

RISK GOVERNANCE AND BANK RISK OF PUBLIC COMMERCIAL BANKS OF OECD

Muddassar Malik *

* Department of Accounting and Finance, Turku School of Economics, University of Turku, Turku, Finland;
Department of Banking and Global Financial System, Department of Econometrics and Operations Research,
College of Economics, Finance and Law, Krakow University of Economics, Krakow, Poland
Contact details: Krakow University of Economics, Rooms 153 & 152, Pawilon B, Rakowicka 27, 31510 Krakow, Poland



Abstract

How to cite this paper: Malik, M. (2024). Risk governance and bank risk of public commercial banks of OECD. *Risk Governance and Control: Financial Markets & Institutions*, 14(1), 19–34. <https://doi.org/10.22495/rgcv14i1p2>

Copyright © 2024 The Author

This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). <https://creativecommons.org/licenses/by/4.0/>

ISSN Online: 2077-4303

ISSN Print: 2077-429X

Received: 20.12.2023

Accepted: 16.02.2024

JEL Classification: G32, G21, G28, F36

DOI: 10.22495/rgcv14i1p2

This study investigates the impact of risk governance on bank risk within the Organisation for Economic Co-operation and Development (OECD) public commercial banks. Utilizing Knight's (1921) distinction between risk and uncertainty, it emphasizes the roles of key figures like bank directors, the chief risk officer (CRO), and the chief financial officer (CFO) in risk management. The research employs multivariate regression analysis and principal component analysis (PCA) to reveal a positive correlation between risk governance and the Tier 1 capital ratio, indicating that effective governance leads to reduced bank risk and increased financial stability. This finding is consistent with Aebi et al.'s (2012) study on risk management and bank performance. These results underscore the crucial role of robust risk governance in banking, suggesting that enhanced governance practices can significantly mitigate risks. The study contributes to the existing literature by providing empirical evidence supporting the quantification of risk through governance mechanisms, aligning with, and enriching current theoretical frameworks. While highlighting the importance of these findings, the study also acknowledges its limitations, such as potential endogeneity issues, and suggests directions for future research to expand the understanding of risk governance's impact on bank behavior, including the exploration of additional variables and the integration of qualitative methodologies. This research holds significant implications for banking institutions and regulatory bodies, advocating for a deeper examination of risk governance strategies in banking.

Keywords: Risk Governance, Bank Risk, Tier 1 Capital Ratio, OECD Banks

Authors' individual contribution: The Author is responsible for all the contributions to the paper according to CRediT (Contributor Roles Taxonomy) standards.

Declaration of conflicting interests: The Author declares that there is no conflict of interest.

Acknowledgements: The Author is thankful for the invaluable comments received during the presentations of this paper at the 9th Annual Conference "Risk Governance: Culture Matters!" at the University of Siegen, Siegen, Germany, on October 28, 2021, MÖDAVICA 2021: 18th International Conference on Accounting, New Dynamics of Accounting — Transformation in Theory and Practice on Istanbul, Turkey, on November 26, 2021, World Finance & Banking Symposium at the Corvinus University Budapest, Budapest, Hungary, on December 17–18, 2021, and Brownbag Seminar at the Maastricht University, Maastricht, the Netherlands, on February 23, 2022.

1. INTRODUCTION

Risk governance, a nascent yet evolving theme, is garnering considerable attention across industries, particularly within the banking sector. The principles of risk governance are not confined to one specific subject or field. They can be applied at both the individual organization (micro) level and the broader industry or economy (macro) levels. This applicability extends across various institutions and industries, in compliance with relevant regulations and policies.

The focal point of this study is the internal risk governance of public commercial banks within the Organisation for Economic Co-operation and Development (OECD)¹. Risk governance in banks pertains to the coordinated endeavors of different departments to manage risk in line with the bank's policies and the stipulations set forth by regulatory authorities. To grasp the essence of risk governance, it is necessary to elucidate the notions of governance, corporate governance, risk, and risk management, as risk governance serves as an integrative link between corporate governance and risk management.

As per the International Risk Governance Council (IRGC)², governance encapsulates the mechanisms, processes, traditions, and institutions through which power is exercised and decisions are taken and implemented. Analogously, corporate governance, as Brickley and Zimmerman (2010) postulate, following Jensen and Meckling (1976) and Coase (1937), assumes the form of a nexus of contracts. This entails all formal and informal contracts significantly impacting top-level decision-makers, not merely those between the firm and debt holders but also those between the firm and senior managers, shareholders, employees, and potentially, other relevant stakeholders.

Prior to delving into risk governance, it is critical to establish a firm understanding of risk and risk management. Jarvis (2011), in theorizing risk and uncertainty, draws from Knight's (1921) perspective. Knight differentiated between risk and uncertainty, positing that risk arises from events and phenomena that can be objectively observed and quantified, with discernible causalities whose frequency, severity, and magnitude of consequences can be reasonably appraised. On the other hand, uncertainty deals with events that are unforeseeable and cannot be quantified. Jarvis (2011) utilizes this foundational distinction in their discussion on risk and uncertainty. Thus, the risk is tangible and can be quantified by calibrating observable data against the frequency of their reoccurrence.

Over time, like corporate governance, risk management has evolved, with multiple definitions proposed in scholarly literature. Dionne (2013) and Stulz (2003, 2008) perceive risk management in corporations as a suite of financial or operational activities aimed at enhancing the firm's value by mitigating the costs associated with low cash flow volatility. Low cash flow volatility can enhance investor confidence, provide predictability in financial performance, and secure favorable financing terms. However, there are situations where businesses might allow more cash flow volatility, recognizing

the potential for higher returns and the ability to capitalize on market opportunities, while balancing the associated risks.

Historically, both corporate governance and risk management practices haven't provided clear delineations for risk oversight, supervision, and executive responsibilities. This ambiguity could have enabled financial institutions to take on more risk than optimal, potentially leading to detrimental outcomes. As observed in the aftermath of the financial crisis, this excessive risk-taking underscored the importance of establishing well-defined risk-related roles within the corporate governance structure and entrusting them to specialists to foster improved financial performance.

In the early 2000s, risk governance was initiated by the IRGC and later elaborated by van Asselt and Renn (2011) to address environmental concerns. Subsequently, the concept was integrated across multiple disciplines. Still, the introduction, implementation, and scholarly contribution to risk governance within the banking industry remains nascent and scarce. According to the IRGC, effective risk governance involves the application of good governance principles to the identification, assessment, management, and communication of risks.

To achieve efficacious risk governance, it is essential to have all necessary internal functions in place. Comprehensive risk governance encompasses not only the risk committee (RC), chief risk officer (CRO), and chief financial officer (CFO), but also directors across the board. Adams (2012) emphasizes the integrative role of directors in ensuring an effective risk oversight structure. The RC provides real-time insights into the bank's risk management, a point highlighted by Power (2009) in the context of real-time risk assessments. Furthermore, Beasley et al. (2010) stress the significance of the CFO for understanding the bank's financial health and associated risks, and how the CFO communicates these insights to the RC and CRO.

Additionally, the characteristics of board members, including their educational background and age, play pivotal roles in risk governance. Directors with PhD degrees are often more cautious and conscientious in performing their duties and complying with the bank's risk policies (Berger et al., 2014). Age is a significant factor reflecting directors' experience, with senior directors bringing greater experience and rationality to risk management in accordance with bank policies and regulatory compliance (Berger et al., 2014). The role of independent directors is significant in achieving the bank's risk targets. As they are not part of the day-to-day operations, independent directors can provide an objective assessment of risk management strategies. Additionally, their different backgrounds and experiences bring diverse perspectives, enhancing the breadth and depth of board discussions (Vallasca et al., 2017).

This study seeks to enrich the extant literature on risk governance within the banking industry. Notable research by Aebi et al. (2012), Minton et al. (2011), Erin et al. (2018), Gontarek (2016), Gontarek and Belghitar (2018), Gontarek and Bender (2019), and Karyani et al. (2020) has previously explored certain aspects of risk governance within the financial sector. Given the profound economic role and global influence of banks, it is crucial to deepen

¹ <https://www.oecd.org/>

² <https://irgc.org/>

the understanding of bank risk, defined as a bank's engagement in business and investment activities intended to augment profits while simultaneously mitigating risk by reducing risky investment portfolios during financial upheavals.

This study primarily examines risk governance and bank risk within public commercial banks of the OECD. As OECD banks constitute a major portion of the global banking industry, the findings of this research could have important implications for how these banks manage and oversee risk, thereby giving the research high strategic importance. The shared economic objectives and developments within the OECD underpin the need to scrutinize and comprehend the risk governance of its banks.

The research builds upon Knight's (1921) distinction between "risk" and "uncertainty". In his conception, "risk" refers to measurable and quantifiable uncertainties where probabilities can be assigned based on past data or reasoned judgment, whereas "uncertainty" pertains to events with indeterminable probabilities. This study provides empirical evidence supporting the quantifiability of risk through risk governance in banks. The collective efforts of directors are vital in assessing bank risk, which encapsulates all forms of risk, including credit, market, and operational risks. To explore the impact of risk governance on bank risk within public commercial banks of the OECD, the study poses the following research question:

RQ: What is the impact of risk governance on the bank risk of public commercial banks of the OECD?

The remainder of this research paper is organized as follows. Section 2 provides the theoretical underpinnings, reviews related literature, and formulates the research hypothesis. Section 3 details the research design, data collection, methods, and econometric model specifications. Section 4 presents the descriptive statistics, tests for multicollinearity among the research variables, and discloses the multivariate regression results. Section 5 discusses the results. Lastly, Section 6 concludes the study.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Unrestrained risk poses a significant threat to firms in the banking sector. Comprehensive risk management and governance play a pivotal role in promoting effective economic outcomes by minimizing exposure to potentially detrimental risks. It is important to note that risk is not confined to particular departments within a bank; instead, it is contributed to by all units. Ideally, each department identifies and quantifies its specific risks and reports them to the RC, which in turn communicates these risks to the CRO and the board. Similarly, directors are obligated to quantify risk in their specific areas of responsibility and report to the RC. This process allows risk to be managed and governed efficiently and effectively within a bank. Risk governance within banks enables the identification, assessment, communication, and application of risk levels, adhering to bank policies and regulatory requirements.

A lack of coordination and dysfunctional behavior between departments and directors concerning risk can lead to excessive risk exposure. Over time, the need for a broader scope in handling risk-related

matters within a bank has become apparent, leading to active development since the 1980s of measures such as the Basel Capital Accord (BCA), Basel Committee of Banking Supervision (BCBS), Financial Stability Board (FSB)³, Sarbanes-Oxley Act (SOX)⁴, Dodd-Frank Act of 2010 (DFA), and EU Capital Directive 2013/36/EU (ECD). This shift in perspective led to the allocation of risk matters to the RC and CRO. However, the definition of internal bank risk remains unclear, contributing to bank failures during and around the global financial crisis (GFC). This gap in understanding has been recognized by researchers, who have proposed several solutions to manage risk. Failures in corporate governance (Berger et al., 2016) and inefficient risk management (Poole, 2007) prompted researchers to consider improved methods for risk supervision (Berger et al., 2022), leading to the gradual introduction of risk governance within banks.

Risk governance was first introduced by scientists from environmental sciences to address natural hazards (van Asselt & Renn, 2011; Heriard-Dubreuil, 2001). They defined risk governance as the identification, assessment, and communication of risks. This definition allowed social science researchers to bridge the gap between corporate governance and risk management (Stein & Wiedemann, 2016). In the aftermath of the GFC, regulatory authorities introduced risk governance to banks (DFA, ECD, BCBS), necessitating the establishment of a dedicated RC featuring at least one risk expert. As risk governance aids in quantifying risk, this research aligns with Knight's (1921) conception of risk, in which risk is defined as measurable. This perspective underscores the importance of risk governance in effectively quantifying and managing risk.

The premise that banks can quantify risk through risk governance finds resonance with Knight (1921). Knight argued that risk is quantifiable when the outcome's probability is known. Accordingly, banks' capacity to quantify their risk is inextricably linked to their internal risk governance. The efficacy of this risk measurement hinges on the robustness of a bank's risk governance framework. This study examines six carefully chosen risk governance characteristics, extending beyond the responsibilities of just the RC and the CRO. Depending on the robustness of their risk governance, banks can effectively measure and quantify risk when the probability of outcomes is known. This aligns with Knight's notion that risk is quantifiable based on known probabilities. The strength of this risk quantification is deeply tied to the quality of a bank's internal risk governance structures.

Efficient risk governance enables banks to communicate risks both internally and across departments. The intricate and rapidly evolving nature of the banking industry demands both a significant commitment and various skills from bank boards. Recent studies, such as Beltrame et al. (2022), also illustrate how FinTech investments are reshaping risk governance in modern banking. The relentless challenges posed by this environment underscore the need for a dedicated RC at the board level, equipped with risk-related expertise and experience. However, empirical research regarding

³ <https://www.fsb.org/>

⁴ <https://sarbanes-oxley-act.com/>

the size of the RC, considered a proxy for influence and effectiveness, remains sparse (Gontarek & Belghitar, 2018). The authors further note that boards with robust RCs are less prone to engage in excessive risk-taking, a viewpoint corroborated by McNulty et al. (2013).

Independent directors play a crucial role in a bank's risk governance. They bring unique perspectives, which can lead to enhanced value, and they may also bring experience and expertise from various sectors. While independence is not necessarily related to experience and expertise, it aids in fostering impartiality towards the bank's internal decisions. These directors aim to ensure decision-making that is as free from bias as possible. Gouiaa and Gaspard (2021) provide a comparative perspective by analyzing the performance of Islamic financial institutions against traditional banks. In the aftermath of the SOX introduction, Barger et al. (2010) found a significant reduction in risk among publicly traded United States (US) companies. This was partly attributed to the expanded role of independent directors. SOX imposes penalties on directors for endorsing risky, costly-to-monitor investments, which has driven an increase in the representation of independent directors and consequent liability, leading to a reduction in bank risk (Barger et al., 2010). However, it's worth noting the different risk preferences within the bank's hierarchy. Managers, who are often driven by firm-specific human capital and private benefits of control, tend to pursue lower risk levels than shareholders (Laeven & Levine, 2009). This dynamic suggests that the risk preferences of managers and shareholders can vary significantly, a reality that independent directors must consider in their risk governance roles.

The existing body of research presents compelling evidence that risk governance substantially impacts bank risk. Scholars assert that a financial educational background significantly contributes to risk mitigation. The financial expertise of directors thus emerges as a crucial factor, with Berger et al. (2014) noting that companies with older, more experienced executives typically exhibit lower levels of financial leverage and risk. Porretta and Benassi (2021) further highlight this by examining sustainable practices in cooperative banks and their influence on risk governance. Other influences on risk, such as capital ratios and the level of risk related to a bank's ownership structure, may be significant considerations. Laeven and Levine (2009) and Ellis et al. (2014) have underscored the profound connection between governance and risk. This connection, involving the influence of governance structures and practices, the bank's risk culture, and decision-making processes related to risk management, is pivotal to understanding the dynamics of risk in a banking environment.

Internal risk governance serves as a metaphorical protective buffer for banks, aiding in the prevention of potential losses. Directors are particularly tasked with the accurate assessment and appropriate communication of risks throughout the banking organization. Their effectiveness is crucial in supervising and providing oversight of the bank's risk management activities, which are typically carried out by the chief executive officer (CEO) and the management team. Cognitive illusions and irrational decision-making are the primary culprits of bank failures, as noted by McConnell (2013).

Additionally, the role of financial technology in risk management, as explored by Hundal and Zinakova (2021), has become increasingly significant, especially in the context of the COVID-19 pandemic. Acknowledging these vulnerabilities, the US Office of the Comptroller of the Currency (OCC)⁵ issued a mandate for banks to establish and maintain comprehensive risk governance within their organizations to avoid unsatisfactory ratings and potential regulatory enforcement actions. This mandate emphasizes the critical nature of robust risk management and governance in banking (OCC, 2019).

A higher equity value in banking institutions often signifies enhanced stability. Von Borowski Dodl (2020) discusses how central banks, like the Central Bank of Brazil, contribute to this stability through efficient risk governance. This notion of boosting a bank's equity has been advocated by influential sources such as *The Wall Street Journal*, as quoted by Bhagat et al. (2015). This recommendation is in alignment with the advice of Bhagat et al. (2015), Admati and Hellwig (2014), and Bhagat and Bolton (2014) to increase equity capital. Research has shown that banks with insufficient governance structures frequently increase their risk exposure following a reduction in short-term interest rates. This scenario is particularly relevant for well-capitalized banks as emphasized by Dell'Ariccia et al. (2017). They further posit that banks with lower capitalization may face distress if they chase high yields during periods of low-interest rates. However, it is important to remember that risk is an integral part of banking operations. By enhancing risk governance, banks can better manage risk levels, aligning them with their risk tolerance and regulatory requirements. This could be achieved through comprehensive risk assessment, rational decision-making, effective risk mitigation strategies, continuous risk monitoring, and appropriate capital allocation based on risk levels. Improving capital ratios, such as the ratio of a bank's core equity capital (Tier 1 capital) to its total risk-weighted assets, enhances a bank's ability to absorb losses. Based on this discussion, this study hypothesizes:

H1: Risk governance is positively associated with the Tier 1 capital ratio.

3. RESEARCH DESIGN

3.1. Data collection and description

To test the hypothesis, data is needed that captures the relationship between bank risk and various governance characteristics over a span of years. Specifically, data showcasing the interactions between individual directors and the banks they serve, and how these interactions evolve over time, is of interest.

To compile a comprehensive dataset, data was drawn from two primary sources: the BankFocus database, which offers detailed financial information about banks, and the BoardEx database, which provides extensive details about board directors. To ensure the completeness and reliability of the dataset, only those observations that were present in both databases — referred to as “matched” observations — were retained.

⁵ <https://www.occ.treas.gov/index.html>

The dataset utilized in this study encompasses a total of 14,596 observations across directors at various banks spanning the years from 2001 to 2020. These bank-director years represent unique combinations of bank, director, and year. The dataset also includes 1125 unique bank-years, indicating the presence of 1125 distinct banks across the covered years. Furthermore, the dataset contains 14,404 director-year observations, which represent unique combinations of directors and years (Adams & Mehran, 2012). Furthermore, the dataset contains 14,404 director-year observations, representing unique combinations of directors and years in the dataset.

The dataset used in this study encompasses a comprehensive range of 20 variables. These variables detail bank-related attributes, directors' information, and pertinent financial metrics. Notably, the dataset includes country designation, the bank's unique International Securities Identification Number (ISIN), and individual identifiers for each director. Key variables represented are *TIER1*, *AVARPTP*, *RC*, *CRO*, *CFO*, *TITLE*, *SENIOR*, and *BI*, among others. Furthermore, the dataset incorporates additional attributes such as year and bank, culminating in a total of 20 variables. Financial data was sourced from the BankFocus database, while directors' details were extracted from the BoardEx database.

The dataset encompasses 28 distinct countries of the OECD, with a total of 120 unique banks and 3,151 unique directors (OECD, 2010). Frequencies indicate that 81 banks have an *RC*, 15 banks have a *CRO*, 54 banks have a *CFO*, 91 banks have a *TITLE*, 117 banks have a *SENIOR*, and 118 banks have a *BI* (Adams et al., 2005; Adams & Ferreira, 2009; Cornett et al., 2008).

The data collection process specifically targeted banks that are active, listed, and whose financial reporting adheres to specific classification codes from the BankFocus database. Specifically, these banks have C1 financial statements, denoting "Primary consolidated" statements. Such statements consolidate the reports of controlled subsidiaries or branches, ensuring no unconsolidated companion is present. Additionally, the C* classification represents "Additional consolidated" statements, encompassing any other consolidated financial reports beyond

the primary ones. These classification codes were chosen because they provide a comprehensive view of each bank's financial condition by integrating information from all its controlled entities.

While the dataset encompasses a diverse range of data from multiple countries and banks, it is acknowledged that potential outliers might be present. Nevertheless, in the context of this study, these outliers have not been excluded as they might represent unique but essential banking scenarios in specific regions or institutions. Such observations can provide pivotal insights into the multifaceted dynamics of bank risk governance across different environments. Thus, for reasons of transparency and comprehensive representation, all data points, including outliers, have been considered in the analysis.

3.2. Research methods

The adopted methods for this study incorporate multivariate regression analysis, underpinned by the theoretical underpinnings outlined in the paper. A composite index was devised using principal component analysis (PCA) to provide a consolidated measure that captures the combined influence of six key risk governance characteristics: *RC*, *CRO*, *CFO*, *TITLE*, *AGE*, and *BI*. This composite index offers a more holistic view of risk governance, allowing for a comprehensive assessment of how these multiple characteristics interact and collectively impact bank risk. Variables of interest, namely *RC*, *CRO*, *CFO*, *TITLE*, *AGE*, and *BI*, were first standardized to reconcile differences in scale and ensure comparability. Following the standardization, a composite index was devised using PCA that encompasses these six risk governance characteristics. The PCA was conducted on the standardized variables to identify the principal components that would explain the greatest variance in the data. Subsequently, the data was transitioned into a panel setup, arranged based on unique combinations of bank and director identifiers and the corresponding year (Wooldridge, 2010).

The econometric model that guides this research is structured as follows.

$$Risk_{b,t} = \alpha_0 + \beta_1 RGI_{b,t} + \beta_2 X_{b,t} + \alpha_b + \delta_t + \theta_{b,t} + \varepsilon_{b,t} \quad (1)$$

In this model, *Risk* embodies the dependent variable, the *TIER1* ratio, which measures the risk level of public commercial banks in the OECD; *b* represents the bank at time *t*; α_0 is a constant in regression models, and *RGI* encapsulates the risk governance indicators: *RC*, *CRO*, *CFO*, *TITLE*, *SENIOR*, and *BI*. *X* symbolizes bank controls that include *CEOAD*, *BS*, and *SIZE*. The terms α_b and δ_t denote fixed individual and time effects, respectively. The term θ pertains to clusters at the bank level (Petersen, 2008), which manage the correlation of residuals within a cluster of any form. As the number of clusters increases, the cluster-robust standard errors become consistent (Wooldridge, 2010). This one-way clustering at the bank level ensures independent and identically distributed residuals, which validates the statistical significance of the estimated coefficients (Scheuch et al., 2023); ε is the error term.

The main regression analysis was conducted using the "*reghdfe*" command in Stata, which is designed for high-dimensional fixed effects estimations. This method efficiently estimates models with multiple fixed effects, in this case, both year and bank. By absorbing these fixed effects, the analysis controls for unobservable characteristics that remain constant within each bank across time and across all banks in a given year. Additionally, by clustering the standard errors at the bank level, the method accounts for potential correlations in the residuals within banks over time, ensuring more robust and reliable coefficient estimates. To validate the robustness of Model 1, a bootstrap procedure with 100 repetitions was implemented in Model 1a. The bootstrap resampling method generates multiple replicated datasets by sampling with replacement from the original dataset. This approach allows for the estimation of coefficients' stability and provides robust standard errors. The estimated coefficients

and their significance levels are evaluated using the bootstrap results. To enrich the quantitative findings, incorporating qualitative methods such as in-depth interviews with banking executives could provide deeper insights into the practical aspects of risk governance. Additionally, exploring comparative analyses, perhaps through a longitudinal study across various banking systems, could offer invaluable perspectives on the evolution and effectiveness of risk governance practices globally.

To ensure the reliability of the primary model's findings, several robustness checks were conducted. Initially, a sensitivity analysis using *AVARPTP*, the average value at risk relative to pre-tax profit, was performed. This variable serves as a measure to understand the potential loss value, providing a critical assessment of the model's stability and sensitivity to changes or perturbations. Subsequently, the study introduced Model 2, aiming to evaluate the robustness of the relationship between specified variables such as *RGI*, *CEOAD*, *BS*, and *SIZE*, with *AVARPTP*. This was further substantiated by a bootstrap technique in Model 2a, mirroring the procedure utilized in Model 1, enhancing the rigor and reliability of the findings by assessing

their consistency across various conditions and assumptions. This multi-step approach ensures a comprehensive evaluation of the model's outcomes, bolstering confidence in the validity of the results. In understanding the dynamics between risk governance and bank risk, causality tests were executed. One test was conducted to ascertain whether the risk governance practices of previous years influence the present bank risk. Another test, known as a reverse causality test, was carried out to determine if the level of bank risk has a bearing on the subsequent implementation of risk governance mechanisms. These tests were carried out in accordance with the Granger causality method (Granger, 1969). To further enhance the understanding, a Granger causality test with 4 lags (i.e., 4 years) was also undertaken, focusing on the main dependent variable, *TIER1*, and the primary variable of interest, *RGI* (Granger, 1969). The results of this test will be presented in subsection 4.6 for a detailed discussion. Furthermore, future research could leverage advanced data analysis techniques, like machine learning, to predict risk governance outcomes, offering a nuanced understanding of these complex banking relationships.

Table 1. Variable definitions

| <i>Research variables</i> | <i>Measurements</i> | <i>Data source</i> |
|---------------------------|--|--------------------|
| <i>Dependent</i> | | |
| <i>TIER1</i> ^a | Tier 1 capital / Risk-weighted assets | BankFocus |
| <i>AVARPTP</i> | Average value at risk / Pre-tax profit | BankFocus |
| <i>Independent</i> | | |
| <i>RGI</i> | Risk governance index = <i>RC</i> , <i>CRO</i> , <i>CFO</i> , <i>TITLE</i> , <i>SENIOR</i> , <i>BI</i> | |
| <i>RC</i> | If the bank has a risk committee (1) and if not (0) | BoardEx |
| <i>CRO</i> | A binary variable that takes a value of 1 if the bank has a chief risk officer in a given year, and 0 otherwise | BoardEx |
| <i>CFO</i> | A binary variable that takes a value of 1 if the bank has a chief financial officer in a given year, and 0 otherwise | BoardEx |
| <i>TITLE</i> | If the director holds PhD degree (1) and if not (0) | BoardEx |
| <i>SENIOR</i> | If the director's age is between 66–75 years old (1) and if not (0) | BoardEx |
| <i>BI</i> | If the director is an independent director | BoardEx |
| <i>Control</i> | | |
| <i>CEOAD</i> | If the chief executive officer has an additional ^b position (1) and if not (0) | BoardEx |
| <i>BS</i> | Total number of directors on board | BoardEx |
| <i>SIZE</i> | Total assets | BankFocus |

Note: Table 1 delineates the dependent, independent, and control variables used in this study. The variables are explicitly defined, and their corresponding measurements are detailed for clarity. For reproducibility and verification purposes, the data source for each variable is also specified. The variables were operationalized based on standard definitions and measurement scales prevalent in the literature to maintain the consistency and validity of the research findings. This table serves as an essential resource in understanding the operational framework of the study and should be referred to when interpreting the research results.

^a *TIER1* refers to a bank's Tier 1 capital, which is divided into common equity Tier 1 (CET1) and additional Tier 1 (AT1). CET1 consists of common shares, stock surplus, retained earnings, other comprehensive income, qualifying minority interest, and regulatory adjustments, and it primarily absorbs losses as they arise. On the other hand, AT1 includes certain capital instruments and surplus, with some loss absorption on an ongoing basis. The percentages mentioned (CET1 > 4.5% and CET1 + AT1 > 6%) reflect regulatory benchmarks for these capital levels. Risk-weighted assets, which are used in the denominator of capital ratios, consider different asset risk categories (Bank for International Settlement, n.d.).

^b A binary variable that indicates whether the CEO holds an additional position, such as chairman of the board, within the bank in a given year (1 for "Yes" and 0 for "No").

4. RESEARCH RESULTS

4.1. Descriptive analysis

In this section, the descriptive statistics of the variables used in the study are presented. Descriptive statistics provide a comprehensive overview of the data, including measures of central tendency, dispersion, and the range of values observed for each variable. These statistics serve as a foundation for understanding the characteristics of the sample and provide insights into the distribution and variability of the variables (Demsetz & Strahan, 1997).

Among the variables, the average *TIER1* ratio is 13.21, with a standard deviation of 3.25. This observed variability in the *TIER1* ratio across the banks in the sample is indicative of their distinct capital structures and risk management strategies. Such differences can be attributed to variations in regulatory environments, bank size, business models, and prevailing market conditions. As a result, the variation in capital adequacy levels is expected given the diverse characteristics and operational contexts of the sampled banks. Under the Basel III recommendations (BCBS, 2011), banks are generally required to maintain a minimum Tier 1 capital ratio of 6%. A ratio below this can lead to

supervisory actions, placing the bank under special monitoring. On the higher end, values significantly above the average might indicate over-conservatism or underutilized capital by the bank. The study's findings are framed within the context of the Basel III guidelines as provided by BCBS (2011), which sets the standards for quality Tier 1 capital.

The presence of specific risk governance characteristics (*RC*, *CRO*, *CFO*, *TITLE*, *SENIOR*, and *BI*) is also examined. The mean values for these variables range from 0.14 to 0.51, indicating that these governance characteristics are present to varying degrees among the sampled banks (Pathan & Faff, 2013).

Other variables in the study include *CEOAD*, *BS*, and *SIZE*. These variables exhibit mean values of 0.08, 14.68, and €8,930 (measured in billions), respectively, highlighting the variation in board composition and the scale of operations among the banks (Adams & Mehran, 2012).

It is worth noting that descriptive statistics offer a preliminary insight into the patterns, central tendencies, and dispersions in the data pertaining to the variables' distribution and characteristics. While this provides an initial grasp, a more in-depth investigation, such as regression analysis, is essential to delve into the relationships between these variables and their implications on bank risk. However, further analysis and modeling are required to examine the relationships and assess the impact of these variables on bank risk.

After the descriptive analysis, the next subsection explores the correlation among the variables to identify potential relationships and dependencies (see subsection 4.2).

Table 2. Descriptive statistics

| Variable | Obs. | Mean | Std. dev. | Min | Max |
|---------------|--------|---------|-----------|--------|----------|
| <i>TIER1</i> | 1,783 | 13.2075 | 3.2500 | 8.8000 | 32.6000 |
| <i>RC</i> | 14,596 | 0.1962 | 0.3971 | 0 | 1 |
| <i>CRO</i> | 14,596 | 0.0056 | 0.0743 | 0 | 1 |
| <i>CFO</i> | 14,596 | 0.0277 | 0.1643 | 0 | 1 |
| <i>TITLE</i> | 14,596 | 0.1361 | 0.3429 | 0 | 1 |
| <i>SENIOR</i> | 14,596 | 0.3013 | 0.4588 | 0 | 1 |
| <i>BI</i> | 14,596 | 0.5060 | 0.5000 | 0 | 1 |
| <i>CEOAD</i> | 14,596 | 0.0800 | 0.2712 | 0 | 1 |
| <i>BS</i> | 14,595 | 14.6828 | 5.0975 | 5 | 32 |
| <i>SIZE*</i> | 14,555 | €8,930 | €85,700 | €0.00 | €177,000 |

Note: * *SIZE* is in billions of euros. Table 2 presents the descriptive statistics for the variables used in the study. The *Obs.* column indicates the number of observations available for each variable. The *Mean* represents the average value of the variable across the observations. The *Std. dev.* represents the standard deviation, which measures the dispersion or variability of the values. The *Min* and *Max* columns indicate the minimum and maximum values observed for each variable, respectively.

4.2. Correlation analysis

In this section, the correlation among the variables used in the study is examined. Correlation analysis allows exploration of the relationships and dependencies between variables, providing insights into their interplay and potential associations (Pathan, 2009).

Based on the correlation matrix, the variable *TIER1* exhibits weak positive correlations with variables such as *RC*, *CRO*, *CFO*, and *TITLE*. However, only the correlations with *CFO* and *TITLE* attain statistical significance at the 0.01 level, as indicated by the double asterisks.

A closer examination of the correlation matrix reveals interesting patterns. Notably, there's a weak yet statistically significant negative correlation between *TIER1* and *BI* (-0.11). Given the definition of *BI*, where a value of 1 indicates an independent director, this suggests that a higher proportion of independent directors on the board is associated with lower capital adequacy levels. While this may seem contrary to common expectations, given the association of independent directors with better governance practices, it's essential to treat this observation with caution. Such relationships might be influenced by a myriad of factors, and further regression analysis is required to discern the underlying mechanisms and to control for potential confounding variables (Erkens et al., 2012).

Referring to Table 3, *TIER1* shows statistically significant positive correlations with *CFO* and *TITLE*. Furthermore, *RC* and *TITLE* have a positive correlation significant at the 0.001 level. *RC* and *CRO* have a negative correlation significant at the 0.05 level, while *CRO* and *TITLE* have a weak positive correlation, though it's not statistically significant. Upon closer examination of the correlation matrix, intriguing patterns of association emerge among risk governance variables. Specifically, while there are positive correlations between *TIER1* and variables such as *RC*, *CRO*, *CFO*, and *TITLE*, the correlations among *RC*, *CRO*, and *CFO* are not uniformly positive. For instance, *RC* negatively correlates with both *CRO* (-0.05) and *CFO* (-0.05). This indicates that the presence or prevalence of one risk governance characteristic doesn't necessarily suggest the presence of another. These varying correlations underscore the intricate nature of risk governance in banks, reflecting that banks may opt for diverse governance structures based on their unique contexts and needs. Such findings accentuate the necessity for rigorous multivariate analyses to delve deeper into the nuanced relationships among these governance variables (Pathan, 2009).

It is important to note that correlation coefficients only measure the linear relationship between variables and do not imply causation. Further analysis is required to establish causal relationships and assess the impact of these variables on bank risk.

The correlation analysis provides initial insights into the relationships between the variables, guiding subsequent modeling and regression analysis. In the next subsection, the focus will shift to the regression analysis, examining the impact of these variables on bank risk.

Table 3. Correlation

| Variables | TIER1 | RC | CRO | CFO | TITLE | SENIOR | BI | CEOAD | BS | SIZE |
|-----------|----------|---------|----------|---------|---------|---------|----------|-------|---------|------|
| TIER1 | 1.00 | | | | | | | | | |
| RC | 0.01 | 1.00 | | | | | | | | |
| CRO | 0.04 | -0.05* | 1.00 | | | | | | | |
| CFO | 0.06** | -0.05* | -0.02 | 1.00 | | | | | | |
| TITLE | 0.06** | 0.08*** | 0.04 | 0.01 | 1.00 | | | | | |
| SENIOR | -0.02 | -0.04 | 0.04 | 0.03 | -0.07** | 1.00 | | | | |
| BI | -0.11*** | 0.25*** | -0.14*** | 0.00 | 0.12*** | -0.03 | 1.00 | | | |
| CEOAD | -0.04 | -0.06* | -0.03 | -0.07** | -0.00 | 0.03 | -0.17*** | 1.00 | | |
| BS | -0.09*** | -0.07** | 0.11*** | 0.03 | 0.10*** | 0.08*** | -0.24*** | -0.03 | 1.00 | |
| SIZE | -0.03 | -0.02 | 0.06* | 0.04 | 0.15*** | 0.07** | -0.07** | 0.03 | 0.52*** | 1.00 |

Note: * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$. Table 3 showcases the correlation matrix of all the variables used in this study. Each cell in the matrix represents the Pearson correlation coefficient between two variables, providing a measure of the strength and direction of their linear relationship. The correlation values range from -1 to 1, with the magnitude of the value indicating the strength of the correlation and the sign indicating the direction. A value of 1 means a perfect positive correlation, while -1 indicates a perfect negative correlation. A value close to 0 suggests a weak or no correlation. This correlation matrix is instrumental in understanding the pairwise relationships between variables and can indicate potential issues of multicollinearity in subsequent analyses.

4.3. Principal component analysis

To uncover the underlying structure of the risk governance characteristics in the dataset, a PCA was conducted, following the method described by Jolliffe (2011). Initially, all relevant variables (such as *RC*, *CRO*, *CFO*, *TITLE*, *SENIOR*, and *BI*) were standardized to ensure equal contribution to the analysis, given PCA's sensitivity to variable magnitudes. After standardizing these variables, the PCA was executed, aiming to extract six principal components that capture the maximum variance from the original set. Post PCA, the scores for each principal component were generated for all observations. The primary component, which often captures the most significant variance, was named *rgi* for ease in subsequent analyses. This component was then incorporated as a predictor in regression analyses, with *TIER1* as the dependent variable, while also considering other control variables.

The eigenvalues offer insights into the variance each component captures in the dataset. Higher eigenvalues signify components that explain a substantial portion of the data's underlying structure. By observing the differences between successive eigenvalues and evaluating the cumulative variance explained, one can discern the optimal number of dimensions for representation, ensuring an effective balance between model simplicity and data fidelity.

Based on Table 4a, the first component, *COMP1*, has the highest eigenvalue of 1.3384, explaining 22.31% of the total variance. *COMP2*, *COMP3*, and *COMP4* follow with eigenvalues of 1.0332, 1.0047, and 0.9609, explaining 17.22%, 16.74%, and 16.02% of the variance, respectively. The remaining components, *COMP5* and *COMP6*, have Eigenvalues of 0.9154 and 0.7474, explaining 15.26% and 12.46% of the variance, respectively. Cumulatively, these six components account for 100% of the total variance in the data. *COMP1* is selected as *RGI* for regression analysis.

Table 4b displays the principal components (PCs) or eigenvectors for each variable obtained from

the PCA. The loadings represent the correlation between the original variables and the derived principal components (Abdi & Williams, 2010). The sign and magnitude of the loadings indicate the contribution of each variable to the corresponding component. Variables with higher absolute loadings have a stronger influence on the respective component.

Table 4c presents the scoring coefficients or loadings of the variables for each principal component. These coefficients represent the weights assigned to each variable in calculating the component scores. The scores provide a measure of each bank's position on each principal component, allowing for further analysis and interpretation.

In Tables 4b and 4c, variables are presented with a *_STD* suffix, denoting their standardized form. The standardization process entails mean-centering and scaling each variable by its standard deviation. This step is essential in PCA to ensure that all variables, regardless of their original measurement units, contribute to the analysis on an equal footing. The process avoids undue influence by any particular variable due to scale disparities. It is worth noting that the variable names in Table 1 (e.g., *RC*) correspond to their standardized counterparts in the PCA tables (e.g., *RC_STD*). For clarity and consistency in this analysis, this notation is adopted, but readers should treat *RC* and *RC_STD* as representations of the same underlying variable, with the latter being its standardized version.

PCA allows for the capture of underlying patterns and relationships within the dataset, enabling a reduction in dimensionality and the identification of key components. By identifying the components that explain the majority of the variance, a deeper understanding of the underlying factors influencing bank risk is obtained.

In the next subsection, the results of the PCA will be utilized in the regression analysis to investigate the relationship between governance variables and bank risk.

Table 4a. PCA eigenvalues

| Component | Eigenvalue | Difference | Proportion | Cumulative |
|-----------|------------|------------|------------|------------|
| COMP1 | 1.3384 | 0.3052 | 0.2231 | 0.2231 |
| COMP2 | 1.0332 | 0.0285 | 0.1722 | 0.3953 |
| COMP3 | 1.0047 | 0.0438 | 0.1674 | 0.5627 |
| COMP4 | 0.9609 | 0.0455 | 0.1602 | 0.7229 |
| COMP5 | 0.9154 | 0.1680 | 0.1526 | 0.8754 |
| COMP6 | 0.7474 | 0.0000 | 0.1246 | 1.0000 |

Note: Table 4a presents the Eigenvalues obtained from the PCA. It showcases six components (COMP1 to COMP6), their respective eigenvalues, the difference in eigenvalues between successive components, the proportion of the total variance explained by each component, and the cumulative proportion of explained variance up to each component. The table provides an overview of how much each component contributes to the total variability of the data. The cumulative proportion column gives a quick way to see how much total variance is accounted for as more components are considered. By the end of COMP6, all the variance in the data (100%) has been accounted for.

Table 4b. Principal components (eigenvectors) from PCA

| Variable | COMP1 | COMP2 | COMP3 | COMP4 | COMP5 | COMP6 | Unexplained |
|------------|---------|---------|---------|---------|---------|---------|-------------|
| RC_STD | 0.5723 | -0.0315 | -0.2229 | 0.4185 | 0.2255 | 0.6291 | 0 |
| CRO_STD | -0.2171 | -0.4719 | 0.4345 | 0.7178 | -0.1218 | -0.106 | 0 |
| CFO_STD | -0.0288 | 0.7367 | 0.5829 | 0.1277 | -0.1906 | 0.2531 | 0 |
| TITLE_STD | 0.2653 | -0.3137 | 0.6356 | -0.4162 | 0.4996 | 0.0658 | 0 |
| SENIOR_STD | -0.4137 | 0.2899 | -0.1306 | 0.2633 | 0.8028 | -0.1183 | 0 |
| BL_STD | 0.6188 | 0.2262 | 0.0260 | 0.2252 | 0.0622 | -0.7146 | 0 |

Note: Table 4b displays the eigenvectors for each variable obtained from the PCA, along with any unexplained variance. These eigenvectors, or coefficients, represent the weight and direction of each variable's contribution to the derived principal components (COMP1 to COMP6). Each of these components captures a specific aspect of the total variance present in the original data, ensuring orthogonality and maximizing the captured variance. The "unexplained variance" for all variables is zero, which indicates that the derived principal components fully account for the variability of all the standardized variables in the dataset.

Table 4c. PCA scores

| Variable | COMP1 | COMP2 | COMP3 | COMP4 | COMP5 | COMP6 |
|------------|---------|---------|---------|---------|---------|---------|
| RC_STD | 0.5723 | -0.0315 | -0.2229 | 0.4185 | 0.2255 | 0.6291 |
| CRO_STD | -0.2171 | -0.4719 | 0.4345 | 0.7178 | -0.1218 | -0.106 |
| CFO_STD | -0.0288 | 0.7367 | 0.5829 | 0.1277 | -0.1906 | 0.2531 |
| TITLE_STD | 0.2653 | -0.3137 | 0.6356 | -0.4162 | 0.4996 | 0.0658 |
| SENIOR_STD | -0.4137 | 0.2899 | -0.1306 | 0.2633 | 0.8028 | -0.1183 |
| BL_STD | 0.6188 | 0.2262 | 0.0260 | 0.2252 | 0.0622 | -0.7146 |

Note: Scoring coefficients — sum of squares (column-loading) = 1. Table 4c, on the other hand, presents the scoring coefficients or loadings. These values are a reflection of the correlation between each original variable and the derived principal components. Loadings help in understanding how well a particular variable can be represented or "reconstructed" using the principal components. A high absolute value of a loading (closer to -1 or 1) signifies that the original variable is closely associated with that principal component and can be well-represented by it. By reviewing these loadings, insights are gained into which original variables are most significant for each derived component and how they relate in terms of positive or negative correlations. It's a tool for understanding the significance and relationship of the original data in the context of the reduced-dimensional PCA space.

4.4. Regression analysis

To investigate the relationship between risk governance variables and bank risk, regression analysis was conducted (Wooldridge, 2015). This analysis allows for the assessment of the impact of independent variables on the dependent variables while controlling for other relevant factors.

Table 5 presents the results of the regression analysis for the dependent variable *TIER1* (Tier 1 capital / Risk-weighted assets). In Model 1, the governance variable *RGI* is included as an independent variable. The coefficient estimates for *RGI* is 0.0089, indicating a positive relationship between risk governance and *TIER1* (Ellul & Yerramilli, 2013). The coefficient is statistically significant at the 0.05 level ($p < 0.05$), suggesting that a one-unit increase in the *RGI* is associated with a 0.0089 increase in *TIER1*. This result suggests that better risk governance practices are positively associated with higher levels of *TIER1*.

In Model 1a, a bootstrapped approach was employed to estimate the coefficient for *RGI*.

The bootstrapped coefficient estimate remains the same as in Model 1, further supporting the robustness of the relationship between risk governance and *TIER1*.

Three control variables, *CEOAD*, *BS*, and *SIZE* were also included in the regression analysis. However, neither of these variables shows a statistically significant relationship with *TIER1*.

Additionally, the regression models include bank-fixed effects and year-fixed effects to control for unobservable heterogeneity across banks and time-specific factors that may affect the dependent variable (Roberts & Whited, 2013). The inclusion of fixed effects helps to mitigate omitted variable bias and enhance the internal validity of the regression results.

These regression results provide empirical evidence supporting the hypothesis that effective risk governance practices positively impact bank performance by increasing *TIER1* which implies lower bank risk. The findings highlight the importance of robust risk governance frameworks in enhancing capital adequacy within banks.

Table 5. Regression (main results)

| Variables | Model 1 | Model 1a |
|--------------------|------------------------|------------------------|
| | TIER1 | TIER1-bootstrapped |
| RGI | 0.0089** (0.0040) | 0.0089** (0.0045) |
| CEOAD | 0.0033 (0.0188) | 0.0033 (0.0178) |
| BS | 0.0035 (0.0636) | 0.0035 (0.1105) |
| SIZE | -0.0000*** (0.0000) | -0.0000 (0.0000) |
| Constant | 14.8851*** (1.4753) | 14.8851*** (2.2053) |
| Observations | 1,783 | 1,783 |
| Adjusted R-squared | 0.9534 | 0.9534 |
| Bank FE | Yes | Yes |
| Year FE | Yes | Yes |
| Clusters | Bank | Bank |

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table 5 presents the regression results with the dependent variable TIER1, representing the ratio of Tier 1 capital to risk-weighted assets. The columns display different model specifications. The Variables column lists the predictor variables. Coefficient estimates for each predictor are shown, accompanied by clustered standard errors in parentheses. These standard errors are robust to heteroskedasticity and potential autocorrelation within the ISIN clusters, distinguishing them from White's heteroskedasticity-corrected standard errors. The total number of observations used in the regression is provided under Observations. The Adjusted R-squared indicates the model's explanatory power. Bank FE and Year FE columns denote the inclusion of bank and year fixed effects, respectively.

4.5. Sensitivity analysis

To examine the robustness and stability of the findings, a sensitivity analysis was conducted (Saltelli et al., 2007). This analysis aimed to assess the sensitivity of the results to potential variations in the model specifications and data.

Table 6 showcases the sensitivity analysis results for the dependent variable, AVARPTP. This ratio measures a bank's risk exposure relative to its pre-tax profits, providing insight into potential loss values of a bank's assets or portfolio over a specified time frame for a set confidence interval. It signifies the portion of a bank's earnings that could be at risk. In Model 2, RGI is introduced as an independent variable, and its coefficient is -0.0095, indicating a negative correlation with AVARPTP, as cited by Ellul and Yerramilli (2013). Comparing this to the results where TIER1 is the dependent variable (Table 5), it can be observed that a unitary rise in RGI relates to a coefficient of 0.0089, pointing to a direct relationship between enhanced risk governance and an increase in TIER1 capital. Conversely, for AVARPTP, a one-unit rise in RGI results in a decrease of 0.0095 in the ratio, emphasizing the negative correlation. Essentially, as a bank refines its risk governance, it ensures potential financial losses relative to its earnings are reduced, but simultaneously bolsters its Tier 1 capital. This dynamic underscores the intricate effects of risk governance on different facets of banking operations. The practical implication is that while better risk governance can decrease potential losses that might impact a bank's pre-tax profits and bolster its Tier 1 capital, its influence, though statistically significant, is weak ($p < 0.1$). Other factors could be affecting AVARPTP, and a nuanced understanding of these contrasting relationships, especially in terms of bank stability and risk appetite, is imperative. The effect size, a modest decrease of 0.0095 for AVARPTP, prompts banks to interpret this within their specific operational context.

In Model 2a, a bootstrapped approach was employed to estimate the coefficient for RGI. The bootstrapped coefficient estimate remains

the same as in Model 2, indicating the stability of the relationship between risk governance and the AVARPTP.

Control variables, CEOAD, BS, and SIZE, played a crucial role in the sensitivity analysis. The negative coefficient for CEOAD (-0.0347) suggests that banks with advisory CEOs tend to adopt more conservative risk strategies. The pronounced negative relationship of BS with AVARPTP, with a coefficient of -0.5944, indicates that as BS increases, the risk relative to pre-tax profit decreases, underscoring its substantial influence on the risk profile of banks. The SIZE variable's coefficient, though close to zero, is reflective of the large units (in 1000 euros) being used, which is typical for datasets dealing with significant financial amounts. Its statistical significance confirms that even subtle variations in SIZE can influence a bank's risk-to-profit dynamics. Together, these variables elucidate the nuances of bank risk governance in the context of the banking industry.

Similar to the regression analysis, bank-fixed effects and year-fixed effects were incorporated into the sensitivity analysis to account for unobservable heterogeneity across banks and time-specific factors (Roberts & Whited, 2013). The inclusion of fixed effects enhances the internal validity of the sensitivity analysis.

The sensitivity analysis results provide additional support for the main findings. While the relationship between risk governance and the AVARPTP is not as strong as with TIER1, the negative coefficient suggests that better risk governance practices may be associated with lower risk levels, as indicated by the AVARPTP.

It is important to note that the sensitivity analysis does not imply causality and should be interpreted with caution. Nevertheless, the consistent findings across different model specifications support the robustness of the observed relationships.

Overall, the sensitivity analysis reinforces the notion that risk governance practices have a potential impact on bank risk-taking measures, such as the AVARPTP. These results further emphasize the importance of effective risk governance frameworks in promoting prudent risk management within banks.

Table 6. Sensitivity analysis

| Variables | Model 2 | Model 2a |
|--------------------|------------------------|------------------------|
| | AVARPTP | AVARPTP-bootstrapped |
| RGI | -0.0095* (0.0044) | -0.0095** (0.0038) |
| CEOAD | -0.0347** (0.0118) | -0.0347** (0.0135) |
| BS | -0.5944*** (0.0602) | -0.5944*** (0.0454) |
| SIZE | 0.0000*** (0.0000) | 0.0000*** (0.0000) |
| Constant | 17.6618*** (0.6152) | 17.6618** (8.7396) |
| Observations | 174 | 174 |
| Adjusted R-squared | 0.9999 | 0.9999 |
| Bank FE | YES | YES |
| Year FE | YES | YES |
| Clusters | Bank | Bank |

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Table 6 showcases the results of the sensitivity analysis for the AVARPTP variable. The table represents Model 2 and its bootstrapped counterpart, Model 2a, respectively. The variables explored are presented in the Variables column, accompanied by their coefficient estimates and standard errors. The Observations row notes the total number of data points analyzed. The Adjusted R-squared metric elucidates the model's fit. Both bank and year-fixed effects are included in the models, and clustering is performed at the bank level. The significance levels, represented by asterisks, indicate the varying levels of confidence in the results.

4.6. Causality analysis

The Granger causality Wald tests, inspired by the work of economist Sir Clive Granger (1969), function as a method to see if one time series can predict another. In this research, these tests aim to discover if historical risk governance data can forecast future bank risk indicators. If risk governance factors “Granger-cause” the bank risk variables, it indicates that these governance elements carry significant predictive information about future bank risks beyond what is provided by the bank risk’s own history. While the term “causality” is utilized, it doesn’t denote a direct cause-and-effect relationship in the conventional sense. Rather, it signifies a predictive association, meaning fluctuations in risk governance might foreshadow changes in bank risk. In summary, the Granger causality Wald tests are applied to determine if there’s a directional link between risk governance practices and subsequent bank risk, and whether risk governance can act as a precursor to bank risk.

Table 7 presents the results of the Granger causality Wald tests. In the first equation, the test was conducted to determine if the RGI Granger causes TIER1. The test yielded a Chi-square (χ^2) statistic of 0.02332 with 1 degree of freedom, resulting in a p-value of 0.879. The high p-value suggests that there is no evidence of Granger causality from RGI to TIER1 (Ellul & Yerramilli, 2013). Similarly, when all control variables were included in the equation, the test yielded the same results, indicating no significant causal relationship between risk governance and TIER1.

In the second equation, the causality was reversed to test if TIER1 Granger causes the RGI. The Chi-square statistic for this test was 3.1646 with 1 degree of freedom, resulting in a p-value of 0.075. Although the p-value is below the conventional significance level of 0.05, it does not provide strong evidence of Granger causality from TIER1 to RGI (Pathan, 2009).

The causality analysis results suggest that there is no strong evidence of a causal relationship between risk governance, as measured by the RGI, and TIER1 in either direction. These findings indicate

that the relationship between risk governance and Tier 1 capital may be driven by other factors or may be influenced by bidirectional causality, rather than a clear causal link.

It is important to underscore that while the Granger causality tests indicate temporal precedence and correlation between variables, they do not conclusively determine causal relationships. The results should be interpreted with caution, as other unobserved factors or omitted variables might influence the observed relationships. Although the current study provides valuable insights, it acknowledges that comprehensive exploration of the underlying mechanisms and potential causal pathways requires further in-depth research.

The results of the causality analysis contribute to the understanding of the relationship between risk governance and bank risk-taking. While risk governance and TIER1 are correlated, the causality analysis suggests that the relationship is not driven by a unidirectional causal effect. This implies that risk governance practices and TIER1 may mutually influence each other or may be influenced by common factors.

These findings highlight the complexity of the relationship between risk governance and bank risk and underscore the need for comprehensive risk management frameworks that integrate risk governance practices with other risk management mechanisms.

Table 7. Granger causality Wald tests

| Equation | Excluded | χ^2 | df | Prob > χ^2 |
|----------|----------|----------|----|-----------------|
| TIER1 | RGI | 0.02332 | 1 | 0.879 |
| TIER1 | All | 0.02332 | 1 | 0.879 |
| RGI | TIER1 | 3.1646 | 1 | 0.075 |
| RGI | All | 3.1646 | 1 | 0.075 |

Note: Table 7 presents the results of Granger causality Wald tests conducted for the specified equations. The Equation column indicates the equation under consideration. The Excluded column shows the variable excluded from the equation. The χ^2 column displays the chi-square test statistic value. The df column represents the degrees of freedom associated with the test. The Prob > χ^2 column indicates the p-value associated with the Chi-square test, which assesses the statistical significance of the causality relationship.

5. DISCUSSION

The discussion of findings and implications delves deep into the insights derived from the empirical analysis, emphasizing their relevance for regulators, policymakers, and practitioners within the banking sector. This research investigated the link between risk governance and bank risk by analyzing a set of specific risk governance indicators, control variables, and distinct measures of bank risk, using data from banks situated in OECD countries during a defined timeframe.

The findings of the study offer insights into the relationship between risk governance and bank risk. The main findings can be summarized as follows.

There was a positive and significant association between risk governance, as measured by the *RGI*, and *TIER1*. This suggests that banks with stronger risk governance practices tend to maintain higher levels of capital, acting as a buffer against potential losses (Minton et al., 2011). Contrarily, for the *AVARPTP*, a negative coefficient was observed, indicating that better risk governance practices might be associated with lower risk levels. However, it's important to note that while this relationship is statistically significant, it may not be as strong as the relationship with *TIER1*.

Among the individual risk governance variables examined, the presence of a *CRO* was explored to discern its influence on *TIER1* capital ratios. While the regression analysis indicates a positive association, suggesting that having a *CRO* might be an asset in managing risk effectively, it is crucial to note that this relationship was not found to be statistically significant. This is further corroborated by the correlation matrix presented in Table 3, where the correlation between *TIER1* and the presence of a *CRO* is a modest 0.04, emphasizing a very weak linear relationship. Consequently, despite the suggestive positive association in the regression analysis, the presence of a *CRO*, while potentially beneficial, does not conclusively imply a strong enhancement of the *TIER1* capital ratio based on the dataset and analyses employed in this study (Ellul & Yerramilli, 2013).

SIZE was negatively related to *TIER1*, suggesting that larger banks tend to maintain relatively lower capital levels (Laeven & Levine, 2009). However, *SIZE* has a significant and positive impact on the *AVARPTP* ratio suggesting that larger banks maintain higher *AVARPTP*. The results from the analysis highlight differing implications of the *BS* on bank risk metrics. Specifically, in Table 5, *BS* does not demonstrate a statistically significant relationship with the *TIER1* capital ratio. However, as evidenced in Table 6, there is a notable negative association between *BS* and the *AVARPTP*. This suggests that banks with larger boards tend to exhibit a reduced value at risk in relation to their pre-tax profits. This might imply that institutions with large boards could potentially benefit from enhanced risk management practices, resulting in minimized potential losses as a percentage of their profits.

These findings have several implications for regulators, policymakers, and practitioners in the banking industry. The positive association between risk governance and *TIER1* emphasizes the importance of robust risk governance practices in maintaining adequate capital levels. Regulators

and policymakers should encourage banks to adopt effective risk governance frameworks that encompass clear risk management policies, strong oversight mechanisms, and appropriate board composition.

In the correlation matrix presented in Table 3, it can be observed that the correlation between *TIER1* and *CRO* is 0.04, which is quite close to zero and indicates a very weak linear relationship between the two variables. This correlation is not statistically significant at conventional levels (as it lacks asterisks), suggesting that the linear association between *TIER1* and *CRO* might not be substantial in the context of this study. This observation should be taken into consideration when interpreting results related to these variables.

The conclusions about the board of directors' composition stem from the methodological approach using the *RGI* constructed through PCA. This index captures the collective risk governance attributes of directors, emphasizing the board's unified decisions and strategies over individual director profiles. Insights from Table 3's correlation matrix also support this, indicating weak correlations between individual director attributes and risk-related variables. While the terms "expertise", "experience", and "diverse" were not directly tested, it is widely acknowledged in risk governance literature that a board comprising members with relevant expertise is beneficial. The study thus suggests that banks prioritize a holistic approach to risk governance by focusing on the collective efforts of the board rather than specific director characteristics.

Regulators and policymakers should carefully monitor the capital adequacy of larger banks to ensure they have sufficient buffers to absorb potential losses.

The Granger causality tests suggest that the relationship between risk governance and *TIER1* may be influenced by bidirectional causality or other factors, rather than a clear causal link (Pathan, 2009).

These findings highlight the complexity of the relationship between risk governance and bank risk-taking and underscore the need for comprehensive risk management frameworks that integrate risk governance practices with other risk management mechanisms (Adams & Mehran, 2012).

The findings from this research shed light on specific aspects of risk governance that can enhance current frameworks. Specifically, the positive correlation between risk governance and *TIER1* highlights the significance of capital buffers, aligning with Basel III's emphasis on increased capital prerequisites (BCBS, 2011). The limited correlation between *TIER1* and the presence of a *CRO* indicates that risk management processes' functionality might be more impactful than individual presence, reflecting insights from Adams and Mehran (2012). Moreover, while insights on bank size can be informative, it's crucial to note that size does not necessarily correlate with the intricacy of bank operations. Any recommendations for tailored governance guidelines should consider this distinction and be approached with caution. These nuanced findings can steer policymakers and regulators in refining governance frameworks to better fit the practicalities of bank risk management.

This research offers significant insights into the interplay between risk governance and bank risk, notably highlighting the pronounced positive

correlation between the *RGI* and *TIER1*. Additionally, the study illuminates the nuanced dynamics encapsulated by the marked negative relationship between risk governance and the average value at risk to pre-tax profit ratio (*AVARPTP*). The potential for bidirectional causality further enriches the complexity of these results. These findings are instrumental for both scholarly discussions and have profound implications for regulators and banking institutions.

6. CONCLUSION

This study provides an in-depth examination of the role of risk governance in managing bank risk within public commercial banks of the OECD. The research builds upon Knight's (1921) conception of risk (where risk pertains to situations with known probabilities and uncertainty to those with unknown probabilities), offering empirical evidence that supports the quantifiability of risk through risk governance in banks. The collective efforts of directors, including their age, educational background, and roles such as the CRO and CFO, are crucial in assessing and managing bank risk.

The results of the regression analysis suggest a positive association between risk governance and *TIER1*. More specifically, the sensitivity analysis conducted for the *AVARPTP* variable further supports this finding, indicating that effective risk governance can help banks better manage and mitigate risks.

However, the study acknowledges potential limitations, such as endogeneity issues. Future research could address these by employing more robust statistical methods or by considering additional variables that may affect banks. Furthermore, the study suggests the incorporation of qualitative methods to capture the qualitative aspects of risk governance, which could provide a more holistic understanding of risk management in banks.

The findings of this study have important implications for both banks and regulatory authorities. They underscore the importance of robust risk governance in managing bank risk and suggest that more effective risk management strategies could be developed by focusing on the collective efforts of directors and the roles of the CRO and CFO.

In the context of the broader literature on risk governance in banking, this study adds nuance to Knight's (1921) risk theory by providing empirical evidence of the quantifiability of risk through risk governance. However, more research is needed to further explore and validate these findings.

This study's examination of risk governance in OECD public commercial banks marks a significant step in understanding how risk is managed in these institutions. It lays the groundwork for further research in diverse economic and regulatory settings beyond the OECD. The study's focus on OECD countries and reliance on employed data sources, while insightful, also suggest areas for expansion. Future research could explore risk governance across a wider range of countries and banking systems, employing varied methodologies and data.

This study's limitations, particularly in its scope and data sources, not only provide a clear direction for future inquiries but also highlight the need for comprehensive and global perspectives in banking research.

First, the study focused on OECD countries and a particular time period, which may limit

the generalizability of the findings to other contexts. The banking industry is influenced by various factors, including legal and regulatory frameworks, cultural norms, and macroeconomic conditions, which can differ across countries and time periods. Therefore, caution should be exercised when applying the findings of this study to different jurisdictions or time periods.

Second, the analysis relied on publicly available data from BankFocus and BoardEx. While these databases provide comprehensive information on banks and their governance practices, there may be limitations or inaccuracies in the data. The use of alternative data sources or access to proprietary data could provide more detailed and accurate insights into risk governance practices and their impact on bank risk-taking.

Third, the study focused on specific risk governance indicators, such as the presence of RC, the presence of a CRO, and board composition. While these indicators capture important aspects of risk governance, they may not fully capture the complexity and nuances of risk governance frameworks in banks. Future research could explore additional dimensions of risk governance, such as the effectiveness of risk management processes, the quality of risk reporting, and the alignment of risk culture within banks.

Fourth, the study's panel design limits the ability to establish causal relationships between risk governance and bank risk-taking. The observed associations may be influenced by endogeneity issues, where unobserved factors or reverse causality could affect the results. To address this limitation, future research could employ longitudinal or experimental designs that allow for a more robust causal analysis.

Fifth, while the study included various control variables such as bank size, there may be other factors that influence bank risk which were not considered in the analysis. Future research could explore additional variables that may affect bank risk-taking, such as market conditions, regulatory environment, or specific characteristics of the banking sector.

Lastly, the study focused on quantitative analysis and did not capture the qualitative aspects of risk governance, such as the organizational culture, decision-making processes, or the quality of risk communication within banks. Incorporating qualitative methods, such as interviews or case studies, could provide deeper insights into the mechanisms through which risk governance practices influence bank risk.

Despite these limitations, the study contributes to the existing literature by examining the relationship between risk governance and bank risk-taking. The findings provide valuable insights for regulators, policymakers, and practitioners in enhancing risk governance and fostering a stable and resilient banking sector. Further research addressing these limitations can advance the understanding of risk governance and its implications for bank performance and stability.

In conclusion, this study contributes to the broader understanding of risk management in the banking sector and highlights the importance of risk governance in managing bank risk. It opens up new avenues for future research and has significant implications for the development of more effective risk management strategies in the banking sector.

REFERENCES

1. Abdi, H., & Williams, L. J. (2010). Principal component analysis. *WIREs Computational Statistics*, 2(4), 433–459. <https://doi.org/10.1002/wics.101>
2. Adams, R. B. (2012). Governance and the financial crisis. *International Review of Finance*, 12(1), 7–38. <https://doi.org/10.1111/j.1468-2443.2011.01147.x>
3. Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics*, 94(2), 291–309. <https://doi.org/10.1016/j.jfineco.2008.10.007>
4. Adams, R. B., & Mehran, H. (2012). Bank board structure and performance: Evidence for large bank holding companies. *Journal of Financial Intermediation*, 21(2), 243–267. <https://doi.org/10.1016/j.jfi.2011.09.002>
5. Adams, R. B., Almeida, H., & Ferreira, D. (2005). Powerful CEOs and their impact on corporate performance. *Review of Financial Studies*, 18(4), 1403–1432. <https://doi.org/10.1093/rfs/hhi030>
6. Admati, A. R., & Hellwig, M. F. (2014). *The bankers' new clothes: What's wrong with banking and what to do about it*. Princeton University Press. <https://doi.org/10.1515/9781400851195>
7. Aebi, V., Sabato, G., & Schmid, M. (2012). Risk management, corporate governance, and bank performance in the financial crisis. *Journal of Banking & Finance*, 36(12), 3213–3226. <https://doi.org/10.1016/j.jbankfin.2011.10.020>
8. Bank for International Settlement (BIS). (n.d.). *Definition of capital in Basel III — Executive Summary*. Financial Stability Institute (FSI). https://www.bis.org/fsi/fsisummaries/defcap_b3.pdf
9. Barger, L. L., Lehn, K. M., & Zutter, C. J. (2010). Sarbanes-Oxley and corporate risk-taking. *Journal of Accounting and Economics*, 49(1–2), 34–52. <https://doi.org/10.1016/j.jacceco.2009.05.001>
10. Basel Committee on Banking Supervision (BCBS). (2011). *Basel III: A global regulatory framework for more resilient banks and banking systems* (revised June 2011). Bank for International Settlements (BIS). <https://www.bis.org/publ/bcbs189.htm>
11. Basel Committee on Banking Supervision (BCBS). (n.d.). *Basel Committee on Banking Supervision — Overview*. Bank for International Settlements (BIS). <https://www.bis.org/bcbs/>
12. Basel Committee on Banking Supervision. (1988). *International convergence of capital measurement and capital standards*. Bank for International Settlements (BIS). <https://www.bis.org/publ/bcbs04a.htm>
13. Beasley, M. S., Hermanson, D. R., Carcello, J. V., & Neal, T. L. (2010). *Fraudulent financial reporting: 1998–2007: An analysis of US public companies* (Association Sections, Divisions, Boards, Teams, Vol. 453). Committee of Sponsoring Organizations of the Treadway Commission (COSO). https://egrove.olemiss.edu/aicpa_assoc/453
14. Beltrame, F., Zorzi, G., & Grasseti, L. (2022). The effect of FinTech investments on listed banks: Evidence from an Italian sample. *Risk Governance and Control: Financial Markets & Institutions*, 12(2), 47–55. <https://doi.org/10.22495/rgcv12i2p4>
15. Berger, A. N., Cai, J., Roman, R. A., & Sedunov, J. (2022). Supervisory enforcement actions against banks and systemic risk. *Journal of Banking & Finance*, 140, Article 106222. <https://doi.org/10.1016/j.jbankfin.2021.106222>
16. Berger, A. N., Imbierowicz, B., & Rauch, C. (2016). The roles of corporate governance in bank failures during the recent financial crisis. *Journal of Money, Credit and Banking*, 48(4), 729–770. <https://doi.org/10.1111/jmcb.12316>
17. Berger, A. N., Kick, T., & Schaeck, K. (2014). Executive board composition and bank risk taking. *Journal of Corporate Finance*, 28, 48–65. <https://doi.org/10.1016/j.jcorpfin.2013.11.006>
18. Bhagat, S., & Bolton, B. (2014). Financial crisis and bank executive incentive compensation. *Journal of Corporate Finance*, 25, 313–341. <https://doi.org/10.1016/j.jcorpfin.2014.01.002>
19. Bhagat, S., Bolton, B., & Lu, J. (2015). Size, leverage, and risk-taking of financial institutions. *Journal of Banking & Finance*, 59, 520–537. <https://doi.org/10.1016/j.jbankfin.2015.06.018>
20. Brickley, J. A., & Zimmerman, J. L. (2010). Corporate governance myths: Comments on Armstrong, Guay, and Weber. *Journal of Accounting and Economics*, 50(2–3), 235–245. <https://doi.org/10.1016/j.jacceco.2010.10.002>
21. Carter, D. A., D'Souza, F., Simkins, B. J., & Simpson, W. G. (2010). The gender and ethnic diversity of US boards and board committees and firm financial performance. *Corporate Governance: An International Review*, 18(5), 396–414. <https://doi.org/10.1111/j.1467-8683.2010.00809.x>
22. Coase, R. H. (1937). The nature of the firm. *Economica*, 4(16), 386–405. <https://www.richschwinn.com/richschwinn/index/teaching/past%20courses/Econ%20340%20-%20Managerial%20Economics/2013%20Fall%20340%20-%20The%20Nature%20of%20the%20Firm.pdf>
23. Cornett, M. M., Marcus, A. J., & Tehranian, H. (2008). Corporate governance and pay-for-performance: The impact of earnings management. *Journal of Financial Economics*, 87(2), 357–373. <https://doi.org/10.1016/j.jfineco.2007.03.003>
24. Dell'Ariccia, G., Laeven, L., & Suarez, G. A. (2017). Bank leverage and monetary policy's risk-taking channel: Evidence from the United States. *The Journal of Finance*, 72(2), 613–654. <https://doi.org/10.1111/jofi.12467>
25. Demsetz, R. S., & Strahan, P. E. (1997). Diversification, size, and risk at bank holding companies. *Journal of Money, Credit and Banking*, 29(3), 300–313. <https://doi.org/10.2307/2953695>
26. Dionne, G. (2013). Risk management: History, definition, and critique. *Risk Management and Insurance Review*, 16(2), 147–166. <https://doi.org/10.1111/rmir.12016>
27. Ellis, L., Haldane, A., & Moshirian, F. (2014). Systemic risk, governance, and global financial stability. *Journal of Banking & Finance*, 45, 175–181. <https://doi.org/10.1016/j.jbankfin.2014.04.012>
28. Ellul, A., & Yerramilli, V. (2013). Stronger risk controls, lower risk: Evidence from U.S. bank holding companies. *The Journal of Finance*, 68(5), 1757–1803. <https://doi.org/10.1111/jofi.12057>
29. Erin, O., Asiriwa, O., Olojede, P., Ajetunmobi, O., & Usman, T. (2018). Does risk governance impact bank performance? Evidence from the Nigerian banking sector. *Academy of Accounting and Financial Studies Journal*, 22(4), 1–14. <https://www.abacademies.org/articles/Does-Risk-Governance-Impact-Bank-Performance-Evidence-From-the-Nigerian-Banking-Sector-1528-2635-22-4-263.pdf>
30. Erkens, D. H., Hung, M., & Matos, P. (2012). Corporate governance in the 2007–2008 financial crisis: Evidence from financial institutions worldwide. *Journal of Corporate Finance*, 18(2), 389–411. <https://doi.org/10.1016/j.jcorpfin.2012.01.005>
31. European Parliament, & Council of the European Union. (2013). Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms. *Official Journal of the European Union*. <http://data.europa.eu/eli/dir/2013/36/oj>

32. Gontarek, W. (2016). Risk governance of financial institutions: The growing importance of risk appetite and culture. *Journal of Risk Management in Financial Institutions*, 9(2), 120-129. https://www.academia.edu/26238650/Risk_governance_of_financial_institutions_The_growing_importance_of_risk_appetite_and_culture
33. Gontarek, W., & Belghitar, Y. (2018). Risk governance: Examining its impact upon bank performance and risk-taking. *Financial Markets, Institutions & Instruments*, 27(5), 187-224. <https://doi.org/10.1111/fmii.12103>
34. Gontarek, W., & Bender, R. (2019). Examining risk governance practices in global financial institutions: The adoption of risk appetite statements. *Journal of Banking Regulation*, 20, 74-85. <https://doi.org/10.1057/s41261-018-0067-2>
35. Gouiaa, R., & Gaspard, P.-R. (2021). Islamic financial institutions: Performance comparison with Canadian banks. *Risk Governance and Control: Financial Markets & Institutions*, 11(3), 16-40. <https://doi.org/10.22495/rgcv11i3p2>
36. Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424-438. <https://doi.org/10.2307/1912791>
37. Heriard-Dubreuil, G. F. (2001). Present challenges to risk governance. *Journal of Hazardous Materials*, 86(1-3), 245-248. [https://doi.org/10.1016/S0304-3894\(01\)00261-8](https://doi.org/10.1016/S0304-3894(01)00261-8)
38. Hundal, S., & Zinakova, T. (2021). Financial technology in the Finnish banking sector and its impact on stakeholders in the wake of COVID-19. *Risk Governance and Control: Financial Markets & Institutions*, 11(1), 8-19. <https://doi.org/10.22495/rgcv11i1p1>
39. Jarvis, D. S. L. (2011). Theorising risk and uncertainty in international relations: The contributions of Frank Knight. *International Relations*, 25(3), 296-312. <https://doi.org/10.1177/0047117811415485>
40. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
41. Jolliffe, I. T. (2011). Principal component analysis. In M. Lovric (Ed.), *International encyclopedia of statistical science* (pp. 1094-1096). Springer. https://doi.org/10.1007/978-3-642-04898-2_455
42. Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, 20(1), 141-151. <https://doi.org/10.1177/00131644600200011>
43. Karyani, E., Dewo, S. A., Santoso, W., & Frensidy, B. (2020). Risk governance and bank profitability in ASEAN-5: A comparative and empirical study. *International Journal of Emerging Markets*, 15(5), 949-969. <https://doi.org/10.1108/IJOEM-03-2018-0132>
44. Kim, J.-B., Li, Y., & Zhang, L. (2011). CFOs versus CEOs: Equity incentives and crashes. *Journal of Financial Economics*, 101(3), 713-730. <https://doi.org/10.1016/j.jfineco.2011.03.013>
45. Knight, F. H. (1921). *Risk, uncertainty and profit*. Houghton Mifflin Company.
46. Laeven, L., & Levine, R. (2009). Bank governance, regulation and risk-taking. *Journal of Financial Economics*, 93(2), 259-275. <https://doi.org/10.1016/j.jfineco.2008.09.003>
47. McConnell, P. (2013). Improving risk governance — A proposal on board decision-making. *Journal of Risk and Governance*, 2(3), 173-200. <https://ssrn.com/abstract=2328037>
48. McNichols, M. F., & Stubben, S. R. (2008). Does earnings management affect firms' investment decisions? *The Accounting Review*, 83(6), 1571-1603. <https://doi.org/10.2308/accr.2008.83.6.1571>
49. McNulty, T., Florackis, C., & Ormrod, P. (2013). Boards of directors and financial risk during the credit crisis. *Corporate Governance: An International Review*, 21(1), 58-78. <https://doi.org/10.1111/corg.12007>
50. Minton, B. A., Taillard, J. P., & Williamson, R. (2011). *Do independence and financial expertise of the board matter for risk taking and performance?* (Dice Center Working Paper No. 2010-14). Fisher College of Business. <http://doi.org/10.2139/ssrn.1661855>
51. Office of the Comptroller of the Currency. (2019). *Comptroller's handbook: Corporate and risk governance* (Version 2.0). <https://www.occ.treas.gov/publications-and-resources/publications/comptrollers-handbook/files/corporate-risk-governance/pub-ch-corporate-risk.pdf>
52. Pathan, S. (2009). Strong boards, CEO power and bank risk-taking. *Journal of Banking & Finance*, 33(7), 1340-1350. <https://doi.org/10.1016/j.jbankfin.2009.02.001>
53. Pathan, S., & Faff, R. (2013). Does board structure in banks really affect their performance? *Journal of Banking & Finance*, 37(5), 1573-1589. <https://doi.org/10.1016/j.jbankfin.2012.12.016>
54. Petersen, M. A. (2008). Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies*, 22(1), 435-480. <https://doi.org/10.1093/rfs/hhn053>
55. Poole, W. (2007). Responding to financial crises: What role for the fed? *Cato Journal*, 27(2), 149-155. <https://www.cato.org/sites/cato.org/files/serials/files/cato-journal/2007/5/cj27n2-4.pdf>
56. Porretta, P., & Benassi, A. (2021). Sustainable vs. not sustainable cooperative banks business model: The case of GBCI and the authority view. *Risk Governance and Control: Financial Markets & Institutions*, 11(1), 33-48. <https://doi.org/10.22495/rgcv11i1p3>
57. Power, M. (2009). The risk management of nothing. *Accounting, Organizations and Society*, 34(6-7), 849-855. <https://doi.org/10.1016/j.aos.2009.06.001>
58. Public Law 111-203 — Dodd-Frank Wall Street Reform and Consumer Protection Act. (2010). <https://www.govinfo.gov/content/pkg/PLAW-111publ203/pdf/PLAW-111publ203.pdf>
59. Roberts, M. R., & Whited, T. M. (2013). Endogeneity in empirical corporate finance. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), *Handbook of the economics of finance* (Vol. 2, Part A, pp. 493-572). North Holland. <https://doi.org/10.1016/B978-0-44-453594-8.00007-0>
60. Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D., Saisana, M., & Tarantola, S. (2007). *Global sensitivity analysis. The primer*. John Wiley & Sons. <https://doi.org/10.1002/9780470725184>
61. Scheuch, C., Voigt, S., & Weiss, P. (2023). *Tidy finance with R*. CRC Press.
62. Stein, V., & Wiedemann, A. (2016). Risk governance: Conceptualization, tasks, and research agenda. *Journal of Business Economics*, 86, 813-836. <https://doi.org/10.1007/s11573-016-0826-4>
63. Stulz, R. M. (2003). *Risk management & derivatives*. Thomson/South-Western.
64. Stulz, R. M. (2008). Rethinking risk management. In D. Chew (Ed.), *Corporate risk management* (pp. 87-120). Columbia University Press. <https://doi.org/10.7312/chew14362-005>

65. Vallascas, F., Mollah, S., & Keasey, K. (2017). Does the impact of board independence on large bank risks change after the global financial crisis? *Journal of Corporate Finance*, 44, 149-166. <https://doi.org/10.1016/j.jcorpfin.2017.03.011>
66. van Asselt, M. A., & Renn, O. (2011). Risk governance. *Journal of Risk Research*, 14(4), 431-449. <https://doi.org/10.1080/13669877.2011.553730>
67. von Borowski Dodl, A. (2020). Central Bank of Brazil's mission: Ensuring the stability of currency purchasing power and a sound, efficient, and 'just' financial system. *Risk Governance and Control: Financial Markets & Institutions*, 10(4), 44-56. <https://doi.org/10.22495/rgcv10i4p4>
68. Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. The MIT Press. <https://www.jstor.org/stable/j.ctt5hhcfr>
69. Wooldridge, J. M. (2015). *Introductory econometrics: A modern approach* (6th ed.). Nelson Education.