-taking behavior.

The analysis of the impact of female representation on the board of directors on the risk performance of Sudanese Islamic banks reveals no significant influence on either credit risk indicators or capital-to-equity ratios. Specifically, [Tables 2 and 3](#) demonstrate that the coefficients for the variable FBSIZE lack statistical significance. This outcome may be interpreted through the lens of the critical mass theory, which emphasizes the importance of the number of women present at a particular management level. In the case of Sudanese Islamic banks, the relatively small number of female board members results in a skewed composition, which, as noted by [Joecks et al. \(2013\)](#), is associated with diminished effectiveness. Consequently, the presence of women on these boards may function more as a symbolic gesture, limiting their substantive impact on decision-making processes. To provide a more nuanced understanding of how gender composition influences risk performance in Sudanese Islamic banks, this analysis extends to assess the effect of male departmental managers on bank risk, as measured by the ratio of total equity to total assets (CAPAD1). [Table 4](#) presents the corresponding regression outcomes. In addition, the table offers a comparative view by juxtaposing these results with earlier findings related to female

departmental managers, applying both OLS and the system-GMM estimators. Overall, Table 4 summarizes the core results concerning the influence of gender composition, alongside other explanatory variables, on the capital adequacy proxy CAPAD1.

The results reported in Table 4 reveal a strong and negative association between capital adequacy and the presence of male departmental managers. This outcome contrasts with the earlier findings regarding female departmental managers, suggesting that male managers are more likely to pursue risk-intensive strategies. These results align with the observations of Skala and Weill (2015), who argue that male executives tend to exhibit lower risk aversion compared to their female counterparts. Moreover, the results in Table 4 demonstrate that gender diversity at the departmental management level has a positive and statistically significant impact. This suggests that the inclusion of women in these leadership roles within Sudanese Islamic banks is associated with improved equity-to-asset ratios and stronger capital adequacy positions. Because of this, Sudanese Islamic banks that employ women at these levels tend to have more cautious capital adequacy ratios, which, in turn, enhances the stability of their performance.

Overall, the findings in Tables 2, 3 and 4 consistently indicate that greater female representation in managerial positions is linked to lower risk-taking by banks. These findings are consistent with the conceptual foundations of agency theory, resource dependence theory and upper echelons theory. Specifically, they imply that female managers may strengthen the monitoring of risk-related decisions, enhance the quality of strategic judgments and improve access to essential resources – factors that collectively promote more cautious and risk-averse banking practices. These findings support the second hypothesis ($H2$), showing that greater female representation in managerial roles is significantly associated with lower risk exposure in the Islamic banks studied.

With respect to the impact of academic qualifications on the risk profile of Sudanese Islamic banks, Tables 2 and 3 indicate a statistically significant and positive relationship between the proportion of departmental managers holding doctoral degrees and both capital adequacy (CAPAD2) and equity-to-assets ratios (CAPAD1). These findings suggest that an increase in the number of PhD-qualified managers is associated with stronger capitalization, potentially reflecting a more cautious financial posture. Additionally, results reported in Table 4 reveal that the coefficients for the variable *Ecoedu*, which captures the proportion of PhD holders, are negative and statistically significant with respect to credit risk indicators (CREDR1 and CREDR3). This suggests that highly educated managers play an active role in reducing credit exposure. Taken together, these outcomes highlight the value of advanced academic training in enhancing the quality of risk management. The presence of PhD level managers appears to support more prudent credit practices and reinforce capital buffers, emphasizing the strategic importance of education in banking governance and financial stability.

Conversely, the results concerning the influence of highly educated individuals on the board of directors, captured by the variable *Bedu*, demonstrate a statistically significant and positive association with both capital adequacy (capital-to-assets ratio) and the equity-to-assets ratio. These outcomes suggest that the presence of PhD qualified board members contributes positively to bank capitalization. Furthermore, evidence from the OLS estimations indicates a significant negative relationship between the proportion of educated board members and credit risk, as proxied by the ratio of loan loss provisions to total assets. When the analysis is extended using the GMM estimation technique, the inverse relationship between education and credit risk persists, appearing significantly in both credit risk proxies: loan loss provisions to total loans and loan loss provisions to total assets.

Table 4. Comparison of the impact of female and male representation on CAPAD1 of Sudanese Islamic banks

Variable name	Females (OLS)	Males (OLS)	Females (GMM)	Males (GMM)
Constant	1.4395*** (0.4782)	2.4637** (0.4526)	1.3378*** (0.3291)	1.2471*** (0.3186)
L.DEF	-	-	0.3298* (0.2312)	0.4217*** (0.6098)
AGE	0.0826* (0.0221)	0.0584** (0.0220)	0.0802* (0.0214)	0.0610*** (0.0216)
TYPE	0.0872 (0.0647)	-0.0055 (0.0569)	0.0544 (0.0682)	0.0511 (0.0223)
Specialised	0.0278 (0.0231)	0.0281 (0.0212)	-0.0160 (0.0519)	-0.0145 (0.0407)
log(Totass)	-0.0781** (0.0171)	-0.0899*** (0.0157)	-0.0565** (0.0401)	-0.0793* (0.0235)
MGT1	-0.2276 (0.0741)	-0.1948* (0.0716)	-0.2302* (0.0305)	-0.2721** (0.0612)
OVER2	-0.0597 (0.1002)	-0.1143 (0.0934)*	-0.0369 (0.0221)	0.0816 (0.0452)
ASSUT1	-0.0709 (0.4682)	-0.0521 (0.4465)	-0.0346 (0.2284)	-0.0211 (0.4453)
PLS	-0.1338* (0.0712)	-0.0715* (0.0679)	-0.1012* (0.0233)	-0.0257*** (0.0242)
SLM	0.6591 (0.4024)	0.5467 (0.3793)	0.2325 (0.2681)	0.3078 (0.4056)
MURBH	-0.2456** (0.0751)	-0.1907*** (0.0712)	-0.2274** (0.0328)	-0.2115* (0.0181)
Bsize	0.0023 (0.0098)	-0.0087 (0.0094)	0.0235 (0.0456)	0.0559 (0.3538)
Gender of BSIZE	0.0333 (0.1100)	0.3952 (0.0674)	-0.2399 (0.1774)	-0.3447 (0.2889)
Gender of ECOS	0.3215* (0.1658)	-0.2006** (0.1332)	0.2065* (0.1377)	-0.2144*** (0.2022)
Adjusted R ²	0.5150	0.5030		
Obs	289	289	289	289
AR(1) p-value			0.110	0.133
AR(2) p-value			0.201	0.277
Hansen p-value			0.430	0.420
Number of instruments			12	13

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source(s): Table by the authors

These findings align with the conclusions of [Berger et al. \(2014\)](#), who identified an inverse relationship between the presence of highly educated executives and risk-taking behavior. The authors argue that individuals with advanced academic credentials are more likely to engage in disciplined and informed decision-making. According to [Berger et al.](#), PhD holders in executive roles enhance the decision-making process by increasing the volume and quality of information considered, which contributes to more cautious and analytically grounded risk strategies. This moderation in risk behavior may be attributed to the tendency of academically trained individuals to rely on data-driven insights, ultimately reducing the likelihood of excessive or impulsive risk-taking.

These results suggest that departmental managers and board members with advanced degrees embrace conservative bank policies by raising capitalization levels and lowering (or not raising) credit risk. Additionally, the conservative approach adopted by managers may also be influenced by Sudan's elevated inflation rate. High inflation can significantly affect managerial decision-making by increasing the perceived risk of eroding anticipated profits or impairing the value of investments, particularly loans. In such an environment, decision-makers may prefer cautious strategies to safeguard financial returns. This tendency is especially pertinent in the context of Islamic banking, where the nature of several financing instruments – often characterized by longer maturities and profit-sharing mechanisms – makes them more vulnerable to inflation-induced uncertainties. As such, the adoption of risk-averse policies under high inflationary conditions appears to be a rational response.

Overall, our findings offer solid evidence reinforcing several fundamental corporate governance theories, particularly agency theory, resource dependence theory and upper echelons theory. Our findings suggest that banks with greater gender diversity and more highly educated executives tend to experience reduced credit risk and improved capital adequacy, supporting agency theory's emphasis on the value of strong oversight to limit managerial risk-taking. Moreover, the significance of educational attainment reinforces the tenets of resource dependence theory, suggesting that highly qualified executives represent a form of critical human capital that enhances institutional resilience. Furthermore, the demonstrated influence of executive demographic attributes on risk behavior lends credence to upper echelons theory, which asserts that organizational decisions and outcomes are shaped by the experiences, values and characteristics of top management. Collectively, these findings highlight the pivotal role of executive composition in shaping risk governance and performance outcomes within Islamic banking institutions.

Regarding the effect of control variables on bank risk, the results presented in [Tables 2–4](#) indicate that board size exerts a statistically significant influence only on capital-related indicators, namely, the capital-to-assets and equity-to-assets ratios. In contrast, the remaining risk measures appear largely unaffected by variations in board size. This outcome may be interpreted in light of the argument put forth by [Berger et al. \(2014\)](#), who contend that chief executive officers often retain a degree of autonomy from their boards. Such autonomy can lead CEOs to withhold certain strategic or risk-related information, thereby limiting the board's ability to intervene or guide managerial decisions. Consequently, board members may lack the necessary insights to perform their advisory and supervisory roles effectively, diminishing their influence over a firm's risk orientation and project selection.

The ratio of loan loss provisions to total loans is positively related to bank size and managerial effectiveness, both of which are negatively associated with capital adequacy and equity-to-assets ratios. Overhead expenses negatively affect capital adequacy under OLS estimation and also reduce equity-to-assets ratios under the GMM method, indicating a broader impact on capital structure. Bank age positively correlates with capital adequacy but

shows no effect on credit risk, while bank type, specialization and asset utilization have no significant influence on risk measures.

Regarding financing modes, the PLS model negatively impacts equity-to-assets ratios under OLS and shows a wider risk effect, including increased credit risk, under GMM. Non-PLS financing also reduces capitalization and raises credit risk, suggesting higher default risk. Salam financing does not significantly affect any risk measures.

5. Robustness check

To reinforce the credibility of the empirical findings and address potential concerns regarding alternative explanations, three robustness tests were performed. Each test is designed to assess the sensitivity of the results to model specification, omitted variables and estimation techniques. Results of the robustness tests are reported in Tables 5–10. First, the loans-to-assets ratio was added as an additional control variable. Although typically excluded because of potential multicollinearity with risk indicators, its inclusion allows for a more comprehensive account of asset structure and risk exposure. This test ensures that the observed effects of gender diversity and educational attainment are not confounded by variations in a bank’s asset composition. Second, all control variables were excluded in a re-estimated baseline model. This specification tests whether the main relationships – particularly those linking female participation and the presence of PhD holders to capital adequacy and credit risk – remain robust in the absence of other covariates. This helps to rule out the possibility that the core findings are an artifact of the specific set of control variables used. Third, a random effects model was used as an alternative estimation technique. While fixed effects control for time-invariant unobserved heterogeneity, random effects models

Table 5. Robustness check: with loans to assets

Variable name	CAPAD1	CAPAD2	CREDR1	REDR3
Constant	1.3832*** (0.4761)	1.4610*** (0.4942)	−0.2387 (0.1932)	−0.0825 (0.0589)
AGE	0.0784*** (0.0219)	0.0701*** (0.0223)	0.0024 (0.0078)	0.0021 (0.0026)
TYPE	0.0865 (0.0634)	−0.0208 (0.0647)	0.0105 (0.0227)	−0.0091 (0.0068)
Specialised	−0.0284 (0.0228)	−0.0160 (0.0232)	−0.0023 (0.0081)	0.0033 (0.0025)
log(Totass)	−0.0768*** (0.0169)	−0.0946*** (0.0174)	0.0128** (0.0066)	0.0031 (0.0021)
MGT1	−0.2168* (0.0737)	−0.1490 (0.0750)	0.0519* (0.0288)	0.0324** (0.0088)
OVER2	−0.0772 (0.0995)	−0.2058** (0.1012)	−0.0048 (0.0363)	−0.0003 (0.0113)
ASSUT1	−0.1312 (0.4631)	−0.4009 (0.4712)	0.4224* (0.2430)	0.1708** (0.0742)
PLS	−0.0963 (0.0738)	0.0367 (0.0750)	−0.0368 (0.0259)	−0.0217*** (0.0088)
SLM	0.6902 (0.3981)	0.0165 (0.4042)	−0.0827 (0.1375)	−0.0594 (0.0420)
MURBH	−0.1905*** (0.0788)	0.0538 (0.0804)	0.0125 (0.0275)	−0.0188** (0.0092)
Bsize	0.0015 (0.0095)	0.0165* (0.0097)	0.0059* (0.0034)	0.0017 (0.0011)
FBSIZE	−0.1435 (0.0874)	−0.1495* (0.0891)	0.0562* (0.0305)	0.0191** (0.0092)
FECOS	0.5921*** (0.1241)	0.5258*** (0.1441)	−0.0240 (0.0430)	−0.0109 (0.0135)
Ecoedu	0.4995*** (0.1413)	0.2927** (0.1261)	0.0104 (0.0490)	−0.0094 (0.0163)
Bedu	0.3602*** (0.1275)	0.4678*** (0.1299)	−0.1057** (0.0447)	−0.0442*** (0.0150)
Loans/assets	0.1410* (0.0802)	0.2297*** (0.0817)	−0.1745*** (0.0298)	−0.0195** (0.0097)
Adjusted R ²	0.5236	0.477371	0.3454	0.2142
Obs	289	289	225	207

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. *, ** and *** indicate significance levels of 10, 5 and 1%, respectively

Source: Table by the authors

Table 6. Robustness check: dependent variable is CAPAD1

Variable name	Original eq.	(1)	(2)	(3)	(4)	(5)
Constant	1.2288** (0.3356)	0.7493* (0.4450)	0.7635* (0.4182)	1.5002*** (0.2924)	1.8725*** (0.2786)	1.6701 (0.2574)
AGE	0.0640*** (0.0214)	0.1003*** (0.0218)	0.0999*** (0.0215)	0.0732*** (0.0166)	0.0834*** (0.0209)	0.0857 (0.0205)
TYPE	0.0697 (0.1123)	0.1297** (0.0642)	0.1284** (0.0629)	0.1098** (0.0573)	0.0569 (0.0508)	0.0502 (0.0509)
Specialised	-0.1556 (0.1234)	-0.0382* (0.0233)	-0.0379* (0.0229)	-0.0389* (0.0205)	-0.0478*** (0.0178)	-0.0425 (0.0183)
log(Totass)	-0.0562** (0.2166)	-0.0553*** (0.0158)	-0.0555*** (0.0155)	-0.0764*** (0.0107)	-0.0887*** (0.0095)	-0.0908 (0.0100)
MG11	-0.1281** (0.0632)					
Excluding Mgt						
OVER2	-0.0399 (0.0881)	0.0109 (0.0999)				
Excluding OVER2						
ASSUT1	-0.0332 (0.6781)	0.7572* (0.3921)	0.7476* (0.3822)			
Excluding ASSUT1						
PLS	-0.1226* (0.0805)	-0.1868*** (0.0712)	-0.1873*** (0.0707)	-0.0431 (0.0768)	-0.0194 (0.0748)	-0.0132 (0.0783)
SLM	0.4522 (0.3299)	0.4992 (0.4083)	0.4976 (0.4064)	0.2577 (0.4721)	-0.1145 (0.4551)	0.00003 (0.4849)
MURBH	-0.2001* (0.0666)	-0.2523*** (0.0774)	-0.2529*** (0.0767)	-0.1157 (0.0819)	-0.1209 (0.0786)	-0.1446 (0.0825)
Bsize	0.0017 (0.0055)	-0.0069 (0.0095)	-0.0070 (0.0094)	-0.0202*** (0.0085)	-0.0200*** (0.0085)	
Excluding Bsize						
FBSIZE	0.1369 (0.1225)	-0.0988 (0.0875)	-0.0989*** (0.0870)	-0.0693 (0.0555)	-0.0536 (0.0588)	-0.0265 (0.0568)
FECOS	0.3415*** (0.1300)	0.5720*** (0.1268)	0.5731*** (0.1259)	0.5950*** (0.0880)	0.5631*** (0.0955)	0.5378 (0.0979)
Ecoedu	0.3660*** (0.1150)	0.5362*** (0.1464)	0.5329*** (0.1425)	0.4592* (0.1680)		
Excluding ECOs educated						
Bedu	0.2002** (0.1365)	0.3654*** (0.1323)	0.3629 (0.1299)	0.3261*** (0.0987)		
Excluding board educated						
Adjusted R ²	0.5150	0.4737	0.4877	0.5007	0.4648	0.4477
Obs	289	289	289	289	289	289

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. *, **, and *** indicate significance levels of 1, 5 and 10%, respectively

Source: Table by the authors

Table 7. Robustness check: dependent variable is CAPAD2

Variable name	Original eq.	(1)	(2)	(3)	(4)	(5)
Constant	1.6420*** (0.4024)	1.0516* (0.4491)	0.8624** (0.4295)	1.0385** (0.3896)	1.3612** (0.3950)	1.4226* (0.3833)
AGE	0.0600* (0.0236)	0.0926* (0.0220)	0.0948 (0.0217)	0.0922* (0.0218)	0.1041*** (0.0226)	0.1049** (0.0225)
TYPE	-0.1166 (0.0667)	0.0138* (0.0647)	0.0275 (0.0640)	0.0179 (0.0635)	-0.0739 (0.0623)	-0.0716 (0.0621)
Specialised	-0.0103 (0.0213)	-0.0192 (0.0231)	-0.0206 (0.0236)	-0.0162* (0.0232)	-0.0109 (0.0236)	-0.0118 (0.0235)
log(Totass)	-0.1659* (0.0175)	-0.0804** (0.0160)	-0.0771** (0.0158)	-0.0826* (0.0150)	-0.0887** (0.0148)	-0.0885** (0.0148)
MGT1	-0.1588** (0.1761)					
Excluding Mgt						
OVER2	-0.1452 (0.1033)	0.1250 (0.1018)				
Excluding OVER2						
ASSUT1	-0.2500 (0.3617)	0.3081 (0.3994)	0.4078 (0.3915)			
Excluding ASSUT1						
PLS	-0.0329* (0.0700)	-0.0663 (0.0722)	-0.0598 (0.0720)	-0.0634 (0.0719)	-0.0962* (0.0735)	-0.0993 (0.0730)
SLM	0.0306 (0.5002)	-0.1564 (0.4159)	-0.1365 (0.4166)	-0.1704 (0.4152)	-0.4896 (0.4315)	-0.5329 (0.4225)
MURBH	-0.0447* (0.0333)	-0.0336 (0.0787)	-0.0248* (0.0784)	-0.0335 (0.0780)	-0.0873 (0.0796)	-0.0838 (0.0791)
Bsize	0.0155* (0.0498)	0.0108 (0.0097)	0.0118 (0.0096)	0.0081 (0.0092)	0.0052 (0.0095)	
Excluding Bsize						
FBSIZE	0.0664 (0.2770)	-0.0805 (0.0892)	-0.0761 (0.0892)	-0.0760 (0.0891)	-0.0685 (0.0943)	-0.0786 (0.0925)
FECOS	0.2277** (0.1170)	0.4773* (0.1289)	0.4651** (0.1288)	0.4559*** (0.1285)	0.3651*** (0.1332)	0.3737*** (0.1322)
Ecoedu	0.3003*** (0.0998)	0.3352* (0.1492)	0.3739** (0.1459)	0.3830** (0.1456)		
Excluding ECOs education						
Bedu	0.3777*** (0.1325)	0.4667* (0.1347)	0.4938** (0.1330)	0.4785*** (0.1323)		
Excluding board education						
Adjusted R ²	0.4582	0.4479	0.4331	0.4308	0.4305	0.4300
Obs	289	289	289	289	289	289

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 10, 5 and 1%, respectively
Source: Table by the authors

Table 8. Robustness check: dependent variable is CRDR1

Variable name	Variable measure	Original eq.	(1)	(2)	(3)	(4)	(5)
Constant			-0.3126* (0.1151)	0.0259 (0.1803)	-0.0371 (0.1731)	-0.1292 (0.1450)	-0.1505 (0.1419)
AGE			-0.1065 (0.0885)	-0.0122 (0.0083)	-0.0113 (0.0082)	-0.0103 (0.0082)	-0.0104 (0.0080)
TYPE			0.1081 (0.1852)	-0.0065 (0.0246)	-0.0016 (0.0242)	0.0014 (0.0239)	0.0209 (0.0223)
Specialised			-0.0055 (0.0186)	-0.0007 (0.0089)	-0.0013 (0.0088)	-0.0028 (0.0087)	-0.0064 (0.0084)
log(Torass)			0.0518* (0.2272)	0.0042 (0.0063)	0.0053 (0.0062)	0.0079 (0.0056)	0.0066 (0.0053)
MGT1			0.0659 (0.0998)				
OVER2	Excluding Mgt						
	OVER2		-0.2479 (0.0284)	0.0423 (0.0392)			
ASSUT1	Excluding OVER2						
	ASSUT1		0.0700 (0.2285)	-0.2416 (0.2163)	-0.2182 (0.2153)		
	Excluding ASSUT1						
PLS			0.0002 (0.0270)	0.0165 (0.0275)	0.0177 (0.0274)	0.0218 (0.0270)	0.0349 (0.0264)
SLM			-0.0339 (0.1555)	-0.0112 (0.1556)	-0.0038 (0.1555)	0.0099 (0.1549)	0.0650 (0.1535)
MURBH			0.0539** (0.0220)	0.0685** (0.0295)	0.0717* (0.0293)	0.0752** (0.0290)	0.0898** (0.0283)
Bsize			0.0033 (0.2540)	0.0063* (0.0037)	0.0067* (0.0037)	0.0073** (0.0035)	0.0091* (0.0034)
	Excluding Bsize						
FBSIZE			0.1336 (0.2306)	0.0054 (0.0333)	0.0068 (0.0332)	0.0070 (0.0332)	0.0049 (0.0336)
FECOS			-0.1220 (0.1375)	0.0094 (0.0484)	0.0052 (0.0481)	0.0098 (0.0479)	0.0295 (0.0473)
Ecoedu			0.1226 (0.0915)	-0.0156 (0.0557)	-0.0035 (0.0546)	-0.0055 (0.0545)	
	Excluding ECOs education						
Bedu			-0.1022* (0.0333)	-0.1179* (0.0509)	-0.1097* (0.0502)	-0.0996* (0.0493)	
	Excluding board education						
Adjusted R ²			0.2678	0.1450	0.1440	0.1441	0.1307
Obs			225	225	225	225	225

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source: Table by the authors

Table 9. Robustness check: dependent variable CRDR3

Variable name	Original eq.	(1)	(2)	(3)	(4)	(5)
Constant	-0.1666** (0.0651)	0.0498 (0.0531)	0.0272 (0.0507)	0.0153 (0.0424)	0.0031 (0.0419)	0.0391 (0.0424)
AGE	0.1006 (0.0114)	-0.0020 (0.0026)	-0.0016 (0.0025)	-0.0015 (0.0025)	-0.0014 (0.0024)	-0.0022 (0.0026)
TYPE	-0.0188 (0.0558)	-0.0173* (0.0070)	-0.0152** (0.0069)	-0.0148** (0.0068)	-0.0075 (0.0065)	-0.0079* (0.0069)
Specialised	0.1029 (0.1026)	0.0052** (0.0026)	0.0050* (0.0025)	0.0048** (0.0024)	0.0040 (0.0025)	0.0035 (0.0026)
log(Totass)	0.1030* (0.0230)	-0.0010 (0.0019)	-0.0006 (0.0019)	-0.0003 (0.0018)	-0.0009 (0.0017)	-0.0006 (0.0017)
MGT1	0.02776* (0.0186)					
Excluding Mgt						
OVER2	-0.0666 (0.0114)	-0.0163 (0.0116)				
Excluding OVER2						
ASSUT1	0.1200 (0.0788)	-0.0347 (0.0623)	-0.0265 (0.0621)			
Excluding ASSUT1						
PLS	-0.0163 (0.0116)	-0.0102* (0.0090)	-0.0090 (0.0090)	-0.0083 (0.0088)	-0.0015 (0.0088)	-0.0016 (0.0090)
SLM	-0.0442 (0.0320)	-0.0347 (0.0450)	-0.0319 (0.0447)	-0.0302 (0.0444)	-0.0089 (0.0448)	-0.0314* (0.0463)
MURBH	-0.0322 (0.0584)	-0.0107 (0.0092)	-0.0094 (0.0091)	-0.0088 (0.0089)	-0.0046 (0.0091)	-0.0006 (0.0094)
Bsize	0.0066 (0.2891)	0.0025* (0.0011)	0.0026** (0.0011)	0.0028** (0.0010)	0.0035* (0.0010)	
Excluding Bsize						
FBSIZE	0.1556 (0.1327)	0.0132 (0.0095)	0.0138 (0.0095)	0.0138 (0.0095)	0.0129 (0.0097)	0.0079 (0.0100)
FECOS	-0.2005 (0.0667)	-0.0119 (0.0144)	-0.0131 (0.0143)	-0.0126 (0.0143)	-0.0029 (0.0144)	-0.0010 (0.0150)
Ecoedu	-0.0999 (0.0345)	-0.0135 (0.0176)	-0.0078 (0.0171)	-0.0083 (0.0169)		
Excluding ECOs education						
Bedu	-0.0551 (0.0160)	-0.0503* (0.0161)	-0.0459** (0.0159)	-0.0444** (0.0155)		
Excluding board education						
Adjusted R ²	0.3365	0.0912	0.0831	0.0899	0.0386	-0.0445
Obs	207	207	207	207	207	207

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source: Table by the authors

Table 10. Robustness check using random effects model

Variable name	CAPAD1	CAPAD2	CREDR1	CREDR3
Constant	1.2983* (0.4820)	1.2145** (0.5031)	-0.8297* (0.2152)	-0.6692* (0.0591)
AGE	0.0798** (0.0213)	0.0767** (0.0221)	-0.0074 (0.0086)	0.0007 (0.0024)
TYPE	0.0814 (0.0622)	-0.0213 (0.0642)	0.0106 (0.0249)	-0.0083 (0.0066)
Specialised	-0.0286 (0.0220)	-0.0122 (0.0231)	-0.0055 (0.0089)	0.0027 (0.0024)
log(Totass)	-0.0731** (0.0164)	-0.0921* (0.0175)	0.0124** (0.0072)	0.0033* (0.0020)
MGT1	-0.2256*** (0.0721)	-0.1651** (0.0754)	0.0651** (0.0318)	0.0334 (0.0085)
OVER2	-0.0578 (0.0982)	-0.1694* (0.1009)	-0.0160 (0.0402)	-0.0026 (0.0112)
ASSUT1	-0.0739 (0.4631)	-0.2912 (0.4798)	0.0796 (0.2619)	0.1312 (0.0709)
PLS	-0.1281* (0.0695)	-0.0258* (0.0725)	0.0007 (0.0277)	0.0168 (0.0085)
SLM	0.6415 (0.3952)	-0.0437 (0.4089)	-0.0466 (0.1519)	-0.0507 (0.0413)
MURBH	-0.2279*** (0.0737)	-0.0207 (0.0765)	0.0642** (0.0286)	-0.0112 (0.0083)
Bsize	0.0218** (0.0094)	0.0158* (0.0099)	0.0047 (0.0037)	0.0014 (0.0011)
FBSIZE	-0.1058 (0.0833)	-0.0827 (0.0867)	0.0065 (0.0321)	0.0139 (0.0087)
FECOS	0.5412** (0.1210)	0.4531* (0.1262)	0.0156 (0.0473)	-0.0083** (0.0133)
Ecoedu	0.5026* (0.1397)	0.3129** (0.1455)	-0.0107 (0.0543)	-0.0107** (0.0162)
Bedu	0.3464** (0.1267)	0.4478*** (0.1319)	-0.1091* (0.0499)	-0.0457* (0.0149)
Adjusted R ²	0.5109	0.4437	0.3614	0.4878
Obs	289	289	225	207

Note(s): Numbers without brackets are the coefficients and numbers in brackets are the standard deviations. ***, ** and * indicate significance levels of 1, 5 and 10%, respectively

Source: Table by the authors

capture both within- and between-entity variation and are particularly useful when variation across banks is of substantive interest. This test provides additional confidence that the results are not driven by unobserved characteristics unique to individual banks or years.

Across all three robustness tests, the key results remain consistent, suggesting that the identified associations between corporate governance attributes – namely, gender diversity and the educational profile of bank managers – and various measures of risk-taking behavior are not sensitive to alternative model specifications or estimation strategies. These findings reinforce the validity of the main conclusions and reduce the likelihood of spurious relationships.

6. Conclusion

This study empirically examines the relationship between gender diversity, specifically at the levels of departmental managers and the board of directors, and risk-taking behavior in Sudanese Islamic banks. It also explores the influence of highly educated personnel at these two hierarchical levels. The study uses capital adequacy, the equity-to-assets ratio and two indicators of credit risk as the outcomes of interest. The results suggest that having female managers at the departmental level is associated with lower bank risk, operating primarily through two distinct mechanisms. First, female departmental managers are associated with higher capital adequacy and equity-to-assets ratios, enhancing the banks' resilience against unexpected losses. This increased capital base also provides a buffer against losses from non-performing loans when loan loss provisions prove insufficient. This suggests that women in these roles tend to support policies favoring higher capital ratios, potentially reflecting a more conservative credit risk approach. Second, the analysis reveals a significant negative relationship between female departmental managers and the two credit risk measures, providing strong evidence that appointing women to these managerial positions in Sudanese

Islamic banks is associated with a conservative risk policy. This suggests that females in such roles tend to adopt strategies that reduce the banks' liabilities. In contrast, the presence of females on the board of directors does not show a significant effect on either credit risk measures or capital-to-equity ratios. Regarding educational diversity, the findings indicate a positive association between the proportion of PhD holders in both departmental management and the board of directors and capital adequacy ratios. Furthermore, banks led by well-educated senior managers and board members tend to experience lower levels of credit risk.

The central finding of this study is that the presence of female departmental managers within Sudanese Islamic banks is strongly associated with risk-averse behavior, which, in turn, contributes to a reduction in the overall risk exposure of these institutions. Additionally, the presence of highly educated senior managers and board members enhances the banks' decision-making processes and moderates their risk-taking practices. The observation that female departmental managers in Sudanese banks tend to demonstrate greater risk aversion significantly enriches our understanding of the factors influencing risk-taking behavior. This insight carries important implications for banking regulators and policymakers. Efforts to curb excessive risk-taking should extend beyond traditional capital adequacy requirements to include improvements in corporate governance frameworks. Specifically, promoting greater female representation in executive management could be an effective strategy, alongside encouraging male managers to adopt more cautious risk approaches. Moreover, the findings highlight the vital role of advanced educational qualifications among senior managers and board members in mitigating risk-taking tendencies. This suggests that regulatory bodies and bank leadership should emphasize recruiting highly educated individuals for top managerial and board positions. Islamic banks, in particular, are encouraged to appoint senior managers with strong academic credentials, as this appears to strengthen decision-making quality and promote more prudent risk management.

Overall, this research provides novel insights for regulators and industry practitioners about how gender diversity, coupled with educational attainment, influences risk behavior in Islamic banking, offering practical guidance for enhancing governance and risk control. While certain informal practices may encourage gender inclusivity and value academic qualifications, Sudan currently lacks formal regulatory requirements mandating such criteria. This absence underscores the practical significance of our findings, which provide empirical evidence supporting the potential advantages of implementing formal policies that foster gender-balanced leadership and emphasize advanced educational credentials among executives in Islamic financial institutions. Moreover, these results contribute meaningfully to the ongoing discourse on gender diversity within corporate governance literature by highlighting its role in improving the oversight of bank risk-taking and promoting overall financial stability. Our study further advances corporate governance theories by situating them within the distinctive institutional and operational context of Islamic banks in emerging markets. In particular, the evidence affirms that gender diversity and educational attainment are critical factors influencing risk behavior, thereby validating traditional governance models within the specific framework of Islamic banking.

This study is subject to certain limitations, primarily related to its geographic scope. Sudan provides a unique institutional context, as it operates a fully Islamic financial system without the presence of conventional banking. This makes it a theoretically relevant setting for examining governance mechanisms, such as board gender diversity, in their most concentrated Shariah-compliant form. While the insights derived from this context can enrich understanding of governance in Islamic finance, caution should be exercised in extending these results to countries with dual banking systems or differing regulatory and

cultural environments. Future research could expand the scope by incorporating comparative analyses across multiple jurisdictions and more recent data to enhance external validity and to explore how institutional and temporal differences shape the governance–risk-taking nexus in Islamic banking. It would also be valuable to expand this study by conducting a more in-depth analysis of board characteristics to build a more robust body of evidence. Additionally, examining the socio-cultural backgrounds of foreign directors from different nationalities could offer deeper insights into how cultural diversity influences board dynamics and decision-making.

Declaration of interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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