



Impact of board of directors on insolvency risk: which role of the corruption control? Evidence from OECD banks

Marwa Sallemi¹ · Salah Ben Hamad² · Nejla Ould Daoud Ellili³ 

Received: 12 February 2022 / Accepted: 7 November 2022 / Published online: 3 December 2022
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2022

Abstract

This study examines the relationship between corporate governance and banking stability by considering the moderating role of corruption controls. This study applies the Generalized Moments Method using a sample of panel data collected from 74 banks in 10 Organization for Economic Co-operation and Development countries during the period 2006–2016. The empirical results reveal that banking governance is positively associated with banking stability as measured by the Z-score. Additionally, the findings indicate that effective corruption control significantly moderates the power of the board of directors in boosting banking stability. This study discerns the fundamental role of the board of directors as the main corporate governance mechanism and internal player in the stability of banking institutions.

Keywords Board of directors · Corruption control index (CCI) · Corporate governance · Z-score · OECD banks

JEL Classification C33 · G20 · G30

1 Introduction

In recent years, banking institutions have experienced severe global crises. These disruptions correlate with recurrent periods of financial stress. Some institutions have gone bankrupt, while others have suffered from financial turmoil due to economic and financial decline in their countries. This was essentially the result of a poor corporate governance system (Choi 2000). In normal instances, bank functions are considered as a solid network heading to its objectives. However,

✉ Nejla Ould Daoud Ellili
oulddaoudnejla@yahoo.fr

¹ Higher Institute of Management of Gabes, Gabès, Tunisia

² University of Economics and Management of Tunis, Tunis, Tunisia

³ College of Business, Abu Dhabi University, Abu Dhabi, UAE

disturbances caused by fluctuations in the monetary sphere threaten the banking environment's stability.

Djebali and Zaghdoudi (2020) consider banking stability as “the degree of resistance of the bank to protect itself against financial shocks and adverse events”. Moreover, it guarantees continuity of bank solvency in bad economic situations. Banks' insolvency risks must be reduced to maintain an acceptable level of stability.

The drawbacks of the traditional financial system appeared during the international crisis that shook the world in 2007 (Trabelsi 2011; Fakhfekh et al. 2016). This crisis has contributed to a decline in financial institutions and the collapse of several economies worldwide. This has led to many questions about banks' ability to defend themselves against economic disturbances and shocks as well as about adequate solutions to financial failures (Bourkhis and Nabi 2013; Rosman et al. 2014).

Since then, the banking profession has become more complex. The main concern of banking institutions is to maintain the continuity of their economic and financial growth. Consequently, new measures have been suggested to guarantee profitable management of banking institutions (Becht et al. 2011). Interestingly, banking governance has received particular attention, and governments worldwide have offered reforms to the compensation structures of bank executives in order to preserve the stability of their financial systems. Some researchers studied the poor performance of financial institutions, in particular, following the crisis which affected the sub-prime mortgage sector in the United States in 2007 and depicted various shortcomings in the system of banking governance.

The Organization for Economic Cooperation and Development (OECD) attributed the financial crisis to the weaknesses and shortcomings of corporate governance arrangements (Kirkpatrick 2009). Thus, better bank supervision is deemed necessary to effectively manage risks (Acharya and Richardson 2009; Demirgüç-Kunt et al. 2018).

The benefits of sound governance frameworks are well recognized (Claessens and Yurtoglu 2013; Boubacar Diallo 2017), particularly in terms of improving performance and efficiency, allowing better access to financing, lower cost of capital, and more favor to all stakeholders. Similarly, weak banking governance can increase risk by affecting the quality of banking assets and causing financial volatility, which is often associated with a lack of transparency and fragility in terms of risk taking. All of these factors complicate the mission of supervisors from legal and procedural points of view (Mehran et al. 2011).

Strong banking regulations are implemented to avoid complex financial intermediation activities such as securitization, which encourages excessive risk-taking. Furthermore, risk specifically increases systemic hazards, and subsequently leads banks to stability problems. Therefore, better governance measures are meant to fix the level of risk taking (Gorton and Rosen 1995; Dinç 2005). Thus, the different banking risks to which the bank is exposed, namely financial risks (Barth et al. 1998; Campbell 2007a b), operational risks, and accidental risks (Greuning and Bratovic-Bratanovic 2004) have been investigated.

The problems of banking governance include the attention given to national legislative systems, adoption of codes of good practice, development of good governance

models, identification of the board of directors, and role of management (Lombardi 2012).

In addition, the principles of the OECD (2015) stipulate that corporate governance is aligned with the strategic choices of the institution, paying particular attention to the effective monitoring of management by the board of directors and the board's responsibility towards the firm and shareholders. The OECD defines the governance framework as "promoting transparent and fair markets and the efficient allocation of resources" while paying particular attention to the role played by stakeholders in control and monitoring.

Additionally, the boards of directors of banking institutions play a key role in controlling and managing risks in both internal and external governance measures in the financial market. Banking governance considers the distribution of rights and liabilities between various parties in the bank, including shareholders, leaders, board of directors, and other stakeholders. It also specifies the rules and procedures for decision-making. Process. Therefore, a bank's governance structure determines which participants have power to combat corruption, which is a coherent theme in terms of banking stability. In recent years, increasing attention has been paid to how banking institutions interact with their stakeholders.

Corruption is linked to irregularity in the decision-making process in exchange for improper incentives or advantages. The control of corruption is at the heart of development policies. Recent studies justify the effectiveness of anti-corruption measures from an innovation perspective (Anokhin and Schulze 2009; Dang and Yang 2016; Xu and Yano 2017).

This study explores the possible links between the board of directors and banking stability by considering the moderating role of corruption control. To the best of our knowledge, no study has examined the impact of the board of directors on a bank's stability by considering the role played by corruption control; therefore, this study sheds light on this topic. OECD banks were the subject of this study for two reasons. First, OECD banks are interested in examining the impact of corruption control on improving their stability. Second, OECD countries were selected based on their tight regulations and high resilience to the financial crisis of 2007–2008.

As shown in Fig. 1, developed countries (Canada, Finland, France, Ireland, and Switzerland) have a higher level of corruption control than emerging countries (Bahrain, Jordan, Qatar, Turkey, and United Arab Emirates). Finland has the highest control of corruption among developed countries, and the United Arab Emirates has the highest control of corruption among emerging countries.

The research questions were as follows. What is the impact of board governance on the insolvency risk and banking stability? To what extent does corruption control moderate the relationship between board of directors and banking stability?

This study makes two significant contributions to the literature: First, we explored the explanatory factors, particularly the attributes of the board of directors, that contribute to banking stability. Second, we examine the relationship between bank stability and the degree of corruption control. Empirically, we contribute to the literature by observing that many studies have examined the direct relationship between banking governance and banking stability (Dong et al. 2017; Ghosh 2018; Raouf and Ahmed 2020), but relatively little attention has been paid to the interaction

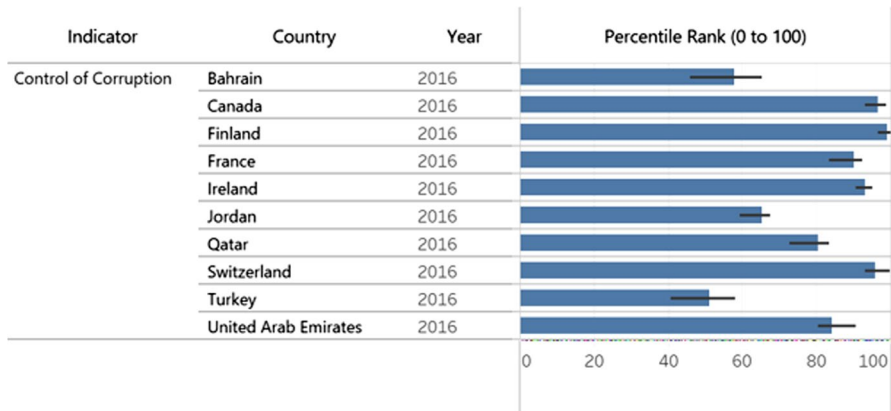


Fig. 1 Control of Corruption in the 10 OECD Countries in 2016. Source: Worldwide Governance Indicators. <http://info.worldbank.org/governance/wgi/Home/Reports>

effect of a country's corruption control in the banking sector. Our contribution relates to the integration of CI as a moderating variable in the study of the relationship between the board of directors and banking stability. Thus, we evaluate whether corruption control strengthens or weakens managerial relationships, which can open up new perspectives. This study uses a sample of 74 banks in 10 OECD countries from 2006 to 2016. The empirical results show the importance of controlling corruption, which significantly moderates the behavior of board members in improving banking stability.

The remainder of this paper is organized as follows. Section 2 surveys the literature and develops hypotheses. Section 3 describes the research design, including the sample, model, and measurement of the variables. Section 4 presents the empirical results. Finally, Sect. 5 provides the conclusions and recommendations for future research.

2 Theoretical framework and development of hypotheses

2.1 Conceptual and theoretical framework

The financial literature includes theories on banking stability and regulation. These theories consist of agency (Jensen and Meckling 1976), and political regulation theories (La Porta et al. 1998).

According to agency theory, the corporate governance mechanisms are used to control managers and subsequently increase their efficiency. However, a managerial entrenchment strategy weakens the power of these mechanisms to manage the firm properly and benefit shareholders (Alexandre and Paquerot 2000). In addition, executive incentives are generally considered effective tools to motivate and align managers' interests with those of shareholders (Berle and Means 1932; Holmstrom 1979; Grossman and Hart 1983; Murphy 1999; Bebchuk and Fried 2004; Bebchuk

et al. 2010). The theory of political regulation states that politicians do not necessarily seek to maximize social well-being, but their own well-being (La Porta et al. 1998). Politicians can compel banks to lend funds to companies for political purposes (Chen et al. 2015). Conversely, large banks can abide by the decisions of politicians so that the rules of supervision of the financial system fit their own interests. Thus, banking supervision by public authorities can negatively affect bank efficiency and credit allocation stability.

In addition to the abovementioned theories, Giammarino et al. (1993) model is inspired by agency theory and proposes the creation of effective oversight mechanisms that solve conflicts of interest and reduce the costs arising from agency conflicts in the process of banking governance. This model relates capital ratio and risk-taking through asymmetric information. Indeed, the regulator has no information on the quality of a bank's assets or ideas regarding its choice to change its risk profile. The model proposed by Giammarino et al. (1993) considers the agency relationships among depositors, banks, and regulators, which represents the probability of default and gives great importance to the regulatory financial system based on deposit insurance and a precise level of equity (Vilanova 2006).

2.2 The effect of board of directors on banking stability

In all countries worldwide, the main objective of banking institutions is to establish a strong board of directors system that aims to improve corporate governance by setting standards for the size, composition, structure, and responsibilities of board members. Following previous studies examining the impact of the board of directors on banking stability (Karkowska and Acedański 2020; Fernandes et al. 2021; Gilani et al. 2021; Marie et al. 2021), this study considers the attributes of the board of directors, including board size, board independence, board diversity, board duality, and number of board meetings.

2.2.1 Board size

In corporate governance literature, there is no agreement on the impact of board size on board efficiency. Daily et al. (1999) and Kiel and Nicholson (2003) confirm that a large number of directors might be necessary in large financial institutions to increase the pool of expertise and available resources as well as the potential for establishing contacts with various customers and depositors. In addition, Bouwman (2011) indicated that a large number of directors not only strengthened the board of directors, but also provided essential resources such as professional networks, domain knowledge, skills, and experience. However, Jensen (1993) and Hermalin and Weisbach (2003) state that a high number of directors decreases the efficiency and control of risk management because of the higher agency costs related to problems encountered by directors and difficulties in coordination and communication. Empirically, Ladipo and Nestor (2009) indicate that the best-performing European banks have smaller boards. In addition, Pathan and Faff (2013) reveal that American banks with smaller boards have superior financial performance. More recently,

Karkowska and Acedański (2020) confirm a negative association between board size and banking stability. Hence, our first hypothesis is as follows.

H1.a There is a negative association between board size and bank stability.

2.2.2 Board of directors composition

2.2.2.1 Board independence This study considers board independence another essential characteristic that can significantly impact bank efficiency and risk. Several studies confirm an inverse relationship between board independence and banking stability (Linck et al. 2008; Minton et al. 2011). In addition, Erkens et al. (2012) confirm that board independence within banks reduces stock market returns. Similarly, Pathan and Faff (2013) note that board independence decreases banking performance. Therefore, the presence of independent directors on the board does not always guarantee better performance. Independent directors should use their skills better and apply their expertise and knowledge in their decision-making processes (Adams and Ferreira 2007).

In contrast, several theoretical reasons explain why greater board independence can be beneficial and effective at the board level (Fama and Jensen 1983). These arguments highlight the important role of independent directors in protecting their reputation in the market, which should make them more effective at monitoring and disciplining managers, reducing opportunistic costs, and protecting shareholders' interests. Other studies confirm that board independence has a positive effect on banking performance (Agrawal and Knoeber 1996; Skully 2002; Park and Shin 2004; Pathan et al. 2007). More recently, Ghosh (2018) shows that greater board independence is essential not only to further enhance profitability but also to reduce the insolvency risk within banking institutions. More recently, Fernandes et al. (2021), Gilani et al. (2021), and Trinh et al. (2021) confirm that board independence is positively associated with banking stability. Thus, our second hypothesis predicts a positive relationship between the presence of independent directors on a board and banking stability.

H1.b There is a positive association between board independence and banking stability.

2.2.2.2 Women on board The greater presence of women on boards affects corporate governance dynamics in several ways. Several studies have shown that a higher proportion of female directors negatively affects performance (Adams and Ferreira 2007; Berger et al. 2014) whereas others have confirmed the opposite effect (Carter et al. 2003; Erhardt et al. 2003; Owen and Temesvary 2018). Adams and Ferreira (2007) explain the negative impact of excessive monitoring or lack of experience. Berger et al. (2014) confirm that the presence of women on boards increases banks' risk-taking decisions in Germany, although the economic impact is marginal. However, the evidence of its impact on bank performance and risk is far from simple. Kanter (1977) suggests that the performance benefits are only achieved when the

proportion of women in the board reaches the “critical mass” that will allow women to form coalitions within the board, help each other’s and influence the culture of the board. Several empirical studies confirm a positive relationship between a higher proportion of female directors and accounting performance (Carter et al. 2003; Erhardt et al. 2003; Gulamhussen and Santa 2015).

Owen and Temesvary (2018) show that women’s participation has a positive effect as soon as a minimum threshold of gender diversity is reached. However, this positive effect is only seen in better-capitalized banks.

Regarding gender differences in attitudes towards risk, organizational psychology and economics documents show that women tend to be more risk averse than men (Palvia et al. 2020). More recently, Marie et al. (2021) reveal that board diversity has a positive and significant impact on Egyptian bank stability. Based on these arguments, we formulate the following hypotheses:

H1.c There is a positive association between the presence of women on a board of directors and banking stability.

2.2.3 The board of directors

2.2.3.1 Board duality Another important feature of the board is the dual appointment of the CEO and the chairperson. Two opposing arguments exist in the literature regarding the potential effects of board duality on bank operations and performance. Organizational theorists (Anderson and Anthony 1986) argue that combined leadership structures on top of the hierarchy can reduce information costs and improve the stability and performance of banking institutions. Empirical studies in the banking sector have provided mixed results. Agency theorists consider board duality to weaken board supervisory powers and increase governance costs (Lipton and Lorsch 1992; Jensen 1993; Lasfer 2006). Additionally, duality allows leaders to take advantage of their power to achieve personal interests (Dey et al. 2011). Hence, the third hypothesis is as follows.

H1.d There is a negative association between the duality and banking stability.

2.2.3.2 Number of board meetings This study tests whether the frequency of meetings has performance advantages in terms of efficiency and banking risk taking. There is no consensus in the empirical literature regarding the impact types. Andres and Vallelado (2008) reveal a non-significant relationship between board meetings and banking performance. Conger et al. (1998) confirmed a positive relationship between the number of board meetings and internal governance, which indirectly facilitates performance through reduced agency costs and lower risk-taking behavior. Adams and Mehran (2003) and Grove et al. (2011) added that compared to non-financial companies, banks require more frequent board meetings because of their business complexity. Liang et al. (2013) reveal that the frequency of such meetings improves both the performance of banks and the quality of their assets, leading to an

interesting reduction in banking risk. Based on this argument, we propose the following hypotheses:

H1.e There is a positive association between the number of meetings and banking stability.

2.3 The moderating effect of corruption control on the relationship between board of directors and banking stability

In the theoretical literature, the alignment hypothesis states that blockholders can impose increased oversight on management and use their power to push managers to make appropriate decisions that will increase shareholder wealth and firm value (Jensen and Meckling 1976; Shleifer and Vishny 1986). According to this hypothesis, having blockholders in an ownership structure could leave managers with fewer discretionary opportunities to engage in credit-corruption.

The actions, interactions, and decision-making processes of the board of directors within the framework of a sustainable corporate governance system aim to prevent corruption in companies (Elkington 2002; Lozano 2012; Allais et al. 2017; Fuente et al. 2017; Adnan et al. 2018; Schrippe and Duarte Ribeiro 2019).

The board of directors is responsible for the adoption and implementation of the corruption prevention code within the company as well as the definition of the sustainable strategic objectives of the corporation.

Thus, the sustainability of banking institutions is the main example of overall business sustainability which aims to avoid negative externalities in the environment (Elkington 2002), and subsequently leads to better banking and economic stability.

A bank's sustainability is based on activities that positively contribute to sustainability (i.e., ecological, social, economic, political, and territorial) by the board of directors and management of the institution (Schrippe and Duarte Ribeiro 2019). From this perspective, corruption requires firms to implement sustainable strategies to prevent it (Atangana Ondo 2014).

Corruption is a fundamental obstacle to economic and social development and hinders sustainable economic development, particularly in developing countries (Spyromitros and Panagiotidis 2022). For banks, corruption increases costs and presents excessive risks, which reduce stability. Undoubtedly, banking institutions need strict anti-corruption measures to protect their reputations and stakeholders' interests (World Bank 2020). In banking governance codes, ethical behavior plays a crucial role in preventing corruption and is mainly seen as an effect of anthropological, ethical, and moral attitudes. According to Beck et al. (2005), the corruption of financial intermediaries mitigates the efficient allocation of capital for small businesses, forcing them to miss profitable investment opportunities and subsequently reduce their economic growth.

La Porta et al. (1998) confirm that corruption negatively affects bank loans in countries with poor investor-protection laws. In countries with strong investor protection laws, banks have the assurance of getting their money back, even if debtors are in payment default. The transparency and strength of the legal system serve to reduce the

level of corruption, which in turn leads to better banking efficiency. Even in the case of borrower bankruptcy, the bank is protected by law. It can recover funds or take possession of business. Corruption reduces protection and paralyzes banking systems. In many countries, efforts to reduce or eliminate corruption have failed (Persson et al. 2013; Ajim Uddin et al. 2020). Thus, anti-corruption measures are advantageous and can reduce the risk of bank loss for banks (Demirgüç-kunt and Detragiache 2000; Beck, et al. 2005). These measures are effective in helping companies move from seeking political relationships to strengthening innovation (Anokhin and Schulze 2009; Dang and Yang 2016; Xu and Yano 2017). The governance system within banks and national anti-corruption laws are the two main pillars operating in complex scenarios. Sustainable banking governance aims to establish an efficient board of directors to facilitate decision making and ensure banking stability.

In addition, national legislation in each country aims to prevent corruption among financial and non-financial companies and reduce negative impacts on the environment.

Thus, a relevant question arises regarding the role of the board of directors in the application of national law and anti-corruption measures to ensure a decrease in insolvency risk and improve banking stability by integrating the corruption control index.

Following these arguments, different hypotheses are developed:

H2 The relationship between the attributes of board of directors and banking stability is affected by the degree of corruption control.

H2.a The relationship between board size and banking stability is affected by the degree of corruption control.

H2.b The relationship between board independence and banking stability is affected by the degree of corruption control.

H2.c The relationship between the presence of women on board of directors and banking stability is affected by the degree of corruption control.

H2.d The relationship between the duality of the chairperson of the board and the CEO, and banking stability is affected by the degree of corruption control.

H2.e The relationship between the number of meetings and risk of insolvency is affected by the degree of corruption.

3 Research methodology

3.1 Sample and data

This study uses a sample of 74 commercial banks operating in ten OECD countries (Canada, Switzerland, France, Ireland, Finland, Turkey, Qatar, Bahrain, Jordan, and the UAE) from 2006 to 2016. The year 2006 marks the beginning of the

subprime mortgage crisis (Amadeo 2021) whereas 2016 marks the beginning of the recovery from the financial crisis of 2007–2008 (McKinsey Global Institute 2018). Data were collected from DataStream and included information on banking governance mechanisms (measured by the attributes of the board of directors) and the control variables. Macroeconomic variables were extracted from the World Bank's website.

3.2 Variables

The dependent variable is the Z-score, which measures financial stability. Table 1 presents all independent variables, along with their respective notations, measures, expected signs, and sources of data.

3.3 Methodology

3.3.1 Impact of board of directors on Banking Stability

The impact of the board of directors on banking stability is tested using the following general model:

$$Z_{it} = \beta_0 + \beta_1 Bsize_{it} + \beta_2 Bindp_{it} + \beta_3 Bfemale_{it} + \beta_4 Bdual_{it} + \beta_5 Bmeetings_{it} + \beta_6 Siz_{it} + \beta_7 LTA_{it} + \beta_8 NPL_{it} + \beta_9 GDP_{it} + \beta_{10} Inf_{it} + \epsilon_{it} \quad (1)$$

Several banking risk measures have been used in the literature. In this study, banking risk is proxied by the Z-score, a synthetic indicator considered a measure of bank insolvency risk. In addition, this measure is widely used to assess bank financial health (Schaeck and Wolfe 2006; Worrell et al. 2007). This indicator is commonly mentioned in the literature (Boyd and Runkle 1993; Lepetit et al. 2008; Laeven and Levine 2009; Houston et al. 2010; Demirgüç-Kunt and Huizinga 2010). According to Houston et al. (2010), this risk-taking measure is linked mainly to creditors' rights and shared information, which subsequently promotes economic growth (Fig. 2). A higher Z-score indicates a decrease in insolvency risk, suggesting that the bank is more stable. Banking stability reflects its ability to remain solvent under difficult economic conditions by using its capital and reserve accounts. In other words, it is a bank's ability to resist and protect itself from adverse events and macroeconomic shock. The Z-score was calculated according to Čihák and Hesse (2010), as follows:

$$Z_{it} = \frac{ROA_{it} + \frac{E_{it}}{TA_{it}}}{\sigma ROA_{it}}$$

Table 1 Definition of independent variables

Variables	Notation	Measure	Expected sign	Source of data
Board Size	Bsize	Number of directors in the board	(-)	DataStream
Board independence	Bindp	The percentage of the independent directors in the board	(+)	DataStream
Women on board	Bfemale	The percentage of the female directors in the board	(+)	DataStream
Board duality	Bduality	It takes the value of 1 if the chairman of the board is the CEO, 0 otherwise	(-)	DataStream
Number of meetings	Bmeetings	The number of board's meetings	(+)	DataStream
Size of the bank	Size	The size is measured by the logarithm of the total assets	(-)	DataStream
Loans to Asset	LTA	This variable measures the liquidity degree of the bank. It's calculated by dividing total liabilities on total Assets	(-)	DataStream
Non-performing loans	NPL	Measures the quality of bank credit risk management. It's calculated by dividing the amount of non-performing loans on total loans	(-)	DataStream
Gross Domestic Product	GDP	This variable measures the gross domestic product of the country	(+)	World Bank
Inflation rate	Inf	This variable measures the degree of price increase for goods and services	(-)	World Bank
Corruption Control Index	CCI	It is an index measuring the control of corruption	(+)	World Bank

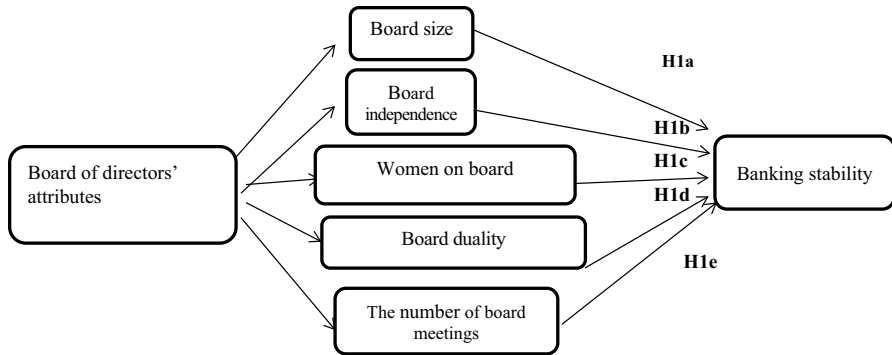


Fig. 2 The effect of board of directors' attributes on banking stability

where ROA is the return on assets, E/TA is the ratio of equity, and σ ROA is the standard deviation of ROA.

3.3.2 The moderating role of the corruption control index

The objective of this section is to study the moderating effect of CI on the relationship between the board of directors and banking stability.

To test Hypothesis (H2), CCI was used to moderate the relationship between the attributes of the board of directors and bank stability (Fig. 3). Specifically, the following model was developed to better understand whether the level of corruption in a country affects the relationship between board governance and banking stability.

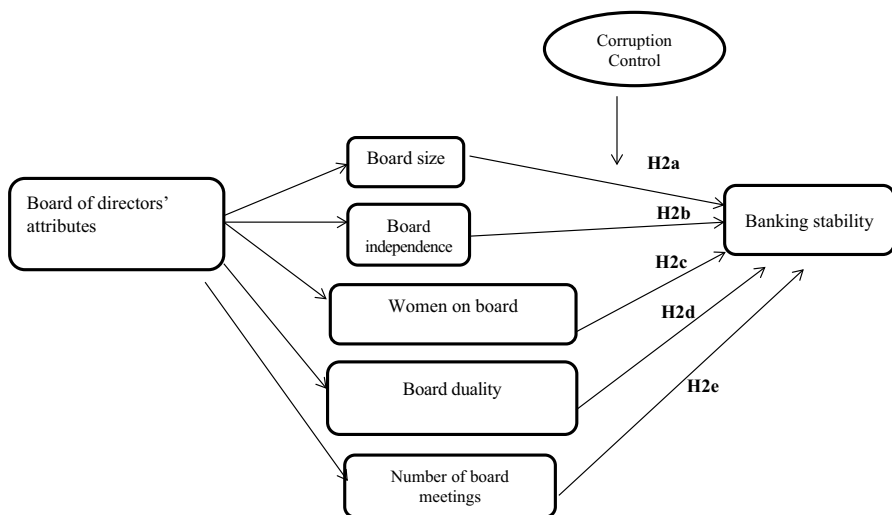


Fig. 3 The effect of corruption on the board of directors-bank stability relationship

$$Z_{it} = \beta_0 + \beta_1 CCI_{it} + \beta_2 Bsize_{it} + \beta_3 Bsize_{it} \times CCI_{it} + \beta_4 Size_{it} + \beta_5 LTA_{it} + \beta_6 NPL_{it} + \beta_7 GDP_{it} + \beta_8 Inf_{it} + \varepsilon_{it} \quad (2)$$

$$Z_{it} = \beta_0 + \beta_1 CCI_{it} + \beta_2 Bindp_{it} + \beta_3 Bindp_{it} \times CCI_{it} + \beta_4 Size_{it} + \beta_5 LTA_{it} + \beta_6 NPL_{it} + \beta_7 GDP_{it} + \beta_8 Inf_{it} + \varepsilon_{it}, \quad (3)$$

$$Z_{it} = \beta_0 + \beta_1 CCI_{it} + \beta_2 Bfemale_{it} + \beta_3 Bfemale_{it} \times CCI_{it} + \beta_4 Size_{it} + \beta_5 LTA_{it} + \beta_6 NPL_{it} + \beta_7 GDP_{it} + \beta_8 Inf_{it} + \varepsilon_{it}, \quad (4)$$

$$Z_{it} = \beta_0 + \beta_1 CCI_{it} + \beta_2 Bdual_{it} + \beta_3 Bdual_{it} \times CCI_{it} + \beta_4 Size_{it} + \beta_5 LTA_{it} + \beta_6 NPL_{it} + \beta_7 GDP_{it} + \beta_8 Inf_{it} + \varepsilon_{it}. \quad (5)$$

$$Z_{it} = \beta_0 + \beta_1 CCI_{it} + \beta_2 Bmeetings_{it} + \beta_3 Bmeetings_{it} \times CCI_{it} + \beta_4 Size_{it} + \beta_5 LTA_{it} + \beta_6 NPL_{it} + \beta_7 GDP_{it} + \beta_8 Inf_{it} + \varepsilon_{it} \quad (6)$$

4 Empirical results

4.1 Descriptive statistics

Table 2 presents descriptive statistics for the variables included in this study. The average of Z-score of all the banks included in the sample (the dependent variable) for the period between 2006 and 2016 was 66.70. As for independent variables, the mean (standard deviation) of board size was 15.71 (4.02), the average of

Table 2 Descriptive statistics

Variables	Mean	STD	Min	Max
Z-score	66.70	28.89	-27.99	99.00
Bsize	15.71	4.02	6.00	28.00
Bindp	45.30	14.18	1.02	86.12
Bfemale	34.39	20.28	0.00	71.94
Bdual	0.51	0.50	0.00	1.00
Bmeetings	12.35	5.92	3.00	47.00
Size	17.84	2.18	11.59	21.69
LTA	64.38	19.57	9.5	123.59
NPL	5.39	7.33	0.05	67.80
GDP	2.74	3.25	-8.26	7.60
Inf	1.08	0.92	-1.14	2.81
CCI	0.91	0.67	-.019	2.50

board independence (standard deviation) was 45.30% (14.18%). The average (standard deviation) of women on board was 34.39% (20.28%), and almost 35% of board members were female directors. The average (standard deviation) of board duality is 0.52 (0.5). The number of meetings on the board of directors was 12.35, with a minimum of three meetings and a maximum of 47 meetings per year.

With regard to control variables, the average size of the banks was 17.84 with a minimum of 11.60 and a maximum of 21.69. The average bank liquidity "LTA" was around 64.39%, its minimum was 9.5%, while its maximum was high, reaching 123.59%. This can be explained by banks' excessive liabilities included in the sample. The values of the bank's credit risk "NPL" were ranging between 0.05% and 67.8% with an average of 5.39%, which shows that most banks had a low rate of non-performing loans.

With regard to the moderating variable, the average corruption control index was 0.91, with a minimum of -0.19 and a maximum of 2.5. This index was collected from the World Bank and is commonly used in literature (Kaufmann et al. 2010). It must be between -2.5 and 2.5, and a higher value of CCI indicates less corruption. Overall, most banks in our sample have good corruption controls.

Table 3 presents the annual mean values of all the variables over the years included in the analysis. The mean of Z-score index was 73.40% in 2006, which decreased to 63.30% in 2016. This finding can be explained by the negative impact of the financial crisis on banks' stability. As for the board of directors variables, the mean board size was 16.10 which 2006 and remained almost stable throughout the study period. The means of board independence and duality increased from 2006 to 2016, while the means of board diversity and the number of board meetings decreased from 2006 to 2016. The means of size, loans to assets, GDP, and the corruption control index decreased from 2006 to 2016, while the means of non-performing loans and inflation increased from 2006 to 2016.

Table 4 presents the mean values of the variables included in this study per country. Developed countries (Finland, Canada, Switzerland, Ireland, and France)

Table 3 The mean of all the variables over the years

Variables	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Z-score	73.40	73.66	73.03	65.67	64.27	64.33	63.93	63.97	60.13	61.87	63.30
Bsize	16.10	15.39	15.72	15.64	15.45	15.71	15.82	15.59	15.90	15.95	15.94
Bindp	42.70	42.18	41.16	41.48	46.55	47.90	46.71	50.46	50.33	46.85	45.01
Bfemale	37.97	37.20	36.84	31.01	31.69	30.46	36.73	35.87	34.20	33.95	32.23
Bdual	0.48	0.44	0.52	0.58	0.57	0.56	0.55	0.54	0.54	0.53	0.53
Bmeetings	12.60	12.58	12.86	12.36	12.51	12.37	12.79	13.10	12.09	11.57	11.21
Size	19.90	19.34	19.39	18.44	17.45	17.54	15.57	14.60	14.62	13.56	15.55
LTA	71.09	71.87	70.74	69.19	68.43	60.88	58.05	57.90	57.45	59.58	59.65
NPL	1.40	1.27	1.77	3.24	3.55	4.05	8.66	8.54	13.24	7.04	6.64
GDP	5.32	7.24	8.50	1.71	0.96	0.61	1.06	0.85	0.38	1.94	1.71
Inf	-0.43	-0.99	0.47	2.22	0.11	2.26	2.69	2.66	2.44	0.21	0.20
CCI	0.95	0.94	0.96	0.97	0.89	0.88	0.85	0.80	0.81	0.81	0.88

Table 4 The mean of all the variables per country

Variables	Finland	Canada	Switzerland	Ireland	France	UAE	Qatar	Jordan	Bahrain	Turkey
Z-score	91.98	91.42	87.81	88.79	82.86	45.96	48.88	36.82	37.94	32.93
Bsize	18.16	18.87	14.75	17.54	16.56	15.75	15.67	14.22	13.55	12.79
Bindp	58.51	49.44	54.95	53.45	58.74	47.02	39.99	35.62	23.92	27.13
Bfemale	57.37	47.49	43.88	45.45	45.40	33.26	17.61	14.43	13.23	24.78
Bdual	0	0.32	0.40	0.36	0.4	0.75	0.83	0.57	0.85	0.64
Bmeetings	14.54	13.45	13.98	14.66	13.74	11.14	10.09	10.74	9.61	9.76
Size	23.72	37.61	24.87	28.98	20.42	3.81	7.24	6.94	8.70	10.56
LTA	87.18	88.73	77.87	75.60	74.35	53.17	47.81	52.80	38.39	44.04
NPL	2.12	2.01	3.13	3.54	4.82	6.15	8.26	8.44	7.63	8.13
GDP	7.41	7.43	6.42	6.15	5.60	0.23	-2.87	0.64	-2.07	-1.56
Inf	-1.05	-0.92	-1.12	0.85	-1.03	2.71	3.66	2.33	1.86	3.64
CCI	1.19	1.30	1.11	1.29	1.48	1.06	0.21	0.48	0.94	0.22

have higher Z-scores than emerging countries (the UAE, Qatar, Jordan, Bahrain, and Turkey). More particularly, Finland had the highest Z-score (91.98%), while Turkey had the lowest Z-score (32.93%). As for the board of directors variables, the highest mean of board size is in Canada (18.87), the highest mean of board independence is in France (58.74%), with a slight difference compared to Finland (58.51%), the highest mean of board diversity is in Finland (57.37%), the highest mean of board duality is in Bahrain (0.85), and the highest mean of the number of board meetings is in Ireland (14.66), with a slight difference compared to Finland (14.54). These results indicate that developed countries have stronger boards of directors that are associated with higher Z-scores.

Similarly, the highest means of size, loans to total assets, GDP, and corruption control index are in developed countries, while the highest means of non-performing loans and inflation are in emerging countries.

Table 5 presents the correlation matrix and shows that all the correlation coefficients are less than 0.7 in absolute value (Kervin 2010) which confirms the absence of multicollinearity between the independent variables.

In addition, Table 6 indicates that the variance inflation factors (VIF) are lower than four, which is the threshold suggested by Benavent and Evrard (2002). This further confirms the results of the correlation matrix and absence of multicollinearity.

4.2 Empirical results

4.2.1 Impact of board of directors on bank stability

In this study, a two-step Generalized Method of Moments (GMM) system was estimated. This estimation was suggested in the Monte Carlo studies conducted by Blundell and Bond (1998) and Blundell and Bond (2000).

The Sargan test was applied as part of the estimation to determine the validity of the instruments. Tables 7 and 8 illustrate the Sargan test results, which confirm the validity of the instruments. The results show that the lagged variable is significant at 1% level, indicating that it is difficult to quickly change the degree of insolvency risk within banks, and the decisions made during a year affect risk-taking in the future. In other words, granting credit in year N affects the banking risk level until the loan is paid fully. Consequently, this finding confirms that banking institutions' insolvency risk is affected by positions generated by previous risk-taking decisions.

In addition, the empirical results reveal that board size (**Bsize**) negatively affects banking stability which confirms H1.a. This result corroborates those of Jensen (1993), Hermalin and Weisbach (2003), and Dong et al. (2017) and shows that the relationship between board size and banking stability is negative. This finding is explained by the high number of directors on the board, which decreases the efficiency and control of risk management because of the higher agency costs. Thus, a large board size is associated with lower stability in banking institutions (Pathan and Faff 2013). These empirical results do not confirm the findings of Daily et al. (1999), Kiel and Nicholson (2003), and Elyasiani and Zhang (2015), who demonstrate a positive relationship between board size and banking stability, because large

Table 5 Correlation Matrix

	Zscore	Bsize	Bindp	Bfemale	Bdual	Bmeetings	Size	LTA	NPL	GDP	Inf	CCI
Zscore	1.00											
Bsize	0.06	1.00										
Bindp	-0.10*	0.01	1.00									
Bfemale	-0.02	0.007	-0.07	1.00								
Bdual	-0.15*	-0.04	0.11*	0.01	1.00							
Bmeetings	0.04	0.11*	-0.04	-0.10*	-0.01	1.00						
Size	0.61*	0.03	-0.05	-0.03	-0.06*	0.02	1.00					
LTA	0.006	0.07*	-0.04	0.01	-0.02	0.04	-0.23*	1.00				
NPL	-0.24*	-0.10*	0.13*	-0.006	0.17*	0.07*	-0.37*	0.18*	1.00			
GDP	0.14*	0.03	0.03	-0.07*	-0.13*	0.02	0.15*	-0.07*	-0.03	1.00		
Inf	-0.17*	-0.05	0.004	0.03	0.02	-0.03	-0.24*	-0.11*	-0.01	0.13*	1.00	
CCI	0.39*	0.03	0.03	-0.04	0.09*	0.06	0.46*	-0.04	0.03	0.14*	-0.17*	1.00

*Significant at 5%

Table 6 Variable Inflation Factors (VIF)

Variables	VIF	1/VIF
Size	1.43	0.698
CCI	1.39	0.720
LTA	1.17	0.851
GDP	1.10	0.913
Inf	1.09	0.916
Bdual	1.07	0.936
Bmeetings	1.07	0.936
Bindp	1.04	0.963
Bfemale	1.03	0.966
NPL	1.03	0.970
Mean VIF	1.13	

Table 7 Board of directors' attributes and banking stability

Dependent variable: Z-score		
Independent variables	Coefficient	Z-Statistic
Z-score L1	0.89***	17.01
Constant	− 4.70***	− 3.31
Bsize	− 0.87***	16.20
Bindp	0.06***	8.27
Bfemale	0.005**	0.66
Bdual	0.16	0.27
Bmeetings	− 0.29***	− 8.69
Size	− 0.67***	− 6.54
LTA	− 0.02***	3.08
NPL	− 0.004***	− 3.33
GDP	0.03	− 0.55
Inf	− 0.02	1.19
Hausman	0.34	
Durbin–Watson	0.56	
AR(1)-test (<i>p</i> value)	− 3.22*** (0.001)	
AR (2)-test (<i>p</i> value)	− 2.001 (0.45)	
Sargan test (<i>p</i> value)	58.44 (0.28)	

Significant at a level of 10%, ** significant at a level of 5%, *** significant at a level of 1%level

boards have a high field of expertise, a high level of available resources, and a high potential to establish contacts with various customers and depositors.

Board independence (**Bindp**) positively affects banking stability; therefore, H1.b is also validated. This result confirms Ghosh (2018), who confirms that independent directors decrease the asymmetry of information within a company, subsequently leading to an increase in banking stability.

Arellano-Bond dynamic panel-data estimation

 Springer

Table 8 (continued)

Arellano-Bond dynamic panel-data estimation										
Dependent variable: Z-score										
Independent variables	Model (2)		Model (3)		Model (4)		Model (5)		Model (6)	
	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic
AR (2) test (<i>p</i> value)	- 1.15 (0.24)		- 1.17 (0.23)		- 1.19 (0.23)		- 1.18 (0.23)		- 1.18 (0.23)	
Sargan test (<i>p</i> value)	62.59 (0.27)		61.54 (0.29)		62.95 (0.26)		62.07 (0.28)		61.37 (0.20)	

* Significant at a level of 10%, ** Significant at a level of 5%, *** Significant at a level of 1%

As for the presence of female directors on the board (**Bfemale**), Table 7 shows that the coefficient of the number of women on board is positive and significant at 5%, which validates H1.c. This result supports those of Kanter (1977), Erhardt et al. (2003), and Temesvary et al. (2018) and reveals that the presence of women on boards has a positive effect on banking stability and that female directors are able to form coalitions and positively influence the company's culture. Adams and Ferreira (2007) suggest the opposite results because of the lack of experience of women in corporate management.

In addition, the results indicate that board duality does not affect the risk of insolvency; therefore, H1.d is rejected. According to Aebi et al. (2012) and Berger et al. (2014), duality in the board of directors (**Bdual**) does not lead to an increase in opportunistic managerial behavior and, subsequently, does not deteriorate or improve stability within banks. This result contradicts Dong et al. (2017) findings, whose empirical results indicate that board duality is associated with a decrease in bank profitability and an increase in insolvency risk.

The second characteristic of the board of directors is the number of meetings (**Bmeetings**). It was noticed that the association of this variable with stability was significantly negative at a level of 1%; hence, Hypothesis H1.e was rejected. According to Vafeas (1999) and Liang et al. (2013), the frequency of board meetings is negatively linked to performance, and therefore, stability. However, this result contradicts the findings of Conger et al. (1998), who confirm a positive relationship between the number of board meetings and banking stability because a high number of meetings mitigates information asymmetry and increases transparency by improving performance and reducing bank insolvency risk.

Regarding the control variables, bank size (**Size**), liquidity (**LTA**), and non-performing loans (**NPLs**) negatively affect banking stability. Thus, large banks are riskier than small ones, based on the risk related to weighted assets, liquidity, and volatility of returns (Demsetz and Strahan 1997; Khan et al. 2017).

Liquidity risk (measured by an increase in the **LTA** ratio) negatively affects banking stability. These results are consistent with those reported by Bourke (1989), Molyneux and Thornton (1992), Barth et al. (1998), Beck et al. (2003), Kosmidou et al. (2005) and Khan et al. (2017). According to these researchers, a high level of liquidity reduces a bank's vulnerability to default and therefore increases its financial stability.

For non-performing loans, they have a negative and significant impact on Z-score. This result indicates that an increase in the credit risk reduces financial stability. As a result, a high level of credit risk leads to the deterioration of assets and, subsequently, higher destabilization and lower stability (Iyer and Puri 2012; Louhichi and Boujelbène 2016).

4.2.2 The moderating role of the corruption control

Table 8 illustrates the estimation results for the control corruption index's impact on the relationship between governance and banking stability.

The results show that the interaction term **Bsize*CCI** was significantly positive (0.52, $p < 0.01$). This result confirmed that H2. Thus, the moderating effect

positively affects the relationship between the board size and bank stability. In the presence of high corruption control, a high number of directors improves the field of expertise, increases the potential to establish contact with various clients and depositors, and reduces banks' insolvency risk of the bank (Daily et al. 1999; Kiel and Nicholson 2003). In other words, a high degree of corruption control in banks leads to better surveillance of board members' decisions (Elkington 2002; Lozano 2012; Allais et al. 2017; Fuente et al. 2017; Adnan et al. 2018).

The interaction term **Bindp*CCI** was significantly positive (0.08, $p < 0.01$). This result confirmed that H2. The moderating effect of the CCI positively affects the relationship between the independence of the board and banking stability. Controlling corruption strengthens market discipline and influences the behavior of independent directors to be firmer and stricter in protecting their reputation in the market (Fama and Jensen 1983). This promotes control of the governing body and reduces costs due to agency disputes, which positively influences the solvency and stability of the bank. Indeed, the presence of independent directors on the board limits managers' opportunistic behavior, which leads to a good agency relationship between shareholders and managers. In such a context of efficient banking governance, members of the board of directors are obligated to increase their efforts and collaborate, leading to a reduction in insolvency risk by achieving performance sustainability and banking stability (Lombardi et al. 2019).

Similarly, regarding the composition of the board, Table 8 shows that the interaction term **Bfemale*CCI** is significantly positive (0.17, $p < 0.01$). This result is consistent with H2, confirming the moderating effect of CCI on the relationship between the presence of women on boards and the risk of bank insolvency. This result suggests a good corruption control in the banking sector. It strengthens the position of women since they do not belong to informal social networks dominated by men and also because of their risk-averse behavior, which consequently increases their effect on decision-making and improves banking stability (Gulamhussen and Santa 2015). Thus, female directors have a positive influence on accounting and market performance, and thereafter, on banking stability. These results suggest the predominance of the advantages associated with the participation of female directors on boards, which are linked to tighter control (Watson et al. 1993), conservatism in monitoring strategies and risks (Wiersema and Bantel 1992) and the quality and solidity of monitoring strategies and risks (Forbes and Milliken 1999; McInerney-Lacombe et al. 2008).

Corruption control moderates the effect of the board of directors on insolvency risk and banking stability. Hypothesis H2 is supported by the moderating effect of CCI on the relationship between board duality and banking stability. The results show that the interaction term **Bdual*CCI** is negative (-1.26) and significant at the 5% level. This indicates that good corruption control can reduce board duality, because it leads to the absence of supervision impartiality, thus achieving banking stability (Rachdi and El Gaied 2009). CCI is a form of internal and external auditing that reduces managerial misconduct. In the case of duality, managers' misconduct is associated with a decrease in bank profitability and increased insolvency risk (Dong et al. 2017). According to agency theory, duality allows managers to leverage their power for their own benefit to the detriment of the company (Dey et al. 2011;

Dong et al. 2017). In addition, other researchers indicate that the government ownership of banks facilitates the financing of politically desirable projects that optimize the private well-being of politicians instead of maximizing social welfare (La Porta et al. 2002; Sapienza 2004; Dinç 2005; Khwaja and Mian 2005). Therefore, H2 was validated.

Hypothesis H2 considers the moderating effect of CCI on the relationship between the number of meetings held by a board of directors and banking stability. The results show that the interaction term **Bmeetings*CCI** is positive (0.21) and significant at 1%. This finding validates H2 and suggests that a high corruption control level facilitates bank transparency. In this case, a high number of meetings helps directors make the right decisions in the bank, which improves performance and reduces risk. Conger et al. (1998) suggested a positive relationship between the number of board meetings and a company's internal oversight, which results in better performance due to reduced agency costs and lower risk. Similarly, Marie et al. (2021) showed that the frequency of board meetings improves bank performance, leading to better banking stability.

Our analysis provides evidence that corruption control plays an important moderating role in strengthening the positive impact of the attributes of the board of directors on financial stability. Banks with larger and dual boards are under stronger pressure and restrictions to avoid risky strategic decisions. Any changes in banks' corporate governance regulations are expected to have a significant impact on their financial stability.

4.2.3 Impact of board of directors on banking stability: developed versus emerging countries

Table 9 illustrates the impact of the corruption control index on the relationship between the boards of directors and banking stability in developed countries (Finland, Canada, Switzerland, Ireland, and France). The results indicate a positive and significant interaction term, **Bsize*CCI** (0.35, $p < 0.01$). This result validates (H2) which states that the Corruption Control Index (CCI) positively moderates the relationship between board size and bank stability. In other words, the presence of many directors in a healthy and non-corrupt environment increases the scope of their expertise, expands the corporate network with various clients and depositors, enhances the efficiency of the decision-making process, and increases bank stability.

Regarding the composition of the board, the **Bindp*CCI** interaction term was positive and significant (0.61, $p < 0.01$). These results corroborate those of Fernandes et al. (2021), Gilani et al. (2021), and Trinh et al. (2021). In addition, the effective control of corruption in banking institutions increases the position and power of women on the board (**Bfemle*CCI**), which promotes and enhances banking stability (0.25, $p < 0.01$) (Marie et al. 2021).

The **Bdual*CCI** interaction term is negative (-7.16) and significant at 1%. The moderating effect of CCI on the relationship between the number of board meetings (**Bmeetings*CCI**) and banking stability is positive (0.62) and significant at 1%. The results for the developed countries are almost the same as those for the overall sample.

Table 9 (continued)

Arellano-Bond dynamic panel-data estimation						
Dependent variable: Z-score						
Independent variables	Model (2)		Model (3)		Model (4)	
	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic
AR (2) test (<i>p</i> value)	-1.37(0.16)		-1.3 (0.18)		-1.64*(0.09)	
Sargan test (<i>p</i> value)	23.31 (0.99)		19.41(1.00)		23.46(0.99)	
					-1.31(0.18)	
					23.30 (0.99)	
						-1.37 (0.17)
						20.79(0.99)

* Significant at a level of 10%, ** Significant at a level of 5%, *** Significant at a level of 1%

Table 10 (continued)

Arellano-Bond dynamic panel-data estimation							
Dependent variable: Z-score							
Independent variables	Model (2)	Model (3)		Model (4)		Model (5)	
	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.
AR (2) test (<i>p</i> value)	1.60 (0.10)		1.68* (0.09)		1.52 (0.12)		1.60 (0.10)
Sargan test (<i>p</i> value)	35.95 (0.96)		36.48 (0.95)		37.68 (0.94)		37.04 (0.95)

* Significant at a level of 10%, ** Significant at a level of 5%, *** Significant at a level of 1%

Table 10 presents the impact of corruption control on the relationship between the board of directors and banking stability in emerging countries (the UAE, Qatar, Jordan, Bahrain, and Turkey). The results deviate slightly from those of developed countries. In fact, the interaction term **Bsize*CCI** has no effect on the relationship between the board of directors and banking stability (0.03, $p=0.32$). This result rejects H2. Regarding the composition of the board of directors, CCI was found to positively moderate the relationship between independent directors (**Bindp*CCI**) on the board and banking stability (0.03, $p<0.01$). Similarly, the interaction term **Bfemale*CCI** is positively and significantly correlated with banking stability (0.07, $p<0.01$). The relationship between board duality (**Bdual*CCI**) and banking stability was negatively moderated by CCI (-3.21 , $p<0.1$), whereas the impact of the number of board meetings (**Bmeetings*CCI**) on banking stability was positively moderated by CCI (0.29, $p<0.01$).

Comparing the results for developed and emerging countries, the difference is generally pronounced at the interaction term level. In particular, the significance of the coefficient is lower for emerging countries than it is for developed countries. This indicates that the degree of significance of the overall sample is essentially explained by the results for developed countries, which have stricter regulations and force the implementation of stronger corporate governance to achieve banking stability.

4.2.4 Impact of board of directors on banking stability: pre and post-crisis

Table 11 demonstrates the moderating effect of corruption control on the relationship between the attributes of the board of directors and banking stability during the pre-crisis period between 2006 and 2008. The interaction terms **Bsize*CCI** (0.97) and **Bindp*CCI** (0.35) are positive and significant at 1%. This could be explained by the fact that in a highly regulated environment, additional and independent directors strengthen corporate governance and subsequently enhance banking stability. As For the board diversity, the term **Bfemale*CCI** is positive (0.31) and significant at 5%. This result confirms H2 and the moderating effect of CCI on the relationship between the presence of women on boards and bank stability. The coefficient of **Bdual*CCI** is negative (-14.54) and significant at the 5%, whereas the **Bmeetings*CCI** interaction coefficient is positive (0.15) and significant at the 5%. These results are similar to those obtained for the entire analysis period.

Table 12 presents the moderating effect of corruption control on the relationship between the attributes of the board of directors and banking stability during the post-crisis period between 2009 and 2016. The results indicate that the moderating effect of corruption control on the relationship between the board of directors and banking stability is weaker than that in the pre-crisis period. Only the impacts of board size and the number of board meetings are moderated by corruption control. More precisely, the interaction terms of **Bsize*CCI** and **Bmeetings*CCI** were positive (0.29, 0.48) and significant at the 5% and 1% levels, respectively. This could be explained by the crisis effect, which hindered and degraded the quality of banking governance, thus deteriorating banking stability during this period (Díaz and Huang 2017).

Table 11 Impact of board of directors on banking stability: Pre- crisis

Arellano-Bond dynamic panel-data estimation										
Dependent variable: Z-score										
Independent Variables	Model (2)		Model (3)		Model (4)		Model (5)		Model (6)	
	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic
Z-Score L 1	0.66***	3.14	0.64***	4.06	0.61***	3.33	0.64***	3.32	0.63***	3.74
Constant	1.90***	0.06	33.51***	1.08	21.90**	0.75	32.05***	1.16	20.54***	0.61
CCI	16.08**	0.53	3.96***	0.23	5.73*	0.54	0.12*	0.01	11.35**	0.68
Bsize	1.07**	0.73								
Bsize*CCI	0.97***	0.43								
Bindp			0.15**	0.76						
Bindp*CCI			0.35***	1.04						
Bfemale					-0.09**	-1.22				
Bfemale*CCI					0.31**	1.16				
Bdual							8.96*	1.90		
Bdual*CCI							-14.54**	-0.78		
Bmeetings									0.22*	0.43
Bmeetings*CCI									0.15**	0.24
Size	1.33	0.56	0.18*	0.09	0.47*	0.22	0.31	0.15	0.20***	0.10
LTA	0.18	1.36	0.2**	1.02	0.24**	1.22	0.25**	1.34	0.22**	1.09
NPL	-0.52**	-0.85	-0.41*	-0.61	-0.44*	-0.58	-0.45*	-0.61	-0.40*	-0.58
GDP	0.07*	0.17	0.27**	0.85	0.24*	0.66	0.05*	0.02	0.19	0.57
Inflation	-0.02*	-0.22	-0.04*	-0.84	-0.04*	-0.33	-0.06	-0.55	-0.06	-0.54
Hausman	0.002		0.0009		0.0001		0.004		0.0002	
Durbin-Watson	1.58		1.63		1.79		1.63		1.66	

Table 11 (continued)

Arellano-Bond dynamic panel-data estimation										
Dependent variable: Z-score										
Independent Variables	Model (2)		Model (3)		Model (4)		Model (5)		Model (6)	
	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic	Coeff.	Z-Statistic
AR (1) test (<i>p</i> value)	−0.85* (0.03)		−0.05** (0.95)		0.09* (0.07)		0.02 (0.97)		0.001* (0.09)	
AR (2) test (<i>p</i> value)	1.50 (0.11)		1.58 (0.32)		−1.62 (0.41)		1.49 (0.13)		1.37 (0.41)	
Sargan test (<i>p</i> value)	2.77 (0.59)		0.48 (0.92)		0.98 (0.80)		0.70 (0.87)		0.58 (0.89)	

*Significant at a level of 10%, ** Significant at a level of 5%, *** Significant at a level of 1%

Bank governance should be reformed to reduce the negative impact of financial crises on stability. A major challenge for policymakers is determining an optimal financial balance that can maximize the benefits of reforms while minimizing the challenges associated with their implementation (Ghosh 2018).

5 Conclusion

This study examines the impact of corporate governance on bank stability by considering the moderating role of corruption controls. Empirical analysis was conducted using a sample of banking establishments in OECD countries between 2006 and 2016. The empirical results combine CCI, which indirectly addresses the relationship between the board of directors and the insolvency risk of banks. These results provide a new way to diagnose and analyze the relationship between the governance of the board of directors and banking stability.

Governments play a fundamental role in controlling corruption, which, in turn, influences the relationship between the board of directors and banking stability. Thus, reforming governance in the banking sector seems delicate. Moreover, it is necessary to ensure the good practice of controlling corruption in different countries, which influences banks to guarantee more solid financial systems based on good governance to improve solvency and banking stability.

This study has several implications. The practical implication would help financial regulators in the different countries included in the analysis to determine the appropriate framework of effective board of directors' rules and guidance and implement effective anti-corruption measures by their respective banking institutions. This will reduce insolvency risk, maintain banking stability, and strengthen banks' resilience in the face of different crises, such as the COVID-19 pandemic. This would ensure sustainable economic development. The strategic implication is related to the significant role played by corruption in a bank's stability and financial decision-making process, which leads to a competitive advantage. As a result, anti-corruption practices should be recognized as strategic decisions related to a bank's stability.

This study had two limitations. First, this study only considered the board of directors' variables. To explain banking stability better, other mechanisms of banking governance could be considered, such as the audit committee and ownership structure. Second, a further possible extension of this research could adopt a comparative approach between the countries used in the sample, considering the difference between the banking systems and the regulatory quality of these countries. This could have different effects on the relationship between banking governance and bank stability and would inform appropriate corrective actions to be taken by each country. Exploration of these newly suggested axes will be the subject of future research.

Funding This research was not funded by any funding agency.

Declarations

Conflict of interest The authors declare no conflicts of interest.

References

- Acharya VV, Richardson M (2009) Causes of the financial crisis. *Crit Rev* 21(2–3):195–210
- Adams RB, Ferreira D (2007) A theory of friendly boards. *J Finance* 62(1):217–250
- Adams R, Mehran H (2003) Is Corporate Governance Different for Bank Holding Companies? *Econ Pol-
icy Rev* 9:123–142
- Adnan SM, Hay D, Van Staden CJ (2018) The influence of culture and corporate governance on corpo-
rate social responsibility disclosure: a cross country analysis. *J Clean Prod* 198:820–832
- Aebi V, Sabato G, Schmid M (2012) Risk management, corporate governance, and bank performance in
the financial crisis. *J Bank Finance* 36:3213–3226
- Agrawal A, Knoeber CR (1996) Firm performance and mechanisms to control agency problems between
managers and shareholders. *J Financ Quant Anal* 31(3):377–397
- Alexandre H, Paquerot M (2000) Efficacité des structures de contrôle et enracinement des dirigeants.
Finance Contrôle Stratégie 3(2):5–29
- Allais R, Roucoules L, Reyes T (2017) Governance maturity grid: a transition method for integrating
sustainability into companies. *J Clean Prod* 140:213–226
- Amadeo K (2021) Subprime mortgage crisis, its timeline and effect. *The Balance*. December, 31. [https://
www.thebalance.com/subprime-mortgage-crisis-effect-and-timeline-3305745](https://www.thebalance.com/subprime-mortgage-crisis-effect-and-timeline-3305745)
- Anderson CA, Anthony RN (1986) *The new corporate director*. Wiley Publication, New York
- Anokhin S, Schulze WS (2009) Entrepreneurship, innovation, and corruption. *J Bus Ventur*
24(5):465–476
- Atangana Ondo H (2014) The determinants of corporate corruption in Cameroon. *Econ Bull*
34(2):938–950
- Barth JR, Caprio G, Levine R (1998) Financial regulation and performance: cross- country evidence.
World Bank Policy Research Working Paper (2037)
- Bebchuk L, Fried J (2004) *Pay without performance*. Harvard University Press, Cambridge, MA
- Bebchuk LA, Cohen A, Spamann H (2010) The wages of failure: executive compensation at Bear Stearns
and Lehman 2000–2008. *Yale J Regul* 27:257–282
- Becht M, Bolton P, Röell A (2011) Why bank governance is different. *Oxf Rev Econ Policy*
27(3):437–463
- Beck T, Demirgüç-Kunt A, Levine R (2003) Bank concentration and crises. *The World Bank*, Washington
- Beck T, Demirgüç-Kunt A, Levine R (2005) SMEs, growth, and poverty: cross- country evidence. *J Econ
Growth* 10(3):199–229
- Berger AN, Kick T, Schaeck K (2014) Executive board composition and bank risk taking. *J Corp Finance*
28:48–65
- Berger AN, Bouwman CHS (2014). *Bank Liquidity Creation, Monetary Policy, and Financial Crises*
Working Paper.
- Berle AA, Means GC (1932) *The modern corporation and private property*. Transaction, New Brunswick,
NJ
- Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. *J
Econom* 87(1):115–143
- Blundell R, Bond S (2000) GMM estimation with persistent panel data: an application to production
functions. *Econ Rev* 19(3):321–340
- Bourke P (1989) Concentration and other determinants of bank profitability in Europe, North America
and Australia. *J Bank Finance* 13(1):65–79
- Bourkhis K, Nabi MS (2013) Islamic and conventional banks' soundness during the 2007–2008 financial
crisis. *Rev Financ Econ* 22(2):68–77
- Bouwman CH (2011) Corporate governance propagation through overlapping directors. *Rev Financ Stud*
24(7):2358–2394
- Boyd JH, Runkle DE (1993) Size and performance of banking firms: testing the predictions of theory. *J
Monet Econ* 31(1):47–67

- Campbell JL (2007a) Why would corporations behave in socially responsible ways? An institutional theory of corporate social responsibility. *Acad Manag Rev* 32(3):946–967
- Campbell JY (2007b) Bank insolvency and the problem of non-performing loans. *J Bank Regul* 9(1):25–45
- Carter DA, Simkins BJ, Simpson WG (2003) Corporate governance, board diversity and firm value. *Financ Rev* 38(1):33–53
- Chen M, Jeon BN, Wang R, Wu J (2015) Corruption and bank risk-taking: evidence from emerging economies. *Emerg Markets Rev* 24:122–148
- Choi J (2000) Asian financial crisis: financial, structural, and international dimensions. *Int Finance Rev* 1:3–4
- Čihák MM, Hesse H (2010) Islamic banks and financial stability: an empirical analysis. *J Financ Serv Res* 38(2–3):95–113
- Claessens S, Yurtoglu BB (2013) Corporate governance in emerging markets: a survey. *Emerg Markets Rev* 15:1–33
- Conger J, Finegold D, Lawler III EE (1998) CEO appraisals: holding corporate leadership accountable. *Organ Dyn* 27(1):7–20
- Daily CM, Certo ST, Dalton DR (1999) A decade of corporate women: some progress in the board room, none in the executive suite. *Strateg Manag J* 20(1):93–100
- Dang L, Yang R (2016) Anti-corruption, marketization and firm behaviors: evidence from firm innovation in China. *Econ Polit Stud* 4(1):39–61
- De Andres P, Vellido E (2008) Corporate governance in banking: the role of the board of directors. *J Bank Finance* 32(12):2570–2580
- Demirgüç-Kunt A, Detragiache E (2000) Monitoring banking sector fragility: a multivariate logit approach. *World Bank Econ Rev* 14(2):287–307
- Demirgüç-Kunt A, Huizinga H (2010) Bank activity and funding strategies: The impact on risk and returns. *J Financ Econ* 98(3):626–650
- Demirgüç-Kunt A, Klapper L, Singer D, Ansar S, Hess J (2018) The Global Findex Database 2017: measuring financial inclusion and the fintech revolution. The World Bank, Washington
- Demsetz RS, Strahan PE (1997) Diversification, size, and risk at bank holding companies. *J Money Credit Bank* 29(3):300–313
- Dey A, Engel E, Liu X (2011) CEO and board chair roles: to split or not to split? *J Corp Finance* 17(5):1595–1618
- Diallo B (2017) Corporate governance, bank concentration and economic growth. *Emerg Mark Rev* 32:28–37
- Díaz V, Huang Y (2017) The role of governance on bank liquidity creation. *J Bank Finance* 77:137–156
- Dinç IS (2005) Politicians and banks: Political influences on government-owned banks in emerging markets. *J Financ Econ* 77(2):453–479
- Djebali N, Zaghdoudi K (2020) Testing the governance-performance relationship for the Tunisian banks: a GMM in system analysis. *Financ Innov* 6:1–24
- Dong Y, Girardone C, Kuo JM (2017) Governance, efficiency and risk taking in Chinese banking. *Br Account Rev* 49(2):211–229
- Elkington J (2002) *Cannibals with forks*. Capstone Publishing Limited Oxford, Oxford
- Elyasiani E, Zhang L (2015) Bank holding company performance, risk, and “busy” board of directors. *J Bank Finance* 60:239–251
- Erhardt NL, Werbel JD, Shrader CB (2003) Board of director diversity and firm financial performance. *Corp Gov Int Rev* 11(2):102–111
- Erkens DH, Hung M, Matos P (2012) Corporate governance in the 2007–2008 financial crisis: evidence from financial institutions worldwide. *J Corp Finance* 18(2):389–411
- Benavent C, Evrard Y (2002) Extension du domaine de l'expérience. *Décisions Market* 7–11
- Fakhfekh M, Hachicha N, Jawadi F, Selmi N, Cheffou AI (2016) Measuring volatility persistence for conventional and Islamic banks: an FI-EGARCH approach. *Emerg Markets Rev* 27:84–99
- Fama EF, Jensen MC (1983) Separation of ownership and control. *J Law Econ* 26(2):301–325
- Fernandes C, Farinha J, Martins FV, Mateus C (2021) The impact of board characteristics and CEO power on banks' risk-taking: stable versus crisis periods. *J Bank Regul* 22:319–341. <https://doi.org/10.1057/s41261-021-00146-4>
- Forbes DP, Milliken FJ (1999) Cognition and corporate governance: Understanding boards of directors as strategic decision-making groups. *Acad Manag Rev* 24(3):489–505

- Fuente JA, García-Sánchez IM, Lozano MB (2017) The role of the board of directors in the adoption of GRI guidelines for the disclosure of CSR information. *J Clean Prod* 141:737–750
- Ghosh S (2018) Governance reforms and performance of MENA banks: are disclosures effective? *Global Finance J* 36:78–95
- Giammarino RM, Lewis TR, Sappington DE (1993) An incentive approach to banking regulation. *J Finance* 48(4):1523–1542
- Gilani U, Keasey K, Vallascas F (2021) Board financial expertise and the capital decisions of US banks. *J Corp Finance* 71:102091. <https://doi.org/10.1016/j.jcorpfin.2021.102091>
- Gorton G, Rosen R (1995) Corporate control, portfolio choice, and the decline of banking. *J Finance* 50(5):1377–1420
- Grossman SJ, Hart OD (1983) Implicit contracts under a symmetric information. *Q J Econ* 90:123–156
- Grove H, Patelli L, Victoravich LM, Xu P (2011) Corporate governance and performance in the wake of the financial crisis: evidence from US commercial banks. *Corp Gov Int Rev* 19:418–436. <https://doi.org/10.1111/j.1467-8683.2011.00882.x>
- Gulamhussen MA, Santa SF (2015) Female directors in bank boardrooms and their influence on performance and risk-taking. *Global Finance J* 28:10–23
- Hermalin B, Weisbach M (2003) Boards of directors as an endogenously determined institution: a survey of the economic literature. *Econ Policy Rev* 9:7–26
- Holmstrom B (1979) Moral hazard and observability. *Bell J Econ* 10(1):74–91
- Houston JF, Lin C, Lin P, Ma Y (2010) Creditor rights, information sharing, and bank risk taking. *J Finance Econ* 96(3):485–512
- Iyer R, Puri M (2012) Understanding bank runs: the importance of depositor-bank relationships and networks. *Am Econ Rev* 102(4):1414–1445
- Jensen MC (1993) The modern industrial revolution, exit, and the failure of internal control systems. *J Finance* 48(3):831–880
- Jensen MC, Meckling WH (1976) Theory of the firm: Managerial behavior, agency costs and ownership structure. *J Finance Econ* 3(4):305–360
- Kanter R (1977) Men and women of the corporation. Basic Books, New York
- Karkowska R, Acedański J (2020) The effect of corporate board attributes on bank stability. *Port Econ J* 19:99–137. <https://doi.org/10.1007/s10258-019-00162-3>
- Kaufmann D, Kraay A, Mastruzzi M (2010) The worldwide governance indicators: methodology and analytical issues. World Bank Policy Research Working Paper No. 5430. The World Bank, Washington, DC
- Kervin JB (1992) Methods for business research. Harper Collins, New York
- Khan MS, Scheule H, Wu E (2017) Funding liquidity and bank risk taking. *J Bank Finance* 82(September):203–216
- Khwaja AI, Mian A (2005) Do lenders favor politically connected firms? Rent provision in an emerging financial market. *Q J Econ* 120(4):1371–1411
- Kiel GC, Nicholson GJ (2003) Board composition and corporate performance: How the Australian experience informs contrasting theories of corporate governance. *Corp Gov Int Rev* 11(3):189–205
- Kirkpatrick G (2009) The corporate governance lessons from the financial crisis. *OECD J Finance Market Trends* 1:61–87
- Kosmidou K, Tanna S, Pasiouras F (2005) Determinants of profitability of domestic UK commercial banks: panel evidence from the period 1995–2002. In: Money Macro and Finance (MMF) Research Group Conference, vol 45, pp 1–27
- La Porta RL, Lopez-de-Silanes F, Shleifer A, Vishny RW (1998) Law and finance. *J Polit Econ* 106(6):1113–1155
- La Porta R, Lopez-de-Silanes F, Shleifer A, Vishny RW (2002) Investor protection and corporate valuation. *J Finance* 57(3):1147–1170
- Ladipo D, Nestor S (2009) Bank boards and the financial crisis. A corporate governance study of the 25 largest European banks. Nesto Advisors Ltd, London
- Laeven L, Levine R (2009) Bank governance, regulation and risk taking. *J Finance Econ* 93(2):259–275
- Lasfer MA (2006) The interrelationship between managerial ownership and board structure. *J Bus Finance Account* 33(7–8):1006–1033
- Lepetit L, Nys E, Rous P, Tarazi A (2008) Bank income structure and risk: an empirical analysis of European banks. *J Bank Finance* 32(8):1452–1467
- Liang Q, Xu P, Jiraporn P (2013) Board characteristics and Chinese bank performance. *J Bank Finance* 37(8):2953–2968

- Linck JS, Netter JM, Yang T (2008) The determinants of board structure. *J Financ Econ* 87(2):320–328
- Lipton M, Lorsch JW (1992) A modest proposal for improved corporate governance. *Bus Lawyer* 48(1):59–77
- Lombardi R (2012) Corporate governance e governo della complessità: un approccio integrato, vol 9. Edizioni Scientifiche Italiane, Napoli
- Lombardi R, Trequatrini R, Cuozzo B, Cano-Rubio M (2019) Corporate corruption prevention, sustainable governance and legislation: first exploratory evidence from the Italian scenario. *J Clean Prod* 217:666–675
- Louhichi A, Boujelbène Y (2016) Credit risk, managerial behaviour and macroeconomic equilibrium with in dual banking systems: interest-free versus interest-based banking industries. *Res Int Bus Finance* 38:104–121
- Lozano R (2012) Towards better embedding sustainability into companies' systems: an analysis of voluntary corporate initiatives. *J Clean Prod* 25:14–26
- Marie M, Kamel H, Elbendary I (2021) How does internal governance affect banks' financial stability? Empirical evidence from Egypt. *Int J Discl Gov* 18:240–255. <https://doi.org/10.1057/s41310-021-00110-8>
- McInerney-Lacombe N, Bilimoria D, Salipante PF (2008) Championing the discussion of tough issues: how women corporate directors contribute to board deliberations. In: Vinnicombe S et al (eds) *Women on corporate boards of directors: International research and practice*. Edward Elgar, Glos, pp 123–139
- McKinsey Global Institute (2018) A decade after the global financial crisis: what has (and hasn't) changed? Accessible at: <https://www.mckinsey.com/~media/McKinsey/Industries/Financial%20Services/Our%20Insights/A%20decade%20after%20the%20global%20financial%20crisis%20What%20has%20and%20hasnt%20changed/MGI-Briefing-A-decade-after-the-global-financial-crisis-What-has-and-hasnt-changed.ashx>
- Mehran H, Morrison A, Shapiro J (2011) Corporate governance and banks: what have we learned from the financial crisis? Federal Reserve Bank of New York, Staff Report No. 502
- Minton BA, Taillard J, Williamson J (2011) Do independence and financial expertise of the board matter for risk taking and performance? Charles A. Dice Center Working Paper No. 2010–14, Fisher College of Business Working Paper No. 2010-03-014, Available at SSRN: <https://doi.org/10.2139/ssrn.1661855>
- Molyneux P, Thornton J (1992) Determinants of European bank profitability: a note. *J Bank Finance* 16(6):1173–1178
- Murphy KJ (1999) Executive compensation. In: *Handbook of labor economics*, vol 3, pp 2485–2563
- Owen AL, Temesvary J (2018) The performance effects of gender diversity on bank boards. *J Bank Finance* 90:50–63
- Palvia A, Vähämaa E, Vähämaa S (2020) Female leadership and bank risk-taking: Evidence from the effects of real estate shocks on bank lending performance and default risk. *J Bus Res* 117:897–909
- Park YW, Shin HH (2004) Board composition and earnings management in Canada. *J Corp Finance* 10(3):431–457
- Pathan S, Faff R (2013) Does board structure in banks really affect their performance? *J Bank Finance* 37(5):1573–1589
- Pathan S, Skully M, Wickramanayake J (2007) Board size, independence and performance: an analysis of Thai banks. *Asia-Pac Financ Markets* 14(3):211–227
- Persson A, Rothstein B, Teorell J (2013) Why anticorruption reforms fail—systemic corruption as a collective action problem. *Governance* 26:449–471. <https://doi.org/10.1111/j.1468-0491.2012.01604.x>
- Rachdi H, El Gaied M (2009) L'impact de l'indépendance et de la dualité du Conseil d'Administration sur la Performance des Entreprises : Application au Contexte Américain. *Revue Libanaise De Gestion Et D'économie* 2(3):127–150
- Raouf H, Ahmed H (2020) Risk governance and financial stability: a comparative study of conventional and Islamic banks in the GCC. *Global Finance J*, 100599
- Rosman R, Wahab NA, Zainol Z (2014) Efficiency of Islamic banks during the financial crisis: an analysis of Middle Eastern and Asian countries. *Pac Basin Financ J* 28:76–90
- Sapienza P (2004) The effects of government ownership on bank lending. *J Financ Econ* 72(2):357–384
- Schrippe P, Duarte Ribeiro JL (2019) Preponderant criteria for the definition of corporate sustainability based on Brazilian sustainable companies. *J Clean Prod* 209:10–19. <https://doi.org/10.1016/j.jclep.2018.10.001>

- Shleifer A, Vishny RW (1986) Large shareholders and corporate control. *J Polit Econ* 94(3):461–488
- Skully MT (2002) Banking and corporate governance: some prudential issues. Presented in Second International Conference on Banking and Finance in Greece, August 9–11
- Spyromitros E, Panagiotidis M (2022) The impact of corruption on economic growth in developing countries and a comparative analysis of corruption measurement indicators. *Cogent Econ Finance* 10(1):2129368. <https://doi.org/10.1080/23322039.2022.2129368>
- Trabelsi MA (2011) The impact of the Financial crisis on the global economy: can the Islamic financial system help? *J Risk Finance* 12(1):15–25
- Tinh VQ, Elnahass M, Cao ND (2021) The value relevance of bank cash Holdings: the moderating effect of board busyness. *J Int Financ Mark Inst Money* 73:101359. <https://doi.org/10.1016/j.intfin.2021.101359>
- Uddin A, Chowdhury MAF, Sajib SD, Masih M (2020) Revisiting the impact of institutional quality on post-GFC bank risk-taking: Evidence from emerging countries. *Emerg Mark Rev* 42:100659
- Vafeas N (1999) Board meeting frequency and firm performance. *J Financ Econ* 53(1):113–142
- Watson WE, Kumar K, Michaelsen LK (1993) Cultural diversity's impact on interaction process and performance: comparing homogeneous and diverse task groups. *Acad Manag* 36:590–602
- Van Greuning H, Brajovic-Bratanovic S (2004) Analyse et gestion du risque bancaire : un cadre de référence pour l'évaluation de la gouvernance d'entreprise et du risque financier, vol 20043. The World Bank, Washington, pp 1–402
- Vilanova L (2006) Financial distress, lender passivity and project finance: the case of Eurotunnel. *Lender Passiv Project Finance Case Eurotunnel*. <https://doi.org/10.2139/ssrn.675304>
- Wiersema MF, Bantel KA (1992) Top management team demography and corporate strategic change. *Acad Manag J* 35(1):91–121
- World Bank (2020) Enhancing government effectiveness and transparency: the fight against corruption. Accessible at: <https://documents1.worldbank.org/curated/en/235541600116631094/pdf/Enhancing-Government-Effectiveness-and-Transparency-The-Fight-Against-Corruption.pdf>
- Worrell MD, Maechler AM, Mitra MS (2007) Decomposing financial risks and vulnerabilities in Eastern Europe (No. 7–248). International Monetary Fund
- Xu G, Yano G (2017) How does anti-corruption affect corporate innovation? Evidence from recent anti-corruption efforts in China. *J Comp Econ* 45(3):498–519

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.