DOCTORAL THESIS

# Board Diversity and Enterprise Risk Management Implementation in Banking Industry

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# Board Diversity and Enterprise Risk Management Implementation in Banking Industry

**LAM, Wing Ho, Fergus**

**A thesis submitted in partial fulfillment of the requirements**

**for the degree of**

**Doctor of Philosophy**

**Principal Supervisor:**

**Dr. SONG Byron Y (Hong Kong Baptist University)**

**February 2022**

Declaration

I hereby declare that this thesis represents my own work which has been done after registration for the degree of PhD at Hong Kong Baptist University, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.

I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures in accordance with the University's Research Ethics Committee (REC). I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

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Date: February 2022

## Abstract

Enterprise risk management (ERM) refers to a holistic approach of corporate risk management. The global financial crisis restates the importance of ERM to safeguard stakeholders' interests. The board of directors takes the main responsibility of risk management and hence the board composition could be a key determinant for the success of ERM implementation. In this study, I examine the effect of board diversity on ERM implementation in the U.S. banking industry. Based on a multidimensional board diversity index of banks during the sample period from 2004 to 2013, I find strong evidence that banks with diverse boards are more likely to implement ERM. In cross-sectional tests, I examine the moderating effects of bank risk exposures and external scrutiny. I find that the effects of board diversity on banks' ERM implementation are stronger for banks with lower regulatory capital and higher duration ratio, for larger banks that are subject to tighter regulation, and for banks that are audited by Big N auditors. In additional tests, I provide evidence that ERM implementation mitigates future non-performing loans and drives future derivative hedging activities.



Keywords: Enterprise risk management; Board diversity; Corporate governance; Banking industry

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## 1. Introduction

Enterprise risk management (ERM) has become a progressively pertinent topic since the last decade. ERM adopts a holistic approach to enhance the board and senior management's ability to manage risk portfolio, monitor, and constrain excessive risk-based activities (Baxter et al., 2013; Beasley et al., 2005). The global significance of ERM is shown by the recent update of the ERM framework by The Committee of Sponsoring Organizations of the Treadway Commission (COSO) (COSO, 2017). Further, ERM facilitates the setting of corporate strategies and the accomplishment of corporate objectives. Viscelli, Hermanson, & Beasley (2017) and Beasley, Branson, & Pagach (2015) demonstrate the cruciality of ERM on its interconnection with corporate strategy and sustainability.

The global financial crisis (GFC) provoked public awareness to demand improvement in banks' risk management systems. Notably, banks are held responsible for a variety of financial transactions and denomination transformations. Individual bank failure spreads to other banks, which could jeopardize the whole financial market (Srivastav & Hagendorff, 2016). The failure of banks' risk management systems could bring significant costs to diverse stakeholders and the community. Stakeholders welcome ERM implementation since it could enhance the risk management system (Lundqvist, 2015). External governance mechanisms, such as COSO and Basel frameworks, are in force to mitigate the probable failure of banks' risk management systems.

Prior literature demonstrates the critical role of ERM in firms, especially banks. A stream of literature examines the firm-specific determinants associated with ERM

implementation (e.g., Beasley et al., 2005; Hines & Peters, 2015; Liebenberg & Hoyt, 2003; Paape & Speklé, 2012; Pagach & Warr, 2011). Besides, a few previous studies focus on the effect of ERM on firm performance (e.g., Baxter et al., 2013; Gordon, Loeb, & Tseng, 2009). Recently, two studies directly address the ERM significance in banks. Lundqvist & Vilhelmsson (2018) demonstrate that ERM implementation could lower banks' default risk. Aljughaiman & Salama (2019) find that the risk management committee (RMC) could enhance the risk management effectiveness.[1]

The board of directors takes the responsibility to enhance internal governance mechanisms since it plays a pivotal and decisive role in risk management. The board is primarily responsible for overseeing the ERM and hence any risk management system weakness is attributed to board oversight deficiency (Kirkpatrick, 2009). As an important attribute of the board, board composition could be a key determinant of the success of ERM implementation. A plethora of prior literature examines the effects of board diversity on bank performance (e.g., Arnaboldi, Casu, Kalotychou, & Sarkisyan, 2020; Cardillo, Onali, & Torluccio, 2020; García-Meca, García-Sánchez, & Martínez-Ferrero, 2015; Gulamhussen & Santa, 2015; Pathan & Faff, 2013; Talavera, Yin, & Zhang, 2018). In addition, the literature focuses on the monitoring effect of board diversity on bank risks (e.g., Bernile, Bhagwat, & Yonker, 2018; Karavitis, Kokas, & Tsoukas, 2021; Lu & Boateng, 2018) and risk management activity (e.g., Berger, Kick, & Schaeck, 2014; Gulamhussen & Santa, 2015; T. Wang & Hsu, 2013). However, there

[1] Risk management committee is a board sub-committee offering advice and guidance on risk management activities.

is currently no study that explores the relationship between multidimensions of board diversity and ERM implementation in banks.

In this study, I examine whether and how board diversity is associated with ERM implementation in banks. Board diversity could improve the decision-making process and equip the board with sound business acumen, risk management knowledge, and financial expertise which are crucial elements for ERM implementation. There are arguments that board diversity might lead to disagreements among directors during the decision-making process which hamper board cohesion. However, this allows the consideration and evaluation of different alternatives for arriving at optimal risk management solutions. On this basis, I conjecture that board diversity is positively associated with banks' ERM implementation.

To test this hypothesis, I follow Bernile et al. (2018) to construct a multidimensional board diversity index (BDI). The BDI comprises seven individual board diversity components, including the percentage of female directors, age diversity, tenure diversity, the average number of outside board seats, financial expertise, ethnic diversity, and education diversity. To measure ERM implementation, I follow Baxter et al. (2013) and Ellul & Yerramilli (2013) to identify the existence of chief risk officer (CRO) and/or RMC as disclosed in 10-K filings.[2] Based on a sample of U.S. banks during 2004-2013, I regress ERM on the multidimensional BDI and a series of bank-level control variables and year fixed effects. Consistent with the hypothesis, I find that there is a positive relation between BDI and ERM. Focusing on individual components of BDI, I find the average number of outside board seats, directors' ethnicity, and

[2] Chief Risk Officer is a board-level executive reporting directly to the CEO.

directors' education institutions are positively correlated with ERM implementation. This suggests that the diversity in board experience, ethnic, and educational institution background could enhance the likelihood of ERM implementation in banks. The main results remain robust when the BDI is constructed using principal factor analysis.

To provide further insights into the association between board diversity and ERM implementation in banks, I employ two internal and two external moderating factors to conduct cross-sectional tests. The first cross-sectional test focuses on the banks' tier-1 capital ratio. To assure the financial strength and solvency of banks, the tier-1 capital ratio is a capital adequacy requirement for banks to comply with. It could be argued that banks with a lower tier-1 capital ratio are in greater need of a risk management system since they are more exposed to capital adequacy risk. Consistent with the hypothesis, I find that the relation between BDI and the ERM implementation is stronger (weaker) when banks have a lower (higher) tier-1 capital ratio. The second cross-sectional test examines the banks' duration ratio. The duration ratio measures the banks' interest rate exposure. It could be argued that banks with higher interest rate risk are in greater need of a risk management system because they are more exposed to interest rate risk. Consistent with the hypothesis, I find that the association between BDI and the ERM implementation is stronger when banks have a higher duration ratio.

The third cross-sectional test exploits the banks' size. Authorities place greater scrutiny on larger banks, as illustrated by the passage of the Dodd-Frank Act. Banking regulators, such as Basel, are also keen to monitor larger banks. Accordingly, it could be argued that banks with larger size total assets are in greater need of a risk management system since they are subject to more intensive external monitoring.

Consistent with the hypothesis, I find that the association between BDI and the ERM implementation is stronger for banks with larger size total assets. The last cross-sectional test focuses on the Big N auditor. Big N auditors are conscious of clients' corporate governance standards. Specifically for banks, Big N auditors are mindful of asset securitization risks. Hence, it could be argued that banks audited by Big N auditors are in greater need of a risk management system since they are subject to intensive external monitoring. Consistent with the hypothesis, I find that the association between BDI and the ERM implementation is stronger when banks are audited by Big N auditors.

Furthermore, I carry out two additional tests to study the effect of ERM implementation on future bank risks and risk management activities. First, I explore whether ERM implementation affects the level of future bank risks, in terms of non-performing loans. Non-performing loans measure a bank's credit risk (Hines, Masli, Mauldin, & Peters, 2015). I find that ERM implementation is negatively associated with non-performing loans, suggesting that ERM implementation could mitigate future credit risk. The second additional test is to explore the impact of ERM implementation on future risk management activities, denoted by derivative hedging. Derivative hedging mitigates derivative contract risks (Ellul & Yerramilli, 2013). Banks carry out derivative hedging as a risk management measure to alleviate the variability of cash flows and reduce probable bankruptcy costs (Smith & Stulz, 1985). I find that ERM implementation is positively associated with derivative hedging. This suggests ERM implementation could drive banks to take part in future risk management activities.

This study makes the following contributions. First, it contributes to the ERM literature in the banking industry. A plethora of literature in ERM explores the firm-specific determinants of ERM implementation (e.g., Beasley et al., 2005; Hines & Peters, 2015; Liebenberg & Hoyt, 2003; Paape & Speklé, 2012; Pagach & Warr, 2011). Besides, prior studies examine the ERM effect on firm performance (e.g., Baxter et al., 2013; Gordon et al., 2009). Recent studies address the significance of ERM in banks, showing that ERM can lower banks' risk exposure and enhance the risk management effectiveness (e.g., Aljughaiman & Salama, 2019; Ellul & Yerramilli, 2013; Lundqvist & Vilhelmsson, 2018). This study sheds new light on the literature by providing evidence that the effect of board diversity on ERM implementation varies with banks' regulatory capital, duration ratio, size, and external auditors.

The study contributes to corporate governance literature. Prior literature examines the board diversity impact on bank performance (e.g., Arnaboldi, Casu, Kalotychou, & Sarkisyan, 2020; Cardillo, Onali, & Torluccio, 2020; García-Meca, García-Sánchez, & Martínez-Ferrero, 2015; Gulamhussen & Santa, 2015; Pathan & Faff, 2013; Talavera, Yin, & Zhang, 2018). In addition, prior studies focus on the monitoring effect of board diversity on bank risks (e.g., Bernile, Bhagwat, & Yonker, 2018; Karavitis, Kokas, & Tsoukas, 2021; Lu & Boateng, 2018) and risk management activity (e.g., Berger, Kick, & Schaeck, 2014; Gulamhussen & Santa, 2015; Wang & Hsu, 2013). To the best of my knowledge, this is the first study to link the relationship between board diversity and ERM implementation. The results of this study underscore the importance of board diversity on the ERM implementation in banks. Furthermore, among seven individual board diversity components, this study demonstrates the

diversity in directors' board experience, ethnic, and educational institution background could enhance the likelihood of ERM implementation in banks.

Third, this study offers significant implications to the existing ERM practices in the banking industry. Prior corporate governance reforms set the scene for the emergence of ERM. The passage of the Sarbanes-Oxley Act requires business entities to employ a top-down approach to identify material risks. Also, the New York Stock Exchange Corporate Governance Rules hold audit committees responsible for "risk assessment and risk management", including risks beyond financial reporting (NYSE Governance Rules 2003, 2003). Further, the U.S. SEC mandates SEC registrants to include risk management oversight activities in the annual reporting. ERM implementation is driven by the framework published by COSO (COSO, 2004). Especially for banks, Basel has provided risk management guidelines for banks to follow, and the Dodd-Frank Act has taken effect to assure risk management effectiveness. In addition, the common practice of board diversity further supports the grandness of this study. All public-listed companies in Singapore are mandated to follow the comply-or-explain approach on board diversity disclosures. This approach is welcomed by other countries, such as Canada, Australia, and the United Kingdom. Taken together, the empirical results of this study could offer new insights for bank policymakers to structure the board for ERM implementation. Indeed, ERM is considered a vital measure to mitigate similar financial distress from recurrence, brings benefits rather than costs to stakeholders and the overall financial market.

The rest of my thesis is structured as follows. Section 2 presents the literature review and hypothesis development. Data and research design are illustrated in Section

3. Section 4 presents the main results and Section 5 shows the cross-sectional analyses. The results of additional tests are presented in Section 6. Finally, Section 7 concludes the thesis.

## 2. Literature review and hypothesis development

### *2.1. Literature on ERM*

Risk governance defines the structure, responsibilities, authorities, and accountability of the ERM and facilitates risk integration to maximize risk management effectiveness (Lundqvist, 2015; Lundqvist & Vilhelmsson, 2018). ERM is an organization-wide risk management process led by the board of directors, which is deployed to identify and manage present and emerging risk events that might affect the organization to achieve strategic objectives (COSO, 2004). Thus, ERM is an essential internal mechanism to coordinate and constrain corporate managers to undertake excessive risk-based activities (Baxter et al., 2013). The board is armed with the responsibilities to oversee and assure ERM implementation. The board establishes CRO and/or RMC to monitor ERM implementation and risk management effectiveness. CRO is a board-level executive that reports directly to the CEO (Liebenberg & Hoyt, 2003), and RMC comprises senior management members to offer advice and guidance to respective business units for risk assessment and management (Hines & Peters, 2015; Hoyt & Liebenberg, 2011).

ERM plays a prominent role to facilitate the formulation of corporate strategy and the accomplishment of corporate objectives to meet stakeholders' expectations. ERM considers present and emerging risks (Meulbroek, 2002) and strikes the optimal

balance between risks and return when setting strategic objectives to maximize stakeholders' value (COSO, 2017). ERM adopts an integrated, systematic, and holistic approach to manage enterprise-wide risks (Gordon, Loeb, & Tseng, 2009; Kleffner, Lee, & McGannon, 2003; Liebenberg & Hoyt, 2003; Meulbroek, 2002). ERM implementation meets diverse stakeholders' expectations in several aspects. First, ERM enhances corporate risk awareness that strengthens risk-based decision-making processes (Anderson, 2017; Kleffner et al., 2003; Liebenberg & Hoyt, 2003). Second, ERM enables efficient risk communication that attenuates information asymmetries among stakeholders (Lechner & Gatzert, 2017). Third, ERM improves risk management disclosure to provide a better understanding of risk profile to stakeholders, which could mitigate earnings volatility and regulatory scrutiny costs (Meulbroek, 2002). Taken together, ERM could optimize business performance, strengthen corporate transparency and accountability, to sufficiently meet stakeholders' expectations (COSO, 2004; Lundqvist, 2015).

Empirical work on ERM can be categorized into two main lines of research – examine the ERM implementation determinants and assess the effect of risk management function. Regarding ERM implementation determinants, early literature uses broad-based samples covering multiple industries. For example, Liebenberg & Hoyt (2003) find the likelihood of CRO appointment is higher for firms with greater financial leverage. Beasley et al. (2005) show CRO appointment, board independence, Big N auditor engagement, firm size, and CEO and CFO support are positively associated with ERM implementation. Similarly, Paape & Speklé (2012) state that firm size, the existence of CRO, and audit committee are positively associated with ERM

implementation. Recent work focuses on a single-industry setting to investigate ERM implementation determinants. Pagach & Warr (2011) demonstrate the likelihood for CRO appointment is higher for larger banks with lower tier-1 capital ratios and greater institutional ownership. Hines & Peters (2015) find financial institutions with a larger-sized and independent board, merger and acquisition activity, international operations, lower financial reporting quality, higher leverage, and audited by Big N auditors are positively associated with RMC formation. Both studies rely on CRO or RMC as the proxies for ERM implementation.

Additional literature addresses ERM could affect firm performance. Referring to the COSO framework and ERM activities disclosed in the 10-Ks, Gordon et al. (2009) state the association between ERM implementation and stock market return to shareholders is conditional on firm-specific factors. Using S&P ERM quality ratings, Baxter et al. (2013) find the positive association between firms with high ERM program ratings and persistent earnings, as measured by earnings response coefficient. Specifically for banks, a few studies assess the effect of risk management function on bank risks and risk-taking activities. Using the risk management index, Ellul & Yerramilli (2013) find that an independent and robust risk management function could mitigate tail risk exposure. Lundqvist & Vilhelmsson (2018) state the negative association between ERM adoption and credit default swap spread in banks. In a similar vein, Aljughaiman & Salama (2019) show RMC is negatively associated with bank risks (include insolvency risk, liquidity risk, market risk, operational risk, and credit risk) for the Middle East and North Africa banks during the post-crisis period.

### *2.2. Literature on board diversity*

Board diversity encompasses demographic and cognitive attributes. Demographic attributes include the director's gender, ethnicity, and age (Milliken & Martins, 1996; Tarus, 2015). Cognitive attributes include the director's educational background, functional background, tenure, and board experience (Milliken & Martins, 1996; Tarus, 2015). Board diversity enables the potential appointment of high-quality directors to enhance the board's capability to monitor management appropriately (Wahid, 2019). Further, in line with stakeholder theory that focuses on wider interests of community-at-large (Carter et al., 2003), board diversity addresses different stakeholders' needs (Carter et al., 2003; Coffey & Wang, 1998; Tarus, 2015).

#### *2.2.1. Gender diversity*

Female directors' traits and competence make them suitably qualified to carry out board monitoring roles effectively (Adams & Ferreira, 2009; Carter et al., 2003; Hillman et al., 2002). They are more benevolent, stimulating, stakeholder-oriented, and universalistic (Adams & Funk, 2012). Female directors exhibit higher independence since they do not affiliate with the "old boys' network" (Gray et al., 2007). Besides, they possess an array of skills and knowledge, including corporate governance and risk management (Kim & Starks, 2016). Female directors are likely to participate in board-level committees, such as the audit committee and corporate governance committee, to oversee board activities (Adams & Ferreira, 2009). Prior literature finds gender diversity is associated with board oversight in banks. Gulamhussen & Santa (2015) show that gender diversity could negatively influence risk-taking measures in OECD

banks.[3] Likewise, Karavitis et al. (2021) find board gender diversity positively impacts accounting practices that could lower bank loan interests. Further, gender diversity could reduce the likelihood of earnings management (Fan et al., 2019) and public bailout (Cardillo et al., 2020).

*2.2.2. Ethnic diversity*

Directors from different ethnicities could preclude themselves from pursuing self-serving objectives (Tarus, 2015). Ethnic diversity facilitates the boards to fill with distinct human capital that leads to high-quality board solutions (Hillman et al., 2002). Besides, ethnic diversity upholds board independence and enhances monitoring effectiveness. Upadhyay & Zeng (2014) show ethnic diversity could lower corporate opacity, hence enhance corporate information environment transparency. However, Guest (2019) does not find any association between ethnic diversity and board monitoring.

*2.2.3. Age diversity*

Age diversity could maximize the accumulation of human and social capital of the board (Arnaboldi et al., 2020). The personal values and risk-taking attitudes are different between younger directors and older ones. Younger directors are more innovative, risk-seeking, and strategic while older counterparts are more risk-averse (Muth & Donaldson, 1998; Wiersema & Bantel, 1992). Hence, age diversity could strike a balance to reach the optimal risk acceptance level (Ali et al., 2013; Ararat et al., 2015) and contribute to a more thorough board decision-making process and

[3] Risk-taking measures include loan loss reserves, impaired loans, loan loss provisions, and Z-Score.

monitoring. Prior literature provides mixed evidence on the association between age diversity and board monitoring. Berger et al. (2014) demonstrate the lower average board director age is associated with higher banks' portfolio risks, which is consistent with the risk-taking attitudes of younger directors. However, Wang & Hsu (2013) find age diversity imposes a negative effect on board monitoring, denoted by operational risk events in financial institutions.

*2.2.4. Tenure diversity*

Directors gain an understanding of firm-specific knowledge and collegiality which is crucial for board dynamics (Sturman, 2003). Long tenure smooths directors' communication flow and expedites work efficiency (Bell et al., 2011). However, this might compromise the board monitoring effectiveness arising from groupthink (Bantel & Jackson, 1989). Short tenure facilitates strategic change (Wiersema & Bantel, 1992) and maintains board independence to uphold board monitoring effectiveness. To summarize, tenure diversity could prevent the "cohort phenomenon" (Wiersema & Bantel, 1992) while safeguard board independence to maintain board monitoring effectiveness. Li & Wahid (2018) show tenure diversity could increase CEO performance-turnover sensitivity and a lower likelihood of accounting restatements.

*2.2.5. Education diversity*

Education diversity could be measured by institutions attended by the board directors (Bernile et al., 2018). Bernile et al. (2018) examine the relationship between board diversity and firm risk, in which the education diversity of board directors is measured using Herfindahl concentration indexes for institutions where the directors received their Bachelor's degree. This measurement captures the similarities in

pedigree or training stemming from the institution. The institutions attended by the board directors could reflect their similarities in values and collegiality. In a similar vein with other components of board diversity, the education diversity could inhibit groupthink while promoting board independence and monitoring effectiveness.

*2.2.6. Financial expertise*

Board directors possess specialized knowledge and skills in a functional area enhance the firm's strategic value (Hambrick & Mason, 1984), and provide proper guidance to the board (Tarus, 2015). Specifically, directors with accounting and finance backgrounds participate in audit and/or risk committees to monitor and assure internal control and risk management effectiveness. García-Sánchez, García-Meca, & Cuadrado-Ballesteros (2017) demonstrate audit committees consist of financial experts could lower bank insolvency risk. Consistent with this, Kang, Kim, & Liao (2020) find the monitoring roles of bank directors could alleviate stock price crash risk.

*2.2.7. Number of outside boards*

The number of outside boards seated by directors denotes the diversification of board experience acquired. Board experience provides directors with important human capital (Carpenter & Westphal, 2001) and social capital (Nahapiet & Ghoshal, 1998). Directors participate in other firms' boards broaden business acumen and expand the social network via communication with other directors during board meetings (Carpenter & Westphal, 2001; Haunschild, 1993; Nahapiet & Ghoshal, 1998). Prior literature finds bank directors holding multiple directorships enhance the board decision-making process, resource utilization efficiency, and monitoring effectiveness,

resulting in lower bank risks (Elyasiani & Zhang, 2015; Kutubi et al., 2018; Trinh et al., 2020).

*2.3. The linkage between board diversity and ERM*

The core objective of ERM is to strike a proper balance between risk and return through appropriate monitoring of excessive risk-taking activities undertaken by the management, in an aim to achieve strategic objectives. ERM implementation requires comprehensive enterprise risk identification, analysis, and discussion. The characteristics of board diversity facilitate the ERM implementation. Board diversity strengthens the quality of decision-making through board dynamics (Sonnenfeld, 2002). Board dynamics is built upon board independence among directors to accept dissenting views (Arfken et al., 2004; Bantel & Jackson, 1989; Berger et al., 2014). This is essential since the ERM implementation process involves continuous innovative and risk-based discussions among directors. Besides, sound business acumen is important since the ERM implementation process requires a considerable understanding of the industry and firm-specific knowledge. This could assure the effectiveness of risk identification, risk analysis, and risk responses. In addition, a good mix of directors having diversified risk knowledge and financial expertise further expedites the consensus to reach risk management solutions. However, it is argued that board diversity could be an impediment to board cohesion since heterogenous directors might perceive each other as outsiders (Adams et al., 2010). The increase in board frictions might hamper the decision-making process efficiency (Adams et al., 2015). Despite the frictions among board directors that might arise, this provides opportunities for them

to consider different perspectives, evaluate more alternatives and explore the consequences of these options (Carter et al., 2003).

Overall, board diversity could strengthen the decision-making process quality via acceptance of dissenting views. Sound business acumen, firm-specific knowledge, extensive risk knowledge, and financial expertise are crucial factors for ERM implementation. Despite probable disagreements among heterogeneous directors that might hamper board cohesion and impact decision-making process efficiency, this allows the consideration and evaluation of different alternatives for reaching better risk management solutions. Considering the positive effects of board diversity would dominate the negative effects, I state the main hypothesis in alternative form as follows:

*H1: Board diversity index is positively associated with ERM implementation in banks.*

*2.4. Cross-sectional effects of board diversity on ERM implementation*

I examine two internal and two external moderating factors that could influence the effect of board diversity on ERM implementation in banks. The four moderating factors are tier-1 capital ratio, duration ratio, bank size, and Big N auditors. These cross-sectional tests aim to provide further insights into the relation between board diversity and banks' ERM implementation.

First, I explore the bank's tier-1 capital ratio that could influence the effect of board diversity on ERM implementation. The tier-1 capital ratio is one of the capital adequacy requirements for banks to comply with to assure their financial strength and solvency. A well-capitalised bank should maintain at least a 6% tier-1 capital ratio

(Pathan & Faff, 2013). Hence, banks with a lower tier-1 capital ratio are more exposed to capital adequacy risk. In respect of the capital adequacy risk, prior studies indicate banks with a lower tier-1 capital ratio are incentivized to report lower probability to default estimates (Berg & Koziol, 2017). Besides, banks with lower tier-1 capital ratios are in higher likelihood to use Level 3 input for financial assets valuation (Yao et al., 2018). Level 3 input provides opportunities to manipulate valuations at one's discretion. Thus, it could be argued that for banks with a lower tier-1 capital ratio, the diverse board is likely to monitor the capital adequacy risk through the implementation of a risk management system. In light of the above findings, I state the following hypothesis:

*H2: The relation between the board diversity index and the ERM implementation is stronger (weaker) when banks have a lower (higher) tier-1 capital ratio.*

Second, I examine the bank's duration ratio that could influence the effect of board diversity on ERM implementation. The duration ratio measures a bank's interest rate exposure. The interest rate exposure is the difference between the duration of assets and liabilities (Pagach & Warr, 2011). This exposure stems from the bank's investment in long-term assets out of short-term liabilities (Vuillemey, 2019). Interest rate risk is the sensitivity of earnings and equity value arising from changes in interest rates (Cheng et al., 2021). Considering high interest rate risk that could affect bank solvency, the U.S. SEC and bank regulators emphasize interest rate risk management and corresponding disclosure (Federal Reserve, 2010). Hence, it could be argued that for banks with higher interest rate risk, the diverse board is likely to devise monitoring

measures through the establishment of a risk management system. Accordingly, I state the following hypothesis:

*H3: The relation between the board diversity index and the ERM implementation is stronger when banks have a higher duration ratio.*

The third cross-sectional test exploits the bank size that could influence the effect of board diversity on ERM implementation. Authorities and bank regulators are keen to monitor and assure the risk management system implementation and effectiveness of large-sized financial institutions, including banks. Dodd-Frank Act mandates U.S. banks with consolidated total asset balances of not less than US$10 billion to enhance risk management system via the establishment of the RMC ("Summary of the Dodd-Frank Wall Street Reform and Consumer Protection Act," 2010). Further, one of the Basel principles stipulates that large-sized and international banks should uphold the risk management function effectiveness under the leadership of the CRO (Basel Committee on Banking Supervision, 2015). Assuming that internal governance and external governance can either supplement or substitute each other, it could be argued that for banks with a larger size of total assets, the diverse board is cognizant of the intensive external monitoring mechanisms, leading to a higher likelihood to implement a risk management system. However, it could also be counter-argued that these banks might demand less ERM if the external monitoring mechanism is substituted by internal governance. Considering the supplementary effect would dominate the substitution effect, I state the following hypothesis:

*H4: The relation between the board diversity index and the ERM implementation is stronger for banks with a larger size of total assets.*

The last cross-sectional test focuses on the Big N auditors that could influence the effect of board diversity on ERM implementation. Big N auditors are regarded as intense external monitors, besides bank regulators and legal authorities. Big N auditors consider the corporate governance mechanisms employed by audit clients when determining the audit client portfolio (Cassell et al., 2012). Specifically for banks, Cullen et al. (2018) find asset securitization risks are positively associated with Big N auditors' audit fees. This indicates Big N auditors are conscious of asset securitization risks during bank audits to lower the likelihood of subsequent restatement on financial statements and reported gains arising from asset securitizations. Assuming that internal governance and external governance can either supplement or substitute each other, it could be argued that for banks audited by Big N auditors, the diverse board is well aware of the monitoring focus on corporate governance and asset securitization, link to a higher likelihood to implement a risk management system. However, it could also be counter-argued that these banks might demand less ERM if the external monitoring mechanism is substituted by internal governance. Considering the supplementary effect would dominate the substitution effect, I state the following hypothesis:

*H5: The relation between the board diversity index and the ERM implementation is stronger when banks are audited by Big N auditors.*

## 3. Empirical model and data

### *3.1. Source of data, sample selection, and measurement of variables*

I use Compustat Bank, ISS Directors database, 10-K filings, BoardEx database, and Thomson Reuters Institutional Holdings database to perform this study. The sample comprises all major U.S. listed banks included in the intersection of the

Compustat Bank and ISS Directors database from 2004 to 2013 for which data are available to compute the multidimensional BDI. The construction of the ERM variables, board diversity variables, and bank-level control variables rely on data available in the 10-K filings, ISS Directors database, and Compustat Bank, respectively. In addition, I utilize the BoardEx database for CEO duality and directors' educational institution background, and the Thomson Reuters Institutional Holdings database for institutional ownership data. I excluded bank-year observations with consolidated total asset balances over US10 billion from 2011 to 2013 and those with missing values.[4] My final sample comprises 610 bank-year observations of 120 banks. The final sample covers 19% of the total assets of the original bank-year observations from the Compustat Bank database. Panel A of Table 1 reports the sample selection procedure for this study.

[INSERT TABLE 1 HERE]

To measure the ERM variables, I need to identify the existence of ERM implementation for each bank year. Following prior literature (e.g., Ellul & Yerramilli, 2013; Hines & Peters, 2015; Pagach & Warr, 2011), I manually search the 10-K filings for the evidence of ERM implementation for each bank year from 2004 to 2013, proxied by the existence of CRO and/or RMC. Specifically, I search for the existence of CRO (or equivalent) and RMC (or equivalent) by reviewing the context in the 10-K filings to ensure each search hit is related to ERM implementation.[5] *ERM* is a dummy

[4] The Dodd-Frank Act was enacted and effective on 21 July 2010, requiring all publicly traded financial firms with consolidated total asset balances over US$10 billion to establish independent RMC to strengthen risk management system. Banks that have consolidated total asset balances over US$10 billion must have set up RMC following the passage of the Dodd-Frank Act. Hence, bank-year observations with consolidated total asset balances over US$10 billion were excluded from the final sample size.

[5] CRO equivalent designations such as chief risk and compliance officer, chief enterprise risk officer, Director of ERM, executive vice president-risk management, head of corporate risk management, chief

variable which equals 1 if the bank has ERM under implementation, proxied by the existence of CRO (or equivalent) and/or RMC (or equivalent), 0 otherwise. *CRO* is a dummy variable which equals 1 if the bank has ERM under implementation, proxied by the existence of CRO (or equivalent), 0 otherwise. *RMC* is a dummy variable which equals 1 if the bank has ERM under implementation, proxied by the existence of RMC (or equivalent), 0 otherwise. Panel B of Table 1 presents the ERM implementation distribution for the sample period from 2004 to 2013.

To construct the multidimensional BDI, I use data that are from the ISS Directors database, which includes information on directors' gender, age, tenure, the number of outside boards, financial expertise, and ethnic. In addition, I use data on directors' education institution backgrounds from the BoardEx database. I follow Bernile et al. (2018) to build an index based on seven individual director attributes. With reference to Milliken & Martins (1996), I use three demographic attributes and four cognitive attributes. The demographic attributes include age, ethnicity, and gender. The cognitive attributes include tenure, higher education institution attended, financial expertise, and the number of outside boards. The multidimensional BDI is calculated as follows. For each bank year, I calculate the female directors' percentage (*TTL_FEM_DIR*), the directors' age standard deviation (*STD_AGE*), the directors' tenure standard deviation (*STD_TENURE*), the mean number of outside boards on which current directors serve (*NUM_BD*), Herfindahl concentration indexes for directors' ethnicity (*HHI_ETHNIC*),

credit officer, chief credit and risk officer, and chief lending officer. RMC equivalent names such as risk committee, risk management committee, risk and compliance committee, ERM committee, risk oversight committee, risk management council, audit and risk committee, and audit and risk management committee.

directors' financial expertise (*HHI_FINEXP*), and institution directors obtained their bachelor's or first higher education degree (*HHI_EDU*). Next, each board diversity component is normalized by its mean and standard deviation to arrive at the comparable scale, then equally weighted to construct the multidimensional BDI as follows:

BDI = STDZ(TTL_FEM_DIR) + STDZ(STD_AGE) + STDZ(STD_TENURE) + STD(NUM_BD) + STDZ(1–HHI_FINEXP) + STDZ(1–HHI_ETHNIC) + STDZ(1–HHI_EDU)

The multidimensional BDI is the sum of the seven board diversity components. Specifically, I subtract each Herfindahl concentration index from one in respect of directors' financial expertise, ethnicity, and education institution to transfer the Herfindahl concentration index to a positive measure of board diversity.

*3.2. Model specification*

*3.2.1. The relation between board diversity index and ERM implementation*

To test *H1*, I estimate the following Logit regression:

$$ERM_{i,t} = \beta_0 + \beta_1 BDI_{i,t-1} + \beta_2 LOG\_ASSETS_{i,t-1} + \beta_3 OPACITY_{i,t-1} + \beta_4 BUSINESS\_GROWTH_{i,t-1} + \beta_5 INT\_OPS_{i,t-1} + \beta_6 INSTIT\_OWN_{i,t-1} + \beta_7 BIG\_N_{i,t-1} + \beta_8 CEO\_DUALITY_{i,t-1} + \beta_9 LOG\_BOARD\_SIZE_{i,t-1} + \beta_{10} TTL\_OUTSIDE\_DIR_{i,t-1} + \beta_{11} T1\_CAP_{i,t-1} + \beta_{12} LOAN\_LOSS\_PROVISION_{i,t-1} + \beta_{13} DURATION\_RATIO_{i,t-1} + \beta_{14} BANK\_EFFICIENCY_{i,t-1} + \text{year fixed effects} + \varepsilon_{i,t} \quad (1)$$

The dependent variable of interest in Equation (1), $ERM_{i,t}$, captures the ERM implementation, as proxied by the existence of CRO and/or RMC in banks. This dependent variable measures bank *i*'s ERM implementation in year *t*. I also examine two alternate dependent variables, *CRO* and *RMC* in separate regressions. I determine

whether multidimensional BDI has a positive association with the implementation of ERM. Prior literature (e.g., Ellul & Yerramilli, 2013; Hines & Peters, 2015; Pagach & Warr, 2011) uses CRO and RMC as ERM proxies to capture ERM implementation. The independent variable of interest is the multidimensional BDI, $\beta_1$ ($BDI_{i,t-1}$), defined as the normalization of the sum of the seven individual directors' attributes. This variable measures the degree of board diversity in bank *i* in year *t-1*. I expect a positive sign on the coefficient for $\beta_1$, which is consistent with the hypothesis that board diversity has a positive association with the ERM implementation.

An array of bank-level control variables is included that could affect the ERM implementation. These control variables are with reference to prior determinants of ERM implementation and banking literature (e.g., Beasley et al., 2005; Beasley, Pagach, & Warr, 2008; Hines & Peters, 2015; Lechner & Gatzert, 2017; Liebenberg & Hoyt, 2003; Lu & Boateng, 2018; Paape & Speklé, 2012; Pagach & Warr, 2011; Wang & Hsu, 2013). To control for bank size, I use lagged total assets ($LOG\_ASSETS_{i,t-1}$) given that authorities and bank regulators are keen to monitor and assure the risk management system implementation and effectiveness of large-sized financial institutions, including banks. Banks inherently possess a high degree of financial opacity (Morgan, 2002), therefore I control for lagged opacity ($OPACITY_{i,t-1}$). Besides, I also control for lagged business growth ($BUSINESS\_GROWTH_{i,t-1}$), consider banks face emerging risks and uncertainties as the business grows, thus the growth rate could affect the ERM implementation. In a similar vein, international banking activities might call for banks to implement ERM as measures against a wider spectrum of risks, so I control for lagged international operations ($INT\_OPS_{i,t-1}$). Next, to address the

preference of a comprehensive risk management system to monitor risks by institutional owners, I control for lagged institutional ownership percentage ($INSTIT\_OWN_{i,t-1}$). Likewise, Big N auditors are intense external monitors with interests in corporate governance standards, so I control for lagged Big N auditor engagement ($BIG\_N_{i,t-1}$).

The board has strong initiatives to implement ERM to monitor excessive risk-taking activities undertaken by the CEO, especially when the CEO is also the chairperson. Hence, I control for lagged CEO duality ($CEO\_DUALITY_{i,t-1}$). Moreover, I control for lagged board size ($LOG\_BOARD\_SIZE_{i,t-1}$) since board size correlates with board monitoring effectiveness. When the board size grows beyond a certain limit, the board monitoring effectiveness might diminish because of the free-rider issue (Raheja, 2005). In addition, I control for lagged percentage of outside directors ($TTL\_OUTSIDE\_DIR_{i,t-1}$) since independent directors hold imperative monitoring roles to oversee management activities. I control for lagged tier-1 capital ratio ($T1\_CAP_{i,t-1}$) since banks should comply with the capital adequacy requirements. Also, I control for lagged provision of loan losses ($LOAN\_LOSS\_PROVISION_{i,t-1}$) since it measures the bank's default risk. Further, I control for lagged duration ratio ($DURATION\_RATIO_{i,t-1}$) since it measures the bank's interest rate exposure. Last, the bank efficiency ratio could indicate the bank's level of risk-taking and its credit risk. So, I control for lagged bank efficiency ($BANK\_EFFICIENCY_{i,t-1}$).

The variable descriptions are summarized in Appendix A. All continuous variables are winsorized at the 1% and 99% levels to alleviate the influence of outliers. I also include year fixed effects for all regression analyses.

*3.2.2. The effects of moderating variables on ERM implementation*

To test *H2 to H5*, I estimate the following Logit regression:

$$ERM_{i,t} = \beta_0 + \beta_1 BDI_{i,t-1} * MODERATOR_{i,t-1} + \beta_2 BDI_{i,t-1} + \beta_3 \text{MODERATOR}_{i,t-1} + \beta_4 LOG\_ASSETS_{i,t-1} + \beta_5 OPACITY_{i,t-1} + \beta_6 BUSINESS\_GROWTH_{i,t-1} + \beta_7 INT\_OPS_{i,t-1} + \beta_8 INSTIT\_OWN_{i,t-1} + \beta_9 BIG\_N_{i,t-1} + \beta_{10} CEO\_DUALITY_{i,t-1} + \beta_{11} LOG\_BOARD\_SIZE_{i,t-1} + \beta_{12} TTL\_OUTSIDE\_DIR_{i,t-1} + \beta_{13} \text{T1\_CAP}_{i,t-1} + \beta_{14} LOAN\_LOSS\_PROVISION_{i,t-1} + \beta_{15} DURATION\_RATIO_{i,t-1} + \beta_{16} BANK\_EFFICIENCY_{i,t-1} + \text{year fixed effects} + \varepsilon_{i,t} \quad (2)$$

The dependent variable in Equation (2), $ERM_{i,t}$, captures the ERM implementation, as proxied by the existence of CRO and/or RMC in banks. This dependent variable measures bank *i*'s ERM implementation in year *t*. I also examine two alternate dependent variables, *CRO* and *RMC* in separate regressions. The variable of interest is the interaction term, $\beta_1$ ($BDI_{i,t-1} * MODERATOR_{i,t-1}$), which measures the moderating effects of moderating variables on BDI in bank *i* in year *t-1*. The four moderating variables are tier-1 capital ratio ($T1\_CAP_{i,t-1}$), duration ratio ($DURATION\_RATIO_{i,t-1}$), bank size ($LOG\_ASSETS_{i,t-1}$), and Big N auditor ($BIG\_N_{i,t-1}$). I include similar control variables that are in Equation (1).

*3.3. Summary statistics and correlations*

Panel A of Table 2 shows the mean, 25th percentile, median, 75th percentile, and standard deviation for each variable used in this study. The final sample consists of 610 bank-year observations from 2004 to 2013. For ERM variables, the average ERM implementation is 66%, as proxied by the existence of CRO and/or RMC. A designated CRO (or an equivalent designation) is present in 57% of the bank-year observations. A

designated RMC (or an equivalent designation) is present in 37% of the bank-year observations. For board diversity variables, the average board shows more diversity in education institutions than along financial expertise or ethnicity. Panel B of Table 2 shows the correlations among all variables used in this study and highlights significant correlations at the 1% level. In general, the variable correlations are in the expected directions.

[INSERT TABLE 2 HERE]

## 4. Main results

### *4.1. Board diversity and ERM implementation*

The hypothesis (*H1*) investigates the association between board diversity and ERM implementation. Supporters state board diversity could inhibit groupthink, uphold board independence, improve the decision-making process, offer extensive business knowledge and expertise which are crucial for ERM implementation. Despite opponents argue board diversity might weaken board cohesion and impair decision-making process efficiency, this allows for evaluation of different alternatives that lead to better risk management solutions. Considering the positive effects of board diversity would dominate the negative effects, I conjecture that there is a positive relation between board diversity and ERM implementation in banks. I employ Equation (1) to estimate the regression results. In this baseline model, I regress the three ERM proxies, namely ERM implementation ($ERM_{i,t}$), the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on the multidimensional BDI ($BDI_{i,t-1}$) along with an array of control variables. I include constant terms and year fixed effects in all regression analysis, but the constant terms are excluded from the presentation.

Table 3 column (1) shows that the regression coefficient on $BDI_{i,t-1}$ is positive. The coefficient on $BDI_{i,t-1}$ is 0.109, statistically significant at the 1% level (z-value = 3.18). For control variables, the coefficient on bank size ($LOG\_ASSETS_{i,t-1}$) is statistically significant and positive, which indicates banks with larger size of total assets could have a higher likelihood of ERM implementation. The negative coefficients on board size ($LOG\_BOARD\_SIZE_{i,t-1}$) and opacity ($OPACITY_{i,t-1}$) suggest that the likelihood of ERM implementation could be hindered by a larger-sized board because of the free-rider problem (Raheja, 2005) and a high degree of opacity (Pagach & Warr, 2011).

In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the dependent variable. The coefficient on $BDI_{i,t-1}$ is 0.095, which remains at the 1% statistical significance level (z-value = 2.93). Consistent with column (1), I continue to find a positive association of bank size and a negative association of board size with ERM implementation. In addition, the coefficients on international operations ($INT\_OPS_{i,t-1}$) and loan loss provision ($LOAN\_LOSS\_PROVISION_{i,t-1}$) are positive, indicate international banking activities (Hines & Peters, 2015) and default risk (Pagach & Warr, 2011) could increase the likelihood of ERM implementation.

In column (3), I rerun the regression by using the existence of RMC ($RMC_{i,t}$) as the dependent variable. The coefficient on $BDI_{i,t-1}$ is 0.219, statistically significant at the 1% level (z-value = 5.31). Consistent with columns (1) and (2), the bank size is positively while board size is negatively associated with ERM implementation. Further, the coefficient on bank efficiency ($BANK\_EFFICIENCY_{i,t-1}$) is positive, suggests high

risk-taking activities and credit risk (Lu & Boateng, 2018) could increase the likelihood of ERM implementation.

Collectively, the results presented in Table 3 support the hypothesis that banks with diverse boards have a higher likelihood of ERM implementation. Besides, banks with a larger size of total assets, opacity, international banking activities, small-sized boards, high loan loss provision, and high bank efficiency ratio could enhance the likelihood of ERM implementation in banks.[6]

[INSERT TABLE 3 HERE]

*4.2. Individual board diversity components and ERM implementation*

Building upon the above baseline results, I further explore the association between individual board diversity components and ERM implementation in banks. Prior literature demonstrates the board monitoring effect of individual board diversity components on risk-taking behaviour. By replacing BDI in Equation (1) with individual components of BDI, I regress ERM implementation ($ERM_{i,t}$), the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on individual components of BDI, including the percentage of female directors ($TTL\_FEM\_DIR_{i,t-1}$), the standard deviation of directors' age ($STD\_AGE_{i,t-1}$), the standard deviation of directors' tenure ($STD\_TENURE_{i,t-1}$), the average number of outside board seats ($NUM\_BD_{i,t-1}$), directors' financial expertise (1-$HHI\_FINEXP_{i,t-1}$), directors' ethnic (1-$HHI\_ETHNIC_{i,t-1}$), and directors' education institution (1-$HHI\_EDU_{i,t-1}$), along with a series of control variables.

[6] After running the baseline model, I check the variance inflation factor (VIF) and find no individual VIF exceeds the value of 10.

Table 4 Panel A shows that the regression coefficient on $NUM\_BD_{i,t-1}$ is positive against $ERM_{i,t}$ and the regression coefficient on $1\text{-}HHI\_ETHNIC_{i,t-1}$ is significantly positive against $ERM_{i,t}$. Column (1) shows the coefficient on $NUM\_BD_{i,t-1}$ is 0.953, statistically significant at the 5% level (z-value = 2.42). The coefficient on $1\text{-}HHI\_ETHNIC_{i,t-1}$ is 2.140, significant at the 1% significance level (z-value = 3.62). Among control variables, the coefficient on bank size ($LOG\_ASSETS_{i,t-1}$) is positive whereas the coefficient on opacity ($OPACITY_{i,t-1}$) is negative, consistent with recent literature Pagach & Warr (2011).

Table 4 Panel B shows that the regression coefficient on $NUM\_BD_{i,t-1}$ is positive against $CRO_{i,t,}$ and $1\text{-}HHI\_ETHNIC_{i,t-1}$ is significantly positive against $CRO_{i,t}$. Column (1) shows the coefficient on $NUM\_BD_{i,t-1}$ is 0.802, statistically significant at the 5% level (z-value = 2.44) and the coefficient on $1\text{-}HHI\_ETHNIC_{i,t-1}$ is 2.718, statistically significant at the 1% level (z-value = 4.76). In addition, I find international banking activities ($INT\_OPS_{i,t-1}$) is positively associated with ERM implementation, consistent with recent literature Hines & Peters (2015).

Table 4 Panel C shows that the regression coefficients on $NUM\_BD_{i,t-1}$ and $1\text{-}HHI\_ETHNIC_{i,t-1}$ are positive against $RMC_{i,t}$. Besides, the regression coefficient on $1\text{-}HHI\_EDU_{i,t-1}$ is significantly positive against $RMC_{i,t}$. Column (1) shows the coefficient on $NUM\_BD_{i,t-1}$ is 0.844, statistically significant at the 5% level (z-value = 2.20). In addition, the coefficient on $1\text{-}HHI\_ETHNIC_{i,t-1}$ is 1.705, statistically significant at the 5% level (z-value = 2.55). Further, the coefficient on $1\text{-}HHI\_EDU_{i,t-1}$ is 6.085, significant at the 1% significance level (z-value = 3.17). Consistent with Panel A of Table 4, bank size ($LOG\_ASSETS_{i,t-1}$) is positive against $RMC_{i,t}$. I also find a positive

association of bank efficiency ($BANK\_EFFICIENCY_{i,t-1}$) while a negative association of board size ($LOG\_BOARD\_SIZE_{i,t-1}$) against $RMC_{i,t}$.

In summary, the results presented in Table 4 provide evidence of the importance of individual board diversity components on ERM implementation in banks. Among seven individual board diversity components, the average number of outside board seats, directors' ethnicity, and directors' education institutions are positively associated with ERM implementation. These results suggest that the diversity in board experience, ethnic, and educational institution background could increase the likelihood of ERM implementation in banks.

[INSERT TABLE 4 HERE]

*4.3. Robustness test*

In this section, I carry out a robustness test to investigate whether the main results reported in Table 3 are sensitive to alternate board diversity index when its construction relies on different weightings of board diversity components. Results are presented in Table 5.

In the main results, I construct the board diversity index by weighting board diversity components equally. The equally-weighted board diversity index is used to examine the association between board diversity and ERM implementation in the banking industry. In the robustness test, I propose using principal factor analysis as an alternative to construct the board diversity index, taking different weightings of board diversity components into account. The principal factor analysis weights the board diversity components, including the female directors' percentage (TTL_FEM_DIR), the directors' age standard deviation (STD_AGE), the directors' tenure standard

deviation (STD_TENURE), the mean number of outside boards on which current directors serve (NUM_BD), the inverse of Herfindahl concentration indexes for directors' ethnicity (1-HHI_ETHNIC), directors' financial expertise (1-HHI_FINEXP), and institution directors obtained their bachelor's or first higher education degree (1-HHI_EDU). The orthogonal varimax rotation method is used since the seven individual board diversity components are uncorrelated with each other. Based on the Kaiser criterion, three factors are retained based on the general rule that factors with eigenvalues greater than 1 should be retained. The eigenvalue for factor 1 is 1.93, factor 2 is 1.12, and factor 3 is 1.09. The three factors account for 59% of the variation of measured components.

I generate the three-factor scores to replace the existing BDI. These factor scores are then regressed against ERM implementation. I regress ERM implementation ($ERM_{i,t}$), the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on first, second, and third factor scores, along with a series of control variables. Table 4 shows that $FIRST\_FACTOR_{i,t-1}$ is positively associated with $ERM_{i,t}$, $CRO_{i,t}$, and $RMC_{i,t}$. When regressed against $ERM_{i,t}$, the coefficient on $FIRST\_FACTOR_{i,t-1}$ is 0.260, statistically significant at the 5% level (z-value = 2.06). The coefficient on $FIRST\_FACTOR_{i,t-1}$ is 0.785, statistically significant at the 1% level (z-value = 5.03) when regressed against $RMC_{i,t}$. For the second factor, I continue to find that $SECOND\_FACTOR_{i,t-1}$ is positively associated with $ERM_{i,t}$ and $RMC_{i,t}$, but negatively associated with $CRO_{i,t}$. The coefficient on $SECOND\_FACTOR_{i,t-1}$ is 0.216, statistically significant at the 5% level (z-value = 1.98) when regressed against $RMC_{i,t}$. Also, I continue to find a significantly positive relation when $THIRD\_FACTOR_{i,t-1}$ is

regressed on $ERM_{i,t}$, $CRO_{i,t}$, and $RMC_{i,t}$. When regressed against $ERM_{i,t}$, the coefficient on $THIRD\_FACTOR_{i,t-1}$ is 0.399, statistically significant at the 1% level (z-value = 3.87). When regressed against $CRO_{i,t}$, the coefficient on $THIRD\_FACTOR_{i,t-1}$ is 0.470, statistically significant at the 1% level (z-value = 4.77). When regressed against $RMC_{i,t}$, the coefficient on $THIRD\_FACTOR_{i,t-1}$ is 0.366, statistically significant at the 1% level (z-value = 3.29).

[INSERT TABLE 5 HERE]

## 5. Cross-sectional tests

The baseline results in section 4 demonstrate the primary effect of multidimensional BDI and individual board diversity components on ERM implementation in banks. In this section, I employ two internal and two external moderating factors to further explore and provide corroborative evidence in support of the BDI effect. For each cross-sectional test, I include the interaction term between moderating variable and BDI into the regression model. Equation (2) is used to estimate the regression results.

### *5.1. The tier-1 capital ratio effect*

The tier-1 capital ratio is a capital adequacy requirement for banks to comply with to assure their financial strength and solvency of banks. So, banks with a lower tier-1 capital ratio are more exposed to capital adequacy risk. Prior studies show banks with capital adequacy risk report lower probability to default estimates (Berg & Koziol, 2017) and manipulate financial assets valuations (Yao et al., 2018). In *H2*, I postulate the relation between BDI and the ERM implementation is stronger (weaker) when banks have a lower (higher) tier-1 capital ratio. I regress ERM implementation ($ERM_{i,t}$),

the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on the interaction term $BDI_{i,t-1}$*$T1\_CAP_{i,t-1}$, along with a series of bank-level control variables.

Table 6 column (1) shows the coefficient on the interaction term, $BDI_{i,t-1}$*$T1\_CAP_{i,t-1}$, is significantly negative. The coefficient on $BDI_{i,t-1}$*$T1\_CAP_{i,t-1}$ is -3.322, significant at the 1% significance level (z-value = -3.12). The result aligns with the hypothesis that the relation between BDI and the ERM implementation is weaker when banks have a higher tier-1 capital ratio. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the dependent variable. I find the coefficient on $BDI_{i,t-1}$*$T1\_CAP_{i,t-1}$ is -2.071, statistically significant at the 5% level (z-value = 2.12). In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the dependent variable. Consistent with the results in columns (1) and (2), the coefficient on $BDI_{i,t-1}$*$T1\_CAP_{i,t-1}$ remains negative but loses statistical significance in this specification. In all, the results provide evidence that the relation between BDI and the ERM implementation is weaker when banks have a higher tier-1 capital ratio.

[INSERT TABLE 6 HERE]

*5.2. The interest rate exposure effect*

The bank's interest rate exposure is measured by the duration ratio. The exposure stems from the bank's investment in long-term assets out of short-term liabilities (Vuillemey, 2019). Interest rate risk arises from the sensitivity of earnings and equity value due to changes in interest rates (Cheng et al., 2021). In *H3*, I conjecture that the relation between BDI and the ERM implementation is stronger when banks have a higher duration ratio. I regress ERM implementation ($ERM_{i,t}$), the existence of CRO

($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on the interaction term $BDI_{i,t-1}$*$DURATION\_RATIO_{i,t-1}$, along with a series of bank-level control variables.

Table 7 column (1) shows the coefficient on the interaction term, $BDI_{i,t-1}$*$DURATION\_RATIO_{i,t-1}$, is positive. The coefficient on $BDI_{i,t-1}$*$DURATION\_RATIO_{i,t-1}$ is 0.082, statistically significant at the 10% level (z-value = 1.68). The result aligns with the hypothesis that the relation between BDI and the ERM implementation is stronger when banks have a higher duration ratio. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the dependent variable. Consistent with column (1), I find the coefficient on $BDI_{i,t-1}$*$DURATION\_RATIO_{i,t-1}$ remains positive but loses statistical significance in this specification. In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the dependent variable, however, the coefficient on $BDI_{i,t-1}$*$DURATION\_RATIO_{i,t-1}$ is negative but statistically insignificant. Collectively, the results provide evidence that the relation between BDI and the ERM implementation is stronger when banks have a higher duration ratio.

[INSERT TABLE 7 HERE]

*5.3. The bank size effect*

Authorities and bank regulators are keen to monitor and assure the risk management system implementation and effectiveness of large-sized financial institutions, including banks. This is demonstrated by the passage of the Dodd-Frank Act ("Summary of the Dodd-Frank Wall Street Reform and Consumer Protection Act," 2010) and Basel principles (Basel Committee on Banking Supervision, 2015), with a focus on large-sized and international financial institutions, including banks. In *H4*, I hypothesize that the relation between BDI and the ERM implementation is stronger for

banks with a larger size of total assets. I regress ERM implementation ($ERM_{i,t}$), the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on the interaction term $BDI_{i,t-1}$*$LOG\_ASSETS_{i,t-1}$, along with a series of bank-level control variables.

Table 8 column (1) shows the coefficient on the interaction term, $BDI_{i,t-1}$*$LOG\_ASSETS_{i,t-1}$, is significantly positive. The coefficient on $BDI_{i,t-1}$*$LOG\_ASSETS_{i,t-1}$ is 0.102, statistically significant at the 1% level (z-value = 2.94). The result aligns with the hypothesis and shows that the relation between BDI and the ERM implementation is stronger for banks with a larger size of total assets. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the dependent variable. Consistent with column (1), I find the coefficient on $BDI_{i,t-1}$*$LOG\_ASSETS_{i,t-1}$ remains positive but loses statistical significance in this specification. In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the dependent variable, however, the coefficient on $BDI_{i,t-1}$*$LOG\_ASSETS_{i,t-1}$ is negative but statistically insignificant. In summary, the results demonstrate that banks with a larger size of total assets are in greater need of a risk management system since they are subject to more intensive external monitoring.

[INSERT TABLE 8 HERE]

*5.4. The Big N auditor effect*

Big N auditors are regarded as intense external monitors, alongside bank regulators and legal authorities. Big N auditors focus on audit clients' corporate governance mechanisms (Cassell et al., 2012). Notably, Big N auditors are attentive to asset securitization risks to reduce the likelihood of subsequent financial statement restatements and reported gains on asset securitization. In *H5*, I conjecture that the

relation between BDI and the ERM implementation is stronger when banks are audited by Big N auditors. I regress ERM implementation ($ERM_{i,t}$), the existence of CRO ($CRO_{i,t}$), and the existence of RMC ($RMC_{i,t}$) on the interaction term $BDI_{i,t-1}*BIG\_N_{i,t-1}$, along with a series of bank-level control variables.

Table 9 column (1) shows the coefficient on the interaction term, $BDI_{i,t-1}*BIG\_N_{i,t-1}$, is positive. The coefficient on $BDI_{i,t-1}*BIG\_N_{i,t-1}$ is 0.161, statistically significant at the 10% level (z-value = 1.78). The result aligns with the hypothesis and demonstrates that the relation between BDI and the ERM implementation is stronger when banks are audited by Big N auditors. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the dependent variable. Consistent with column (1), I find the coefficient on $BDI_{i,t-1}*BIG\_N_{i,t-1}$ remains positive but loses statistical significance in this specification. In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the dependent variable. Consistent with column (2), the coefficient on $BDI_{i,t-1}*BIG\_N_{i,t-1}$ is positive but statistically insignificant. In summary, the results provide evidence that the relation between BDI and the ERM implementation is stronger when banks are audited by Big N auditors.

[INSERT TABLE 9 HERE]

## 6. Additional tests

I perform two additional tests to explore the relation between ERM implementation and future bank risks and risk management activities, respectively.

### *6.1. Consequence of ERM implementation on future bank risks*

First, I explore the impact of ERM implementation on future bank risks. I focus on non-performing loans that measure a bank's credit risk (Hines et al., 2015). Prior

literature shows ERM implementation could lower bank risks. For instance, Lundqvist & Vilhelmsson (2018) find ERM implementation could lower banks' default risk. Jiang (2020) also finds the RMC establishment could reduce bank risks effectively. To examine the association between ERM implementation and future bank risks, I estimate the following OLS regression:

$$NON\text{-}PERFORMING\_LOANS_{i,t+1} = \beta_0 + \beta_1 ERM_{i,t} + \beta_2 LOG\_ASSETS_{i,t} + \beta_3 OPACITY_{i,t} + \beta_4 BUSINESS\_GROWTH_{i,t} + \beta_5 INT\_OPS_{i,t} + \beta_6 INSTIT\_OWN_{i,t} + \beta_7 BIG\_N_{i,t} + \beta_8 CEO\_DUALITY_{i,t} + \beta_9 LOG\_BOARD\_SIZE_{i,t} + \beta_{10} TTL\_OUTSIDE\_DIR_{i,t} + \beta_{11} T1\_CAP_{i,t} + \beta_{12} LOAN\_LOSS\_PROVISION_{i,t} + \beta_{13} DURATION\_RATIO_{i,t} + \beta_{14} BANK\_EFFICIENCY_{i,t} + \text{year fixed effects} + \varepsilon_{i,t} \quad (3)$$

The dependent variable $NON\text{-}PERFORMING\_LOANS_{i,t+1}$ in Equation (3) is bank *i*'s total non-performing assets divided by gross loans in year *t+1*. The independent variable of interest is $ERM_{i,t}$, captures ERM implementation as proxied by the existence of CRO and/or RMC in banks. The independent variable measures bank *i*'s ERM implementation in year *t*. I also explore the impact of CRO and RMC on banks' non-performing loans, employing $CRO_{i,t,}$ and $RMC_{i,t}$ as alternate independent variables in separate regressions. I conjecture a negative sign on the coefficient for $\beta_1$ in support of ERM implementation could lower non-performing loans. I include similar control variables that are in Equations 1-2.

Table 10 column (1) shows the coefficient on $ERM_{i,t}$ is negatively associated with $NON\text{-}PERFORMING\_LOANS_{i,t+1}$, statistically significant at the 5% level. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the independent variable. Consistent with column (1), I find the coefficient on $CRO_{i,t}$ remains negative

with the same magnitude. In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the independent variable. Consistent with columns (1) and (2), the coefficient on $RMC_{i,t}$ remains negative with a stronger magnitude, statistically significant at the 1% level. In all, these results support ERM implementation could mitigate future bank risks, in terms of non-performing loans. In other words, ERM implementation could mitigate banks' future credit risk.

[INSERT TABLE 10 HERE]

*6.2. Consequence of ERM implementation on future bank risk management activity*

Next, I investigate the impact of ERM implementation on future bank risk management activity. I focus on derivative hedging that could mitigate derivative contract risks (Ellul & Yerramilli, 2013). Banks carry out derivative hedging as a risk management measure to alleviate the variability of cash flows and reduce probable bankruptcy costs (Smith & Stulz, 1985). Therefore, I envisage there is a positive association between ERM implementation and future bank risk management activity. The value of derivatives is based on the available data from Bank Regulatory Call Reports.[7] To investigate the association between ERM implementation and future bank risk management activity, I estimate the following OLS regression:

$$DERIV\_HEDGING/ASSETS_{i,t+1} = \beta_0 + \beta_1 ERM_{i,t} + \beta_2 LOG\_ASSETS_{i,t} + \beta_3 OPACITY_{i,t} + \beta_4 BUSINESS\_GROWTH_{i,t} + \beta_5 INT\_OPS_{i,t} + \beta_6 INSTIT\_OWN_{i,t} + \beta_7 BIG\_N_{i,t} + \beta_8 CEO\_DUALITY_{i,t} + \beta_9 LOG\_BOARD\_SIZE_{i,t}$$

[7] The value of derivatives is the total of the following held for purposes other than trading: foreign exchange derivative contracts, equity derivative contracts, interest rate derivative contracts, and commodity and other derivative contracts.

$+ \beta_{10} TTL\_OUTSIDE\_DIR_{i,t} + \beta_{11} T1\_CAP_{i,t} + \beta_{12} LOAN\_LOSS\_PROVISION_{i,t} +$

$\beta_{13} DURATION\_RATIO_{i,t} + \beta_{14} BANK\_EFFICIENCY_{i,t}$ + year fixed effects + $\varepsilon_{i,t}$ (4)

The dependent variable $DERIV\_HEDGING/ASSETS_{i,t+1}$ in Equation (4) is bank *i*'s value of derivatives divided by total assets in year *t+1*. The independent variable of interest is $ERM_{i,t}$, captures ERM implementation as proxied by the existence of CRO and/or RMC in banks. The independent variable measures bank *i*'s ERM implementation in year *t*. In addition to $ERM_{i,t}$, I also examine the effect of CRO and RMC on banks' derivative hedging. Hence, I employ $CRO_{i,t}$ and $RMC_{i,t}$ as the alternate independent variables in separate regressions. I conjecture a positive sign on the coefficient for $\beta_1$ in support of ERM implementation that could drive the bank's derivative hedging. I include similar control variables that are in Equations 1-3.

Table 11 column (1) shows the coefficient on $ERM_{i,t}$ is positively associated with $DERIV\_HEDGING/ASSETS_{i,t+1}$, but statistically insignificant. In column (2), I rerun the regression using the existence of CRO ($CRO_{i,t}$) as the independent variable. Consistent with column (1), the coefficient on $CRO_{i,t}$ is positive but remains statistically insignificant. In column (3), I rerun the regression using the existence of RMC ($RMC_{i,t}$) as the independent variable. Consistent with columns (1) and (2), the coefficient on $RMC_{i,t}$ remains positive but with a stronger magnitude, statistically significant at the 1% level. Collectively, these results support the prediction that ERM implementation could drive a bank's future risk management activity, in terms of derivative hedging.

[INSERT TABLE 11 HERE]

## 7. Conclusion

This study examines the association between board diversity and ERM implementation in banks. Using a multidimensional board diversity index for a sample of banks during 2004-2013, I find that banks with diverse boards are more likely to implement ERM. Besides, among individual board diversity components, I find the diversity in board experience, ethnic, and education institution background could enhance the likelihood of ERM implementation in banks. In cross-sectional tests, I find that the effects of board diversity on banks' ERM implementation are stronger for banks with higher risk exposures (i.e., lower regulatory capital and higher duration ratio), for larger banks that are subject to tighter regulation, and for banks that are audited by Big N auditors. In additional tests, I find ERM implementation could mitigate banks' future credit risk, in terms of non-performing loans. I also find ERM implementation could drive a bank to engage in future risk management activities, in terms of derivative hedging.

My work establishes the link between board diversity and ERM implementation in banks, which extends corporate governance literature. My study also contributes to the ERM literature in the banking industry by demonstrating that internal and external factors could enhance the effect of board diversity on ERM implementation. In terms of practical implications, this study provides insights for bank policymakers to structure the board for ERM implementation. This study has some limitations. First, the results might not be generalized to other industries since this study focuses on the banking industry. Another limitation is the construction of key variables, CRO and RMC, which are entirely dependent on the information found in the 10-K filings

disclosed by banks. Considering the significance of research on ERM and board diversity, future research could further explore the relationship between board diversity and other dimensions of ERM, such as ERM quality.

## Appendix A: Description of Variables

| Variables | Descriptions | Source |
|---|---|---|
| **Enterprise risk management variables:** | | |
| $ERM_{i,t}$ | A dummy variable which equals 1 if the bank has ERM under implementation, proxied by the existence of CRO (or equivalent) and/or RMC (or equivalent), 0 otherwise. | 10-K filings |
| $CRO_{i,t}$ | A dummy variable which equals 1 if the bank has a board level CRO (or equivalent) reporting directly to the CEO, and 0 otherwise. | 10-K filings |
| $RMC_{i,t}$ | A dummy variable which equals 1 if the bank has an RMC (or equivalent), a subcommittee of the board, offering advice and guidance on risk management activities, 0 otherwise. | 10-K filings |
| **Board diversity variables:** | | |
| $BDI_{i,t-1}$ | For each bank year, the board diversity index is computed by normalizing the sum of the following 7 components: percentage of female directors, the standard deviation of director's age, the standard deviation of director's tenure, director's mean number of outside board seats, inverse HHI of the number of directors that have financial expertise, inverse HHI of the number of directors that are categorized by ethnicity, and inverse HHI of the number of directors that are categorized by their bachelor's (or first higher education degree) granting institutions. | ISS Directors database |
| TTL FEM $DIR_{i,t-1}$ | The number of female directors divided by board size. | ISS Directors database |

| | | |
|---|---|---|
| STD AGE$_{i,t-1}$ | The standard deviation of the board members' ages. | ISS Directors database |
| STD TENURE$_{i,t-1}$ | The standard deviation of the board members' tenure. | ISS Directors database |
| NUM BD$_{i,t-1}$ | Mean number of other boards served by current directors. | ISS Directors database |
| HHI FINEXP$_{i,t-1}$ | HHI of the number of directors in each bank year that are categorized as having financial expertise. | ISS Directors database |
| HHI ETHNIC$_{i,t-1}$ | HHI of the number of directors in each bank year that are categorized in terms of ethnic, including Asian, African-American, Caucasian, and Hispanic. | ISS Directors database |
| HHI EDU$_{i,t-1}$ | HHI of the number of directors in each bank-year that are categorized by their bachelor's (or first higher education degree) granting institutions. | BoardEx |
| **Bank-level variables:** | | |
| LOG ASSETS$_{i,t-1}$ | The natural logarithm of the book value of total assets of each bank. | Compustat Bank |
| OPACITY$_{i,t-1}$ | Intangible assets divided by the book value of assets. | Compustat Bank |
| BUSINESS GROWTH$_{i,t-1}$ | Annual growth of business turnover over the last year. | Compustat Bank |
| INT OPS$_{i,t-1}$ | A dummy variable which equals 1 if the bank has business operations in other countries besides the U.S. and 0 otherwise. | Compustat Bank |
| INSTIT OWN$_{i,t-1}$ | The percentage of the number of shares owned by outside institutional shareholders. | Thomson Reuters Institutional Holdings |

| | | |
|---|---|---|
| BIG $N_{i,t-1}$ | A dummy variable which equals 1 for bank audited by Big N auditor and 0 otherwise. | 10-K filings |
| CEO $DUALITY_{i,t-1}$ | A dummy variable which equals 1 if the CEO is also the board chairperson, 0 otherwise. | BoardEx |
| LOG BOARD $SIZE_{i,t-1}$ | The natural logarithm of the board size. | ISS Directors database |
| TTL OUTSIDE $DIR_{i,t-1}$ | The number of outside directors on the board divided by the board size. | ISS Directors database |
| T1 $CAP_{i,t-1}$ | Tier 1 capital ratio in percentage. | Compustat Bank |
| LOAN LOSS $PROVISION_{i,t-1}$ | Provision of loan losses divided by gross loans. | Compustat Bank |
| DURATION $RATIO_{i,t-1}$ | Annual percentage change in total assets over the annual percentage change in total liabilities. | Compustat Bank |
| BANK $EFFICIENCY_{i,t-1}$ | Total current operating expenses divided by net income. | Compustat Bank |
| NON-PERFORMING $LOANS_{,i,t+1}$ | Total non-performing assets divided by gross loans. | Compustat Bank |
| $DERIV\_HEDGING/ASSETS_{i,t+1}$ | Derivatives used for hedging purposes are divided by total assets. Derivatives include foreign exchange derivative contracts, equity derivative contracts, interest rate derivative contracts. and commodity derivative contracts. | Call reports |

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**Table 1 Descriptive statistics**

Panel A: sample selection procedure

| | |
|---|---|
| Bank-year observations with financial data for 2004-2013 on Compustat Bank database | 7,381 |
| Less: | |
| Banks not available on ISS Directors database | (6,527) |
| Banks with consolidated total asset balances over US10B for 2011-2013 | (149) |
| Missing data to construct necessary variables | (95) |
| Final sample size | 610 |

Panel B: sample distribution by year

| Year | ERM=0 | ERM=1 | Total Obs. | % of ERM=1 |
|---|---|---|---|---|
| 2004 | 22 | 34 | 56 | 61% |
| 2005 | 22 | 38 | 60 | 63% |
| 2006 | 22 | 44 | 66 | 67% |
| 2007 | 24 | 52 | 76 | 68% |
| 2008 | 29 | 54 | 83 | 65% |
| 2009 | 28 | 54 | 82 | 66% |
| 2010 | 26 | 57 | 83 | 69% |
| 2011 | 13 | 22 | 35 | 63% |
| 2012 | 11 | 22 | 33 | 67% |
| 2013 | 13 | 23 | 36 | 64% |
| Total | 210 | 400 | 610 | 66% |

This table presents the distribution of ERM implementation for the sample period from 2004 to 2013.

**Table 2** Summary statistics

Panel A: descriptive statistics for regression variables

| | Obs. | Mean | S.D. | 25% | Median | 75% |
|---|---|---|---|---|---|---|
| $ERM_{i,t}$ | 610 | 0.66 | 0.48 | 0 | 1 | 1 |
| $CRO_{i,t}$ | 610 | 0.57 | 0.50 | 0 | 1 | 1 |
| $RMC_{i,t}$ | 610 | 0.37 | 0.48 | 0 | 0 | 1 |
| $BDI_{i,t-1}$ | 610 | 0 | 3.07 | -1.88 | 0.34 | 1.90 |
| TTL FEM $DIR_{i,t-1}$ | 610 | 0.12 | 0.08 | 0.07 | 0.11 | 0.17 |
| STD $AGE_{i,t-1}$ | 610 | 7.09 | 2.15 | 5.51 | 6.76 | 8.37 |
| STD $TENURE_{i,t-1}$ | 610 | 7.12 | 2.70 | 5.19 | 7.04 | 8.91 |
| NUM $BD_{i,t-1}$ | 610 | 0.40 | 0.49 | 0 | 0.18 | 0.67 |
| 1-HHI $FINEXP_{i,t-1}$ | 610 | 0.29 | 0.13 | 0.18 | 0.30 | 0.40 |
| 1-HHI $ETHNIC_{i,t-1}$ | 610 | 0.22 | 0.18 | 0 | 0.20 | 0.38 |
| 1-HHI $EDU_{i,t-1}$ | 610 | 0.85 | 0.09 | 0.82 | 0.88 | 0.91 |
| LOG $ASSETS_{i,t-1}$ | 610 | 9.64 | 1.45 | 8.62 | 9.22 | 10.34 |
| $OPACITY_{i,t-1}$ | 610 | 0.03 | 0.02 | 0.02 | 0.03 | 0.04 |
| BUSINESS $GROWTH_{i,t-1}$ | 610 | 0.07 | 0.19 | -0.07 | 0.02 | 0.17 |
| INT $OPS_{i,t-1}$ | 610 | 0.05 | 0.23 | 0 | 0 | 0 |
| INSTIT $OWN_{i,t-1}$ | 610 | 0.62 | 0.16 | 0.50 | 0.62 | 0.73 |
| BIG $N_{i,t-1}$ | 610 | 0.88 | 0.32 | 1 | 1 | 1 |
| CEO $DUALITY_{i,t-1}$ | 610 | 0.65 | 0.48 | 0 | 1 | 1 |
| LOG BOARD $SIZE_{i,t-1}$ | 610 | 2.51 | 0.22 | 2.30 | 2.48 | 2.64 |
| TTL OUTSIDE $DIR_{i,t-1}$ | 610 | 0.75 | 0.12 | 0.67 | 0.78 | 0.83 |
| T1 $CAP_{i,t-1}$ | 610 | 0.11 | 0.03 | 0.09 | 0.11 | 0.13 |
| LOAN LOSS $PROVISION_{i,t-1}$ | 610 | 0.01 | 0.01 | 0 | 0 | 0.01 |
| $DURATION\ RATIO_{i,t-1}$ | 610 | 0.99 | 0.76 | 0.86 | 0.98 | 1.08 |
| BANK $EFFICIENCY_{i,t-1}$ | 610 | 1.83 | 0.93 | 1.25 | 1.61 | 2.09 |

Panel B: correlation matrix

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ERM | 1.00 | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | CRO | **0.84** | 1.00 | | | | | | | | | | | | | | | | | | | | | | |
| 3 | RMC | **0.55** | **0.31** | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| 4 | BDI | **0.25** | **0.19** | **0.41** | 1.00 | | | | | | | | | | | | | | | | | | | | |
| 5 | TTLFEM DIR | **0.15** | 0.10 | **0.20** | **0.49** | 1.00 | | | | | | | | | | | | | | | | | | | |
| 6 | STD AGE | -0.05 | -0.02 | **-0.17** | **0.15** | -0.09 | 1.00 | | | | | | | | | | | | | | | | | | |
| 7 | STD TENURE | -0.06 | -0.06 | 0.00 | **0.35** | -0.08 | **0.09** | 1.00 | | | | | | | | | | | | | | | | | |
| 8 | NUM BD | **0.32** | **0.24** | **0.54** | **0.51** | **0.17** | **-0.33** | -0.06 | 1.00 | | | | | | | | | | | | | | | | |
| 9 | 1-HHI FINEXP | **0.16** | 0.10 | **0.30** | **0.55** | **0.22** | **-0.12** | 0.09 | **0.30** | 1.00 | | | | | | | | | | | | | | | |
| 10 | 1-HHI ETHNIC | **0.07** | 0.11 | 0.04 | **0.42** | 0.04 | 0.07 | -0.06 | **0.12** | -0.03 | 1.00 | | | | | | | | | | | | | | |
| 11 | 1-HHI EDU | **0.18** | 0.10 | **0.35** | **0.62** | **0.25** | **-0.16** | 0.08 | **0.39** | **0.22** | **0.15** | 1.00 | | | | | | | | | | | | | |
| 12 | LOG ASSETS | **0.32** | **0.21** | **0.59** | **0.40** | **0.24** | **-0.28** | -0.09 | **0.76** | **0.24** | 0.03 | **0.34** | 1.00 | | | | | | | | | | | | |
| 13 | OPACITY | -0.04 | 0.00 | 0.09 | 0.07 | 0.07 | **-0.14** | -0.04 | 0.09 | 0.09 | 0.05 | 0.10 | **0.23** | 1.00 | | | | | | | | | | | |
| 14 | BUSINESS GROWTH | 0.06 | 0.04 | 0.04 | 0.07 | 0.00 | -0.02 | -0.08 | **0.13** | -0.06 | **0.20** | 0.06 | **0.15** | **0.23** | 1.00 | | | | | | | | | | |
| 15 | INT OPS | **0.17** | **0.16** | **0.27** | **0.12** | **0.12** | **-0.20** | **-0.11** | **0.40** | 0.07 | -0.07 | **0.18** | **0.53** | **0.25** | 0.09 | 1.00 | | | | | | | | | |
| 16 | INSTIT OWN | **0.19** | **0.14** | **0.20** | **0.23** | **0.26** | -0.07 | -0.05 | **0.18** | **0.21** | 0.07 | **0.14** | **0.15** | -0.05 | 0.03 | 0.09 | 1.00 | | | | | | | | |
| 17 | BIG N | 0.09 | 0.12 | **0.13** | **0.17** | **0.15** | **-0.14** | **-0.15** | **0.25** | **0.15** | **0.12** | **0.15** | **0.26** | 0.04 | **0.08** | 0.09 | **0.13** | 1.00 | | | | | | | |
| 18 | CEO DUALITY | 0.04 | 0.01 | **0.16** | **0.15** | 0.01 | **-0.17** | 0.01 | **0.29** | **0.13** | **0.12** | 0.08 | **0.37** | 0.01 | 0.03 | **0.12** | 0.02 | **0.21** | 1.00 | | | | | | |
| 19 | LOG BOARD SIZE | 0.01 | -0.01 | **0.15** | **0.20** | 0.01 | **-0.13** | 0.01 | **0.28** | -0.04 | 0.06 | **0.44** | **0.36** | **0.23** | **0.11** | **0.16** | -0.13 | **0.24** | **0.19** | 1.00 | | | | | |
| 20 | TTL OUTSIDE DIR | 0.08 | 0.06 | **0.18** | 0.10 | **0.21** | **-0.20** | **-0.12** | **0.15** | **0.17** | -0.06 | **0.16** | 0.06 | -0.01 | **-0.15** | **0.17** | **0.18** | 0.01 | 0.03 | **-0.12** | 1.00 | | | | |
| 21 | T1 CAP | -0.03 | 0.01 | **-0.14** | -0.02 | 0.00 | 0.08 | **0.17** | **-0.22** | 0.04 | **-0.14** | 0.00 | **-0.32** | **-0.16** | **-0.32** | **-0.12** | **0.16** | **-0.18** | **-0.25** | **-0.20** | **0.15** | 1.00 | | | |
| 22 | LOAN LOSS PROVISION | **0.12** | **0.13** | **0.15** | 0.09 | 0.12 | -0.07 | -0.05 | **0.13** | 0.05 | -0.01 | **0.12** | **0.18** | **-0.13** | **-0.41** | 0.08 | 0.10 | -0.05 | 0.01 | -0.01 | 0.08 | **0.14** | 1.00 | | |
| 23 | DURATION RATIO | 0.02 | -0.01 | 0.02 | 0.06 | 0.00 | 0.03 | 0.01 | 0.03 | 0.03 | 0.04 | 0.06 | 0.05 | 0.04 | 0.01 | -0.01 | 0.05 | -0.05 | -0.05 | -0.04 | 0.02 | -0.01 | -0.01 | 1.00 | |
| 24 | BANK EFFICIENCY | **0.11** | 0.05 | **0.32** | **0.15** | 0.04 | -0.08 | **-0.13** | **0.35** | 0.07 | 0.05 | **0.16** | **0.39** | 0.02 | -0.03 | **0.18** | 0.10 | 0.05 | **0.19** | **0.14** | 0.04 | **-0.21** | **0.38** | -0.03 | 1.00 |

In the table, Panel A presents the mean, standard deviation (S.D.), 25$^{th}$ percentile (25%), median, and the 75$^{th}$ percentile (75%) of the variables for the sample period from 2004 to 2013. Panel B presents the correlation matrix among all key variables used in this study. Bold text indicates statistically significant at 1% level. Variables are winsorized at 1% and 99%. Description of variables is summarized in Appendix A.

**Table 3** The association between board diversity index and ERM implementation

| Dep. Var. = | (1) $ERM_{i.t}$ | (2) $CRO_{i.t}$ | (3) $RMC_{i.t}$ |
|---|---|---|---|
| **$BDI_{i.t-1}$** | **0.109*** ** | **0.095*** ** | **0.219*** ** |
| | **(3.18)** | **(2.93)** | **(5.31)** |
| LOG ASSETS$_{i.t-1}$ | 0.515*** | 0.220** | 0.903*** |
| | (4.52) | (2.27) | (7.13) |
| OPACITY$_{i.t-1}$ | -11.510** | -4.487 | -1.690 |
| | (-2.54) | (-1.05) | (-0.33) |
| BUSINESS GROWTH$_{i.t-1}$ | 0.774 | 0.524 | -0.538 |
| | (1.13) | (0.84) | (-0.73) |
| INT OPS$_{i.t-1}$ | 1.007 | 1.255** | -0.764 |
| | (1.23) | (2.05) | (-1.29) |
| INSTIT OWN$_{i.t-1}$ | 0.590 | 0.240 | 0.395 |
| | (0.96) | (0.42) | (0.57) |
| BIG N$_{i.t-1}$ | -0.065 | 0.369 | -0.371 |
| | (-0.22) | (1.31) | (-1.08) |
| CEO DUALITY$_{i.t-1}$ | 0.071 | 0.114 | 0.031 |
| | (0.34) | (0.57) | (0.13) |
| LOG BOARD SIZE$_{i.t-1}$ | -0.995** | -0.888** | -1.130** |
| | (-2.07) | (-1.98) | (-2.13) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -0.649 | -1.190 | 1.146 |
| | (-0.79) | (-1.54) | (1.20) |
| T1 CAP$_{i.t-1}$ | -1.721 | 0.578 | -5.823 |
| | (-0.45) | (0.16) | (-1.32) |
| LOAN LOSS PROVISION$_{i.t-1}$ | 13.388 | 19.650** | -19.066* |
| | (1.27) | (2.08) | (-1.75) |
| DURATION RATIO$_{i.t-1}$ | -0.016 | -0.069 | -0.037 |
| | (-0.13) | (-0.59) | (-0.26) |
| BANK EFFICIENCY$_{i.t-1}$ | -0.000 | -0.022 | 0.344** |
| | (-0.00) | (-0.19) | (2.34) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.118 | 0.073 | 0.279 |

This table presents the main results. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i.t-1}$), defined as the sum of STDZ(TTL FEM DIR) + STDZ(STD AGE) + STDZ(STD TENURE) + STDZ(NUM BD) + STDZ(1-HHI FINEXP) + STDZ(1-HHI ETHNIC)

+ STDZ(1-HHI EDU) in bank *i* in year *t-1*. Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 4** Components of board diversity index

Panel A: the relation between individual board diversity components and ERM implementation, proxied by the existence of CRO and/or RMC

| Dep. Var. = $ERM_{i.t}$ | (1) All components | (2) 1st component | (3) 2nd component | (4) 3rd component | (5) 4th component | (6) 5th component | (7) 6th component | (8) 7th component |
|---|---|---|---|---|---|---|---|---|
| **TTL FEM DIR$_{i.t-1}$** | **1.221** | **1.153** | | | | | | |
| | **(0.91)** | **(0.89)** | | | | | | |
| **STD AGE$_{i.t-1}$** | **0.042** | | **0.034** | | | | | |
| | **(0.90)** | | **(0.75)** | | | | | |
| **STD TENURE$_{i.t-1}$** | **0.024** | | | **0.022** | | | | |
| | **(0.65)** | | | **(0.62)** | | | | |
| **NUM BD$_{i.t-1}$** | **0.953**** | | | | **0.996***** | | | |
| | **(2.42)** | | | | **(2.78)** | | | |
| **1-HHI FINEXP$_{i.t-1}$** | **-0.453** | | | | | **-0.033** | | |
| | **(-0.56)** | | | | | **(-0.04)** | | |
| **1-HHI ETHNIC$_{i.t-1}$** | **2.140***** | | | | | | **2.392***** | |
| | **(3.62)** | | | | | | **(4.16)** | |
| **1-HHI EDU$_{i.t-1}$** | **0.124** | | | | | | | **1.504** |
| | **(0.10)** | | | | | | | **(1.30)** |
| LOG ASSETS$_{i.t-1}$ | 0.458*** | 0.580*** | 0.601*** | 0.586*** | 0.383*** | 0.592*** | 0.656*** | 0.577*** |
| | (3.32) | (5.21) | (5.42) | (5.31) | (2.93) | (5.27) | (5.78) | (5.20) |
| OPACITY$_{i.t-1}$ | -10.198** | -11.393** | -10.939** | -11.212** | -9.251** | -11.133** | -12.329*** | -10.967** |
| | (-2.16) | (-2.52) | (-2.42) | (-2.48) | (-2.03) | (-2.45) | (-2.68) | (-2.43) |
| BUSINESS | 0.386 | 0.858 | 0.838 | 0.874 | 0.732 | 0.841 | 0.434 | 0.797 |
| GROWTH$_{i.t-1}$ | (0.55) | (1.26) | (1.24) | (1.29) | (1.08) | (1.24) | (0.63) | (1.18) |
| INT OPS$_{i.t-1}$ | 0.862 | 0.847 | 0.882 | 0.861 | 0.712 | 0.841 | 0.992 | 0.830 |
| | (1.04) | (1.04) | (1.08) | (1.06) | (0.86) | (1.03) | (1.22) | (1.03) |
| INSTIT OWN$_{i.t-1}$ | 0.576 | 0.798 | 0.919 | 0.914 | 0.764 | 0.905 | 0.691 | 0.805 |
| | (0.90) | (1.29) | (1.52) | (1.51) | (1.26) | (1.48) | (1.12) | (1.32) |
| BIG N$_{i.t-1}$ | -0.136 | -0.057 | -0.019 | -0.008 | -0.104 | -0.031 | -0.105 | -0.036 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (-0.46) | (-0.20) | (-0.07) | (-0.03) | (-0.37) | (-0.11) | (-0.37) | (-0.12) |
| CEO DUALITY$_{i.t-1}$ | 0.049 | 0.082 | 0.075 | 0.051 | 0.073 | 0.065 | 0.019 | 0.084 |
| | (0.23) | (0.40) | (0.36) | (0.25) | (0.35) | (0.32) | (0.09) | (0.41) |
| LOG BOARD SIZE$_{i.t-1}$ | -0.997$^{*}$ | -0.787$^{*}$ | -0.790$^{*}$ | -0.798$^{*}$ | -0.828$^{*}$ | -0.793$^{*}$ | -0.896$^{*}$ | -1.080$^{**}$ |
| | (-1.81) | (-1.67) | (-1.68) | (-1.69) | (-1.75) | (-1.66) | (-1.86) | (-2.06) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -0.660 | -0.574 | -0.328 | -0.348 | -0.700 | -0.426 | -0.505 | -0.645 |
| | (-0.75) | (-0.69) | (-0.40) | (-0.42) | (-0.85) | (-0.52) | (-0.61) | (-0.78) |
| T1 CAP$_{i.t-1}$ | -0.014 | -0.002 | -0.003 | -0.007 | -0.009 | -0.003 | -0.007 | -0.009 |
| | (-0.37) | (-0.05) | (-0.08) | (-0.18) | (-0.25) | (-0.09) | (-0.19) | (-0.24) |
| LOAN LOSS | 8.868 | 14.603 | 15.760 | 15.837 | 14.647 | 15.400 | 9.916 | 14.109 |
| PROVISION$_{i.t-1}$ | (0.83) | (1.40) | (1.51) | (1.52) | (1.40) | (1.48) | (0.94) | (1.35) |
| DURATION RATIO$_{i.t-1}$ | -0.022 | 0.005 | -0.003 | 0.000 | -0.001 | 0.000 | -0.026 | -0.011 |
| | (-0.18) | (0.04) | (-0.02) | (0.00) | (-0.01) | (0.00) | (-0.21) | (-0.09) |
| BANK EFFICIENCY$_{i.t-1}$ | -0.001 | -0.009 | -0.019 | -0.010 | -0.039 | -0.016 | 0.001 | -0.016 |
| | (-0.01) | (-0.07) | (-0.15) | (-0.08) | (-0.30) | (-0.12) | (0.00) | (-0.12) |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 610 | 610 | 610 | 610 | 610 | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.138 | 0.106 | 0.105 | 0.105 | 0.115 | 0.105 | 0.128 | 0.107 |

Panel B: the relation between individual board diversity components and ERM implementation, proxied by the existence of CRO

| Dep. Var. = $CRO_{i.t}$ | (1) All components | (2) 1st component | (3) 2nd component | (4) 3rd component | (5) 4th component | (6) 5th component | (7) 6th component | (8) 7th component |
|---|---|---|---|---|---|---|---|---|
| **TTL FEM DIR$_{i.t-1}$** | **0.914** | **0.605** | | | | | | |
| | **(0.72)** | **(0.50)** | | | | | | |
| **STD AGE$_{i.t-1}$** | **0.046** | | **0.046** | | | | | |
| | **(1.01)** | | **(1.07)** | | | | | |
| **STD TENURE$_{i.t-1}$** | **0.015** | | | **0.009** | | | | |
| | **(0.43)** | | | **(0.28)** | | | | |
| **NUM BD$_{i.t-1}$** | **0.802**** | | | | **0.830***** | | | |
| | **(2.44)** | | | | **(2.79)** | | | |
| **1-HHI FINEXP$_{i.t-1}$** | **-0.617** | | | | | **-0.432** | | |
| | **(-0.80)** | | | | | **(-0.60)** | | |
| **1-HHI ETHNIC$_{i.t-1}$** | **2.718***** | | | | | | **2.913***** | |
| | **(4.76)** | | | | | | **(5.24)** | |
| **1-HHI EDU$_{i.t-1}$** | **-1.108** | | | | | | | **0.252** |
| | **(-0.90)** | | | | | | | **(0.23)** |
| LOG ASSETS$_{i.t-1}$ | 0.200 | 0.287*** | 0.309*** | 0.292*** | 0.097 | 0.307*** | 0.361*** | 0.291*** |
| | (1.63) | (3.06) | (3.30) | (3.16) | (0.84) | (3.23) | (3.78) | (3.12) |
| OPACITY$_{i.t-1}$ | -3.394 | -4.554 | -4.038 | -4.444 | -2.824 | -4.136 | -5.337 | -4.393 |
| | (-0.76) | (-1.07) | (-0.95) | (-1.05) | (-0.66) | (-0.97) | (-1.23) | (-1.04) |
| BUSINESS | 0.109 | 0.598 | 0.588 | 0.608 | 0.510 | 0.578 | 0.154 | 0.589 |
| GROWTH$_{i.t-1}$ | (0.17) | (0.97) | (0.95) | (0.98) | (0.82) | (0.93) | (0.24) | (0.95) |
| INT OPS$_{i.t-1}$ | 1.228** | 1.088* | 1.117* | 1.090* | 1.036* | 1.054* | 1.298** | 1.081* |
| | (1.97) | (1.80) | (1.84) | (1.80) | (1.70) | (1.74) | (2.11) | (1.78) |
| INSTIT OWN$_{i.t-1}$ | 0.245 | 0.467 | 0.529 | 0.523 | 0.434 | 0.566 | 0.227 | 0.505 |
| | (0.41) | (0.81) | (0.94) | (0.93) | (0.77) | (0.99) | (0.39) | (0.89) |
| BIG N$_{i.t-1}$ | 0.311 | 0.381 | 0.414 | 0.405 | 0.336 | 0.412 | 0.320 | 0.394 |
| | (1.06) | (1.36) | (1.48) | (1.43) | (1.20) | (1.46) | (1.11) | (1.41) |
| CEO DUALITY$_{i.t-1}$ | 0.076 | 0.117 | 0.123 | 0.103 | 0.119 | 0.114 | 0.057 | 0.111 |
| | (0.37) | (0.59) | (0.62) | (0.51) | (0.60) | (0.57) | (0.28) | (0.56) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOG BOARD SIZE$_{i.t-1}$ | -0.746 | -0.714 | -0.721 | -0.726 | -0.757* | -0.762* | -0.872* | -0.767 |
| | (-1.44) | (-1.62) | (-1.63) | (-1.64) | (-1.70) | (-1.71) | (-1.91) | (-1.58) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -1.072 | -1.047 | -0.830 | -0.945 | -1.314* | -0.931 | -1.083 | -1.013 |
| | (-1.27) | (-1.35) | (-1.07) | (-1.22) | (-1.69) | (-1.21) | (-1.38) | (-1.30) |
| T1 CAP$_{i.t-1}$ | 0.015 | 0.018 | 0.018 | 0.016 | 0.014 | 0.019 | 0.014 | 0.017 |
| | (0.41) | (0.54) | (0.52) | (0.47) | (0.39) | (0.56) | (0.40) | (0.49) |
| LOAN LOSS | 15.889 | 20.321** | 21.374** | 20.855** | 20.864** | 20.452** | 15.207 | 20.512** |
| PROVISION$_{i.t-1}$ | (1.63) | (2.16) | (2.26) | (2.22) | (2.21) | (2.18) | (1.59) | (2.18) |
| DURATION RATIO$_{i.t-1}$ | -0.080 | -0.050 | -0.056 | -0.052 | -0.052 | -0.051 | -0.090 | -0.053 |
| | (-0.68) | (-0.44) | (-0.49) | (-0.46) | (-0.45) | (-0.45) | (-0.76) | (-0.47) |
| BANK EFFICIENCY$_{i.t-1}$ | -0.019 | -0.024 | -0.036 | -0.026 | -0.053 | -0.027 | -0.005 | -0.028 |
| | (-0.16) | (-0.21) | (-0.31) | (-0.23) | (-0.46) | (-0.24) | (-0.05) | (-0.25) |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 610 | 610 | 610 | 610 | 610 | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.107 | 0.063 | 0.064 | 0.063 | 0.072 | 0.063 | 0.098 | 0.063 |

Panel C: the relation between individual board diversity components and ERM implementation, proxied by the existence of RMC

| Dep. Var. = $RMC_{i.t}$ | (1) All components | (2) 1st component | (3) 2nd component | (4) 3rd component | (5) 4th component | (6) 5th component | (7) 6th component | (8) 7th component |
|---|---|---|---|---|---|---|---|---|
| **TTL FEM DIR$_{i.t-1}$** | **1.331** | **2.388*** | | | | | | |
| | **(0.88)** | **(1.71)** | | | | | | |
| **STD AGE$_{i.t-1}$** | **0.035** | | **0.018** | | | | | |
| | **(0.66)** | | **(0.36)** | | | | | |
| **STD TENURE$_{i.t-1}$** | **0.034** | | | **0.064** | | | | |
| | **(0.81)** | | | **(1.59)** | | | | |
| **NUM BD$_{i.t-1}$** | **0.844**** | | | | **1.224***** | | | |
| | **(2.20)** | | | | **(3.47)** | | | |
| **1-HHI FINEXP$_{i.t-1}$** | **1.166** | | | | | **1.983**** | | |
| | **(1.30)** | | | | | **(2.36)** | | |
| **1-HHI ETHNIC$_{i.t-1}$** | **1.705**** | | | | | | **2.190***** | |
| | **(2.55)** | | | | | | **(3.43)** | |
| **1-HHI EDU$_{i.t-1}$** | **6.085***** | | | | | | | **7.951***** |
| | **(3.17)** | | | | | | | **(4.36)** |
| LOG ASSETS$_{i.t-1}$ | 0.800*** | 1.007*** | 1.027*** | 1.012*** | 0.759*** | 0.974*** | 1.075*** | 0.953*** |
| | (5.38) | (8.17) | (8.36) | (8.35) | (5.40) | (7.85) | (8.70) | (7.66) |
| OPACITY$_{i.t-1}$ | -0.302 | -2.089 | -1.246 | -1.487 | 0.963 | -2.511 | -2.210 | -0.306 |
| | (-0.06) | (-0.41) | (-0.25) | (-0.29) | (0.19) | (-0.50) | (-0.44) | (-0.06) |
| BUSINESS | -0.693 | -0.335 | -0.306 | -0.249 | -0.347 | -0.135 | -0.576 | -0.498 |
| GROWTH$_{i.t-1}$ | (-0.91) | (-0.47) | (-0.43) | (-0.35) | (-0.47) | (-0.19) | (-0.79) | (-0.68) |
| INT OPS$_{i.t-1}$ | -0.910 | -1.037* | -1.018* | -0.974* | -1.208* | -0.969 | -0.878 | -1.015* |
| | (-1.51) | (-1.75) | (-1.71) | (-1.66) | (-1.95) | (-1.62) | (-1.48) | (-1.72) |
| INSTIT OWN$_{i.t-1}$ | 0.201 | 0.836 | 1.032 | 1.076 | 0.819 | 0.826 | 0.792 | 0.610 |
| | (0.29) | (1.24) | (1.56) | (1.61) | (1.22) | (1.23) | (1.18) | (0.90) |
| BIG N$_{i.t-1}$ | -0.488 | -0.344 | -0.274 | -0.207 | -0.420 | -0.385 | -0.384 | -0.256 |
| | (-1.36) | (-1.00) | (-0.80) | (-0.60) | (-1.24) | (-1.13) | (-1.12) | (-0.74) |
| CEO DUALITY$_{i.t-1}$ | 0.085 | 0.021 | 0.021 | -0.018 | 0.034 | -0.009 | -0.010 | 0.118 |
| | (0.34) | (0.09) | (0.09) | (-0.08) | (0.14) | (-0.04) | (-0.04) | (0.48) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOG BOARD SIZE$_{i.t-1}$ | -1.792*** | -0.723 | -0.780 | -0.844 | -0.878* | -0.602 | -0.858* | -2.060*** |
| | (-2.90) | (-1.41) | (-1.52) | (-1.64) | (-1.68) | (-1.16) | (-1.66) | (-3.48) |
| TTL OUTSIDE DIR$_{i.t-1}$ | 0.362 | 1.248 | 1.606* | 1.748* | 1.048 | 1.245 | 1.504 | 0.601 |
| | (0.35) | (1.33) | (1.70) | (1.86) | (1.12) | (1.34) | (1.62) | (0.62) |
| T1 CAP$_{i.t-1}$ | -0.070 | -0.029 | -0.029 | -0.038 | -0.039 | -0.034 | -0.030 | -0.065 |
| | (-1.57) | (-0.69) | (-0.68) | (-0.90) | (-0.92) | (-0.80) | (-0.73) | (-1.46) |
| LOAN LOSS | -21.310* | -15.997 | -14.122 | -14.223 | -14.950 | -13.177 | -18.171* | -17.878* |
| PROVISION$_{i.t-1}$ | (-1.93) | (-1.52) | (-1.35) | (-1.35) | (-1.40) | (-1.24) | (-1.71) | (1.68) |
| DURATION RATIO$_{i.t-1}$ | -0.062 | 0.003 | -0.014 | -0.015 | -0.026 | -0.016 | -0.042 | -0.045 |
| | (-0.45) | (0.02) | (-0.10) | (-0.11) | (-0.19) | (-0.12) | (-0.30) | (-0.32) |
| BANK EFFICIENCY$_{i.t-1}$ | 0.334** | 0.301** | 0.283** | 0.308** | 0.252* | 0.294** | 0.323** | 0.302** |
| | (2.23) | (2.15) | (2.02) | (2.15) | (1.77) | (2.07) | (2.30) | (2.09) |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 610 | 610 | 610 | 610 | 610 | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.294 | 0.244 | 0.240 | 0.243 | 0.256 | 0.247 | 0.255 | 0.272 |

This table presents the relation between individual board diversity components and ERM implementation. In Panel A, the dependent variable is enterprise risk management (ERM$_{i.t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. In Panel B, the dependent variable is chief risk officer (CRO$_{i.t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. In Panel C, the dependent variable is risk management committee (RMC$_{i.t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variables include total female director percentage (TTL FEM DIR$_{i.t-1}$) as defined by the number of female directors divided by the board size; directors' age diversity (STD AGE$_{i.t-1}$) as defined by the standard deviation of the board members' ages; director's tenure diversity (STD TENURE$_{i.t-1}$) as defined by the standard deviation of the board members' tenure; director's number of outside boards (NUM BD$_{i.t-1}$) as defined by the mean number of other boards served by current directors; director's financial expertise (1-HHI FINEXP$_{i.t-1}$) as defined by the HHI of the number of directors in each bank-year that are categorized as having financial expertise; director's ethnic diversity (1-HHI ETHNIC$_{i.t-1}$) as defined by the HHI of the number of directors in each bank-year that are categorized in terms of ethnic, including Asian, African-American, Caucasian and Hispanic; and director's education diversity (1-HHI EDU$_{i.t-1}$) as defined by the HHI of the number of directors in each bank-year that are categorized by their bachelor's (or first higher education degree) granting institutions. Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 5** Principal factor analysis: the relation between board diversity index (first, second and third principal factors) and ERM implementation

| | (1) | (2) | (3) |
|---|---|---|---|
| Dep. Var. = | $ERM_{i.t}$ | $CRO_{i.t}$ | $RMC_{i.t}$ |
| **FIRST FACTOR**$_{i.t-1}$ | **0.260**$^{**}$ | **0.153** | **0.785**$^{***}$ |
| | **(2.06)** | **(1.29)** | **(5.03)** |
| **SECOND FACTOR**$_{i.t-1}$ | **0.027** | **-0.024** | **0.216**$^{**}$ |
| | **(0.29)** | **(-0.27)** | **(1.98)** |
| **THIRD FACTOR**$_{i.t-1}$ | **0.399**$^{***}$ | **0.470**$^{***}$ | **0.366**$^{***}$ |
| | **(3.87)** | **(4.77)** | **(3.29)** |
| LOG ASSETS$_{i.t-1}$ | 0.503$^{***}$ | 0.237$^{**}$ | 0.780$^{***}$ |
| | (4.24) | (2.30) | (5.87) |
| OPACITY$_{i.t-1}$ | -11.479$^{**}$ | -4.628 | -2.359 |
| | (-2.55) | (-1.09) | (-0.45) |
| BUSINESS GROWTH$_{i.t-1}$ | 0.808 | 0.579 | -0.317 |
| | (1.19) | (0.93) | (-0.43) |
| INT OPS$_{i.t-1}$ | 0.833 | 1.106$^{*}$ | -1.054$^{*}$ |
| | (1.03) | (1.82) | (-1.76) |
| INSTIT OWN$_{i.t-1}$ | 0.632 | 0.375 | 0.345 |
| | (1.02) | (0.65) | (0.50) |
| BIG N$_{i.t-1}$ | -0.100 | 0.353 | -0.563 |
| | (-0.35) | (1.25) | (-1.62) |
| CEO DUALITY$_{i.t-1}$ | 0.072 | 0.112 | 0.007 |
| | (0.35) | (0.56) | (0.03) |
| LOG BOARD SIZE$_{i.t-1}$ | -0.948$^{**}$ | -0.807$^{*}$ | -1.157$^{**}$ |
| | (-1.98) | (-1.80) | (-2.17) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -0.884 | -1.263 | -0.008 |
| | (-1.05) | (-1.59) | (-0.01) |
| T1 CAP$_{i.t-1}$ | -1.039 | 1.391 | -5.659 |
| | (-0.28) | (0.39) | (-1.27) |
| LOAN LOSS | 13.543 | 19.820$^{**}$ | -18.334$^{*}$ |
| PROVISION$_{i.t-1}$ | (1.30) | (2.11) | (-1.70) |
| DURATION RATIO$_{i.t-1}$ | -0.006 | -0.055 | -0.016 |
| | (-0.05) | (-0.48) | (-0.12) |
| BANK EFFICIENCY$_{i.t-1}$ | -0.010 | -0.026 | 0.317$^{**}$ |
| | (-0.08) | (-0.22) | (2.16) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.110 | 0.065 | 0.275 |

This table presents the principal component analysis. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC.

The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i,t-1}$), defined as the first, second and third principal factors of individual board diversity components in bank *i* in year *t-1*. Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 6** Cross-sectional tests: tier-1 capital ratio effect

| Dep. Var. = | (1) $ERM_{i.t}$ | (2) $CRO_{i.t}$ | (3) $RMC_{i.t}$ |
|---|---|---|---|
| **$BDI_{i.t-1}$ x T1 $CAP_{i.t-1}$** | **-3.322***** | **-2.071**** | **-0.813** |
| | **(-3.12)** | **(-2.12)** | **(-0.62)** |
| $BDI_{i.t-1}$ | 0.479**** | 0.324**** | 0.307*** |
| | (3.85) | (2.85) | (2.06) |
| T1 $CAP_{i.t-1}$ | -3.707 | -0.134 | -5.629 |
| | (-0.97) | (-0.04) | (-1.28) |
| LOG $ASSETS_{i.t-1}$ | 0.522**** | 0.210*** | 0.904**** |
| | (4.49) | (2.15) | (7.12) |
| $OPACITY_{i.t-1}$ | -12.953**** | -5.197 | -1.926 |
| | (-2.81) | (-1.21) | (-0.38) |
| BUSINESS $GROWTH_{i.t-1}$ | 0.483 | 0.321 | -0.588 |
| | (0.69) | (0.51) | (-0.79) |
| INT $OPS_{i.t-1}$ | 0.880 | 1.216*** | -0.781 |
| | (1.07) | (1.98) | (-1.31) |
| INSTIT $OWN_{i.t-1}$ | 0.798 | 0.355 | 0.445 |
| | (1.27) | (0.61) | (0.64) |
| BIG $N_{i.t-1}$ | -0.024 | 0.399 | -0.372 |
| | (-0.08) | (1.41) | (-1.08) |
| CEO $DUALITY_{i.t-1}$ | 0.064 | 0.112 | 0.031 |
| | (0.31) | (0.56) | (0.13) |
| LOG BOARD $SIZE_{i.t-1}$ | -1.104*** | -0.930*** | -1.134*** |
| | (-2.26) | (-2.06) | (-2.13) |
| TTL OUTSIDE $DIR_{i.t-1}$ | -0.727 | -1.245 | 1.113 |
| | (-0.88) | (-1.61) | (1.17) |
| LOAN LOSS $PROVISION_{i.t-1}$ | 9.434 | 17.435* | -19.432* |
| | (0.90) | (1.85) | (-1.79) |
| DURATION $RATIO_{i.t-1}$ | 0.018 | -0.051 | -0.034 |
| | (0.15) | (-0.44) | (-0.24) |
| BANK $EFFICIENCY_{i.t-1}$ | 0.042 | 0.006 | 0.349*** |
| | (0.31) | (0.05) | (2.36) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.131 | 0.079 | 0.279 |

This table presents the cross-sectional results of tier-1 capital ratio on ERM implementation. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), defined as the dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The

dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i.t-1}$), defined as the sum of STDZ(TTL FEM DIR) + STDZ(STD AGE) + STDZ(STD TENURE) + STDZ(NUM BD) + STDZ(1-HHI FINEXP) + STDZ(1-HHI ETHNIC) + STDZ(1-HHI EDU) in bank *i* in year *t-1*. To capture the effect of tier-1 capital ratio, I use the tier-1 capital ratio in t-1 (T1 $CAP_{i,t-1}$), to interact with board diversity index ($BDI_{i.t-1}$). Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 7** Cross-sectional tests: interest rate exposure effect

| Dep. Var. = | (1) $ERM_{i.t}$ | (2) $CRO_{i.t}$ | (3) $RMC_{i.t}$ |
|---|---|---|---|
| **$BDI_{i.t-1}$ x DURATION RATIO$_{i.t-1}$** | **0.082*** | **0.071** | **-0.038** |
| | **(1.68)** | **(1.58)** | **(-0.68)** |
| $BDI_{i.t-1}$ | 0.034 | 0.028 | 0.257*** |
| | (0.61) | (0.54) | (3.67) |
| DURATION RATIO$_{i.t-1}$ | 0.026 | -0.067 | -0.022 |
| | (0.20) | (-0.55) | (-0.16) |
| LOG ASSETS$_{i.t-1}$ | 0.511*** | 0.212** | 0.907*** |
| | (4.48) | (2.19) | (7.14) |
| OPACITY$_{i.t-1}$ | -11.483** | -4.408 | -1.764 |
| | (-2.54) | (-1.04) | (-0.35) |
| BUSINESS GROWTH$_{i.t-1}$ | 0.748 | 0.514 | -0.549 |
| | (1.09) | (0.82) | (-0.74) |
| INT OPS$_{i.t-1}$ | 1.027 | 1.280** | -0.774 |
| | (1.25) | (2.08) | (-1.30) |
| INSTIT OWN$_{i.t-1}$ | 0.553 | 0.206 | 0.416 |
| | (0.89) | (0.36) | (0.60) |
| BIG N$_{i.t-1}$ | -0.094 | 0.345 | -0.347 |
| | (-0.33) | (1.22) | (-1.00) |
| CEO DUALITY$_{i.t-1}$ | 0.052 | 0.094 | 0.035 |
| | (0.25) | (0.47) | (0.14) |
| LOG BOARD SIZE$_{i.t-1}$ | -0.997** | -0.893** | -1.128** |
| | (-2.06) | (-1.98) | (-2.12) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -0.596 | -1.158 | 1.116 |
| | (-0.72) | (-1.50) | (1.17) |
| T1 CAP$_{i.t-1}$ | -2.308 | 0.208 | -5.773 |
| | (-0.61) | (0.06) | (-1.31) |
| LOAN LOSS PROVISION$_{i.t-1}$ | 14.194 | 20.144** | -19.512* |
| | (1.35) | (2.13) | (-1.79) |
| BANK EFFICIENCY$_{i.t-1}$ | 0.007 | -0.016 | 0.343** |
| | (0.05) | (-0.14) | (2.33) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.122 | 0.077 | 0.279 |

This table presents the cross-sectional results of duration ratio effect on ERM implementation. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), defined as the dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The

dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i.t-1}$), defined as the sum of STDZ(TTL FEM DIR) + STDZ(STD AGE) + STDZ(STD TENURE) + STDZ(NUM BD) + STDZ(1-HHI FINEXP) + STDZ(1-HHI ETHNIC) + STDZ(1-HHI EDU) in bank *i* in year *t-1*. To capture the effect of interest rate exposure, I use the duration ratio in t-1 (DURATION $RATIO_{i,t-1}$), defined as the annual percentage change on total assets over annual percentage change on total liabilities, to interact with board diversity index ($BDI_{i.t-1}$). Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 8** Cross-sectional tests: bank size effect

| Dep. Var. = | (1) $ERM_{i.t}$ | (2) $CRO_{i,t}$ | (3) $RMC_{i.t}$ |
|---|---|---|---|
| **$BDI_{i.t-1}$ x LOG $ASSETS_{i.t-1}$** | **0.102*** ** | **0.039** | **-0.025** |
| | **(2.94)** | **(1.52)** | **(-0.72)** |
| $BDI_{i.t-1}$ | -0.819*** | -0.270 | 0.474 |
| | (-2.59) | (-1.12) | (1.39) |
| LOG $ASSETS_{i.t-1}$ | 0.443*** | 0.161 | 0.899*** |
| | (3.66) | (1.54) | (6.58) |
| $OPACITY_{i.t-1}$ | -10.936** | -3.958 | -3.115 |
| | (-2.41) | (-0.93) | (-0.59) |
| $BUSINESS\ GROWTH_{i.t-1}$ | 0.745 | 0.507 | -0.627 |
| | (1.07) | (0.81) | (-0.83) |
| $INT\ OPS_{i.t-1}$ | 1.291 | 1.346** | -0.697 |
| | (1.47) | (2.14) | (-1.17) |
| $INSTIT\ OWN_{i.t-1}$ | 0.702 | 0.286 | 0.539 |
| | (1.14) | (0.50) | (0.77) |
| $BIG\ N_{i.t-1}$ | -0.010 | 0.394 | -0.278 |
| | (-0.03) | (1.40) | (-0.78) |
| $CEO\ DUALITY_{i.t-1}$ | 0.059 | 0.116 | 0.036 |
| | (0.29) | (0.58) | (0.14) |
| LOG $BOARD\ SIZE_{i.t-1}$ | -1.051** | -0.894** | -1.174** |
| | (-2.18) | (-2.00) | (-2.17) |
| $TTL\ OUTSIDE\ DIR_{i.t-1}$ | -0.887 | -1.305* | 1.422 |
| | (-1.07) | (-1.68) | (1.44) |
| $T1\ CAP_{i.t-1}$ | -2.438 | 0.355 | -7.433* |
| | (-0.64) | (0.10) | (-1.66) |
| $LOAN\ LOSS\ PROVISION_{i.t-1}$ | 12.741 | 19.793** | -18.639* |
| | (1.30) | (2.21) | (-1.84) |
| $DURATION\ RATIO_{i.t-1}$ | -0.014 | -0.067 | -0.147 |
| | (-0.11) | (-0.57) | (-1.00) |
| $BANK\ EFFICIENCY_{i.t-1}$ | 0.054 | -0.023 | 0.693*** |
| | (0.42) | (-0.21) | (4.63) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.130 | 0.076 | 0.304 |

This table presents the cross-sectional results of bank size effect on ERM implementation. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), defined as the dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The

dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i.t-1}$), defined as the sum of STDZ(TTL FEM DIR) + STDZ(STD AGE) + STDZ(STD TENURE) + STDZ(NUM BD) + STDZ(1-HHI FINEXP) + STDZ(1-HHI ETHNIC) + STDZ(1-HHI EDU) in bank *i* in year *t-1*. To capture the effect of bank size, I use the bank size in t-1 (LOG $ASSETS_{i,t-1}$), defined as the natural logarithm of the book value of total assets of each bank, to interact with board diversity index ($BDI_{i.t-1}$). Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 9** Cross-sectional tests: Big N auditor effect

| Dep. Var. = | (1) $ERM_{i.t}$ | (2) $CRO_{i.t}$ | (3) $RMC_{i.t}$ |
|---|---|---|---|
| **$BDI_{i.t-1}$ x BIG $N_{i.t-1}$** | **0.161*** | **0.086** | **0.013** |
| | **(1.78)** | **(0.98)** | **(0.10)** |
| $BDI_{i.t-1}$ | -0.025 | 0.021 | 0.221* |
| | (-0.30) | (0.25) | (1.73) |
| BIG $N_{i.t-1}$ | 0.161 | 0.477 | -0.262 |
| | (0.52) | (1.57) | (-0.73) |
| LOG ASSETS$_{i.t-1}$ | 0.477*** | 0.206** | 0.863*** |
| | (4.15) | (2.11) | (6.72) |
| OPACITY$_{i.t-1}$ | -11.344** | -4.301 | -3.082 |
| | (-2.50) | (-1.01) | (-0.58) |
| BUSINESS GROWTH$_{i.t-1}$ | 0.755 | 0.513 | -0.605 |
| | (1.10) | (0.82) | (-0.80) |
| INT OPS$_{i.t-1}$ | 1.034 | 1.269** | -0.660 |
| | (1.26) | (2.07) | (-1.10) |
| INSTIT OWN$_{i.t-1}$ | 0.610 | 0.243 | 0.563 |
| | (0.99) | (0.42) | (0.81) |
| CEO DUALITY$_{i.t-1}$ | 0.102 | 0.133 | 0.040 |
| | (0.49) | (0.66) | (0.16) |
| LOG BOARD SIZE$_{i.t-1}$ | -1.008** | -0.886** | -1.177** |
| | (-2.09) | (-1.97) | (-2.17) |
| TTL OUTSIDE DIR$_{i.t-1}$ | -0.584 | -1.174 | 1.357 |
| | (-0.71) | (-1.52) | (1.38) |
| T1 CAP$_{i.t-1}$ | -1.971 | 0.519 | -7.518* |
| | (-0.52) | (0.15) | (-1.68) |
| LOAN LOSS PROVISION$_{i.t-1}$ | 11.893 | 19.036** | -18.675* |
| | (1.21) | (2.13) | (-1.83) |
| DURATION RATIO$_{i.t-1}$ | -0.032 | -0.070 | -0.150 |
| | (-0.26) | (-0.61) | (-1.01) |
| BANK EFFICIENCY$_{i.t-1}$ | 0.075 | -0.018 | 0.694*** |
| | (0.60) | (-0.17) | (4.61) |
| Year fixed effects | Yes | Yes | Yes |
| N | 610 | 610 | 610 |
| Pseudo $R^2$ | 0.122 | 0.074 | 0.303 |

This table presents the cross-sectional results of Big N auditor effect on ERM implementation. The dependent variable in column 1 is enterprise risk management ($ERM_{i.t}$), defined as the dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. The dependent variable in column 2 is chief risk officer ($CRO_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. The

dependent variable in column 3 is risk management committee ($RMC_{i,t}$), a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. The independent variable is board diversity index ($BDI_{i.t-1}$), defined as the sum of STDZ(TTL FEM DIR) + STDZ(STD AGE) + STDZ(STD TENURE) + STDZ(NUM BD) + STDZ(1-HHI FINEXP) + STDZ(1-HHI ETHNIC) + STDZ(1-HHI EDU) in bank *i* in year *t-1*. To capture the effect of Big N auditor, I use Big N auditor in t-1 ($BIG\ N_{i,t-1}$), defined as the dummy variable which equals 1 for bank engages Big N auditor, to interact with board diversity index ($BDI_{i.t-1}$). Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. Z-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 10** Additional tests: Consequence of ERM implementation on future non-performing loans

| Dep. Var. = | (1) NON-PERFORMING LOANS$_{i.t+1}$ | (2) NON-PERFORMING LOANS$_{i.t+1}$ | (3) NON-PERFORMING LOANS$_{i.t+1}$ |
|---|---|---|---|
| **ERM$_{i.t}$** | **-0.0018$^{**}$** | | |
| | **(-2.26)** | | |
| **CRO$_{i.t}$** | | **-0.0018$^{**}$** | |
| | | **(-2.20)** | |
| **RMC$_{i.t}$** | | | **-0.0043$^{***}$** |
| | | | **(-3.02)** |
| LOG ASSETS$_{i.t}$ | 0.0007 | 0.0006 | 0.0010$^{*}$ |
| | (1.26) | (1.14) | (1.89) |
| OPACITY$_{i.t}$ | 0.0091 | 0.0102 | 0.0102 |
| | (0.33) | (0.37) | (0.37) |
| BUSINESS GROWTH$_{i.t}$ | -0.0025 | -0.0024 | -0.0026 |
| | (-0.84) | (-0.82) | (-0.90) |
| INT OPS$_{i.t}$ | -0.0107$^{***}$ | -0.0106$^{***}$ | -0.0096$^{***}$ |
| | (-2.89) | (-2.87) | (-2.58) |
| INSTIT OWN$_{i.t}$ | -0.0112$^{***}$ | -0.0112$^{***}$ | -0.0119$^{***}$ |
| | (-4.54) | (-4.51) | (-4.84) |
| BIG N$_{i.t}$ | -0.0041$^{***}$ | -0.0041$^{***}$ | -0.0043$^{***}$ |
| | (-3.96) | (-3.94) | (-4.09) |
| CEO DUALITY$_{i.t}$ | 0.0018$^{**}$ | 0.0018$^{**}$ | 0.0019$^{**}$ |
| | (2.11) | (2.11) | (2.21) |
| LOG BOARD SIZE$_{i.t}$ | -0.0051$^{***}$ | -0.0051$^{***}$ | -0.0051$^{***}$ |
| | (-3.38) | (-3.38) | (-3.42) |
| TTL OUTSIDE DIR$_{i.t}$ | -0.0023 | -0.0024 | -0.0013 |
| | (-0.61) | (-0.63) | (-0.34) |
| T1 CAP$_{i.t}$ | -0.0141 | -0.0136 | -0.0133 |
| | (-1.13) | (-1.10) | (-1.08) |
| LOAN LOSS PROVISION$_{i.t}$ | 0.7503$^{***}$ | 0.7511$^{***}$ | 0.7438$^{***}$ |
| | (14.66) | (14.67) | (14.55) |
| DURATION RATIO$_{i.t}$ | -0.0007 | -0.0008 | -0.0007 |
| | (-1.59) | (-1.60) | (-1.58) |
| BANK EFFICIENCY$_{i.t}$ | 0.0025$^{***}$ | 0.0025$^{***}$ | 0.0026$^{***}$ |
| | (3.01) | (3.00) | (3.18) |
| Year fixed effects | Yes | Yes | Yes |
| N | 4116 | 4116 | 4116 |
| Adj. $R^2$ | 0.308 | 0.308 | 0.309 |

This table presents the effect of ERM implementation on bank risk in year t+1. The dependent variable is non-performing loans (NON-PERFORMING LOANS$_{i,t+1}$), defined as the total non-performing assets of bank *i* in year *t+1* divided by the gross loans. The independent variables are enterprise risk management, chief risk officer, and risk management committee. Enterprise risk management (ERM$_{i.t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. Chief risk officer (CRO$_{i,t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. Risk management committee (RMC$_{i,t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. T-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

**Table 11** Additional tests: Consequence of ERM implementation on future derivative hedging

| Dep. Var. = | (1) DERIV_HEDGING/ASSETS$_{i.t+1}$ | (2) DERIV_HEDGING/ASSETS$_{i.t+1}$ | (3) DERIV_HEDGING/ASSETS$_{i.t+1}$ |
|---|---|---|---|
| **ERM$_{i.t}$** | **0.0024** | | |
| | **(1.25)** | | |
| **CRO$_{i.t}$** | | **0.0010** | |
| | | **(0.52)** | |
| **RMC$_{i.t}$** | | | **0.0158$^{***}$** |
| | | | **(4.62)** |
| LOG ASSETS$_{i.t}$ | 0.0186$^{***}$ | 0.0187$^{***}$ | 0.0169$^{***}$ |
| | (14.53) | (14.65) | (12.79) |
| OPACITY$_{i.t}$ | -0.1042 | -0.1075 | -0.0949 |
| | (-1.53) | (-1.58) | (-1.40) |
| BUSINESS | 0.0203$^{***}$ | 0.0205$^{***}$ | 0.0199$^{***}$ |
| GROWTH$_{i.t}$ | (2.85) | (2.87) | (2.80) |
| INT OPS$_{i.t}$ | 0.0112 | 0.0113 | 0.0056 |
| | (1.27) | (1.28) | (0.63) |
| INSTIT OWN$_{i.t}$ | -0.0208$^{***}$ | -0.0204$^{***}$ | -0.0196$^{***}$ |
| | (-3.43) | (-3.35) | (-3.25) |
| BIG N$_{i.t}$ | 0.0045$^{*}$ | 0.0045$^{*}$ | 0.0047$^{*}$ |
| | (1.75) | (1.76) | (1.85) |
| CEO DUALITY$_{i.t}$ | 0.0051$^{**}$ | 0.0051$^{**}$ | 0.0049$^{**}$ |
| | (2.47) | (2.45) | (2.38) |
| LOG BOARD | -0.0070$^{*}$ | -0.0070$^{*}$ | -0.0064$^{*}$ |
| SIZE$_{i.t}$ | (-1.86) | (-1.87) | (-1.71) |
| TTL OUTSIDE | 0.0274$^{***}$ | 0.0275$^{***}$ | 0.0234$^{**}$ |
| DIR$_{i.t}$ | (2.99) | (3.00) | (2.55) |
| T1 CAP$_{i.t}$ | -0.1062$^{***}$ | -0.1080$^{***}$ | -0.1038$^{***}$ |
| | (-3.39) | (-3.45) | (-3.33) |
| LOAN LOSS | 0.1353 | 0.1362 | 0.1591 |
| PROVISION$_{i.t}$ | (1.07) | (1.08) | (1.26) |
| DURATION | 0.0002 | 0.0002 | 0.0002 |
| RATIO$_{i.t}$ | (0.21) | (0.20) | (0.18) |
| BANK | 0.0113$^{***}$ | 0.0114$^{***}$ | 0.0104$^{***}$ |
| EFFICIENCY$_{i.t}$ | (5.56) | (5.61) | (5.13) |
| Year fixed effects | Yes | Yes | Yes |
| N | 3474 | 3474 | 3474 |
| Adj. $R^2$ | 0.188 | 0.187 | 0.192 |

This table presents the effect of ERM implementation on bank risk-taking activity in year t+1. The dependent variable is derivative hedging

($DERIV\_HEDGING_{i,t+1}/ASSETS_{i,t+1}$), defined as the value of derivatives of bank *i* in year *t+1* divided by total assets. The value of derivatives is obtained from Bank Regulatory Call Reports by adding the following: foreign exchange derivative contracts, equity derivative contracts, interest rate derivative contracts, and commodity derivative contracts. The independent variables are enterprise risk management, chief risk officer, and risk management committee. Enterprise risk management ($ERM_{i.t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO and/or RMC. Chief risk officer ($CRO_{i,t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of CRO. Risk management committee ($RMC_{i,t}$), is defined as a dummy variable which equals 1 if bank *i* in year *t* has ERM under implementation, proxied by the existence of RMC. Description of variables is summarized in Appendix A. To mitigate the influence of outliners, variables are winsorized at 1% and 99%. Constant terms are considered but not reported. Year fixed effects are included. T-values are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent levels, respectively.

## Curriculum Vitae

Academic qualifications of the thesis author, Mr. LAM Wing Ho Fergus:

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