Journal of International Accounting, Auditing and Taxation 53 (2023) 100576

Contents lists available at ScienceDirect

Journal of International Accounting, Auditing and Taxation

Lead independent director, managerial risk-taking, and cost of debt: Evidence from UK

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ARTICLE INFO

Keywords:
Lead independent director
Managerial risk-taking
Cost of debt

ABSTRACT

We extend the existing literature on how the adoption of a lead independent director is related to corporate outcomes by documenting that the presence of a lead independent director on the board is significantly and negatively related to managerial risk-taking. The result is more pronounced for firms with a non-independent board chair. In a further analysis, we document that decreased managerial risk-taking leads to a reduction in the cost of debt for firms with a lead independent director on the board. Overall, our results suggest that the adoption of a lead independent director is an effective governance mechanism when the board chair is not independent, which supports the motivation of the United Kingdom corporate governance code.

1. Introduction

The appointment of a lead independent director on corporate boards has been promoted as an effective monitoring mechanism to reduce agency conflicts (National Association of Corporate Directors (NACD) 2004). As a result, there is a growing interest among public firms in the adoption of a lead independent director to offset the power when one person is both the Chief Executive Officer (CEO) and chair of the Board of directors (also called duality) (Chen & Ma, 2017). According to the United Kingdom (UK) Corporate Governance Code (2018, p. 7), lead independent directors "provide a sounding board for the chair and serve as an intermediary for the other directors and shareholders". Corporate governance observers have also provided several reasons why firms should adopt lead independent director representation on the board. For the NACD (2004), the lead independent director represents a credible alternative when the CEO and board chair positions are combined. For Krause et al. (2017), lead independent director representation on the board reflects a balanced power on the board. For the Institute of Directors (2018), a lead independent director has the capacity to intervene, mediate, and build consensus when there is disagreement or a dispute between the CEO and the board chair. Another reason why firms adopt lead independent director representation on the board is to address the concerns of investors when they are unable to discuss them with the CEO, board chair, or other executive directors.

In the UK, a lead independent director is the most senior independent director appointed by the board[1]. Unlike other independent board members, a lead independent director is charged with many important responsibilities, including undertaking checks and balances when there is a dispute between the CEO and the board chair, addressing the concerns of shareholders and/or non-executive directors and the board chair or the CEO, meeting with the non-executive directors (without the chair present) at least once annually to appraise the chair's performance, intervening when there is close relationship between the CEO and the board chair, and intervening when the strategy put forward by both leaders is not supported by the entire board. These responsibilities point to the expectation that a lead independent director has the authority to intervene in the event that the CEO or the board chair or both deviate from the objectives of the firm.

Most previous research based on the adoption of a lead independent director has explored its effect on a forced CEO turnover (Chen & Ma, 2017) or firm performance (Krause et al., 2017; Lamoreaux et al., 2019). More recent research has analyzed the impact of a lead independent

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[1] The term lead independent director is used in this study rather than senior independent director as described in the 2018 UK Corporate Governance Code.

https://doi.org/10.1016/j.intaccaudtax.2023.100576

Available online 19 September 2023

director on investment efficiency (Rajkovic, 2020). However, these studies mainly focused on the United States (US), where a dual CEO-chair is permitted, and it is uncertain whether the effectiveness of a lead independent director in the US will manifest in other jurisdictions, particularly in the UK, where the corporate governance environment is different. For example, while the adoption of a lead independent director in the US is a compromise solution to avoid dual CEO-chair separation (Krause et al., 2017)[2], a dual CEO-chair is discouraged by UK regulators (Combined Code, 2003; UK Corporate Governance Code, 2018). Thus, the unique features of the UK corporate governance environment provide an interesting setting to undertake UK-based research on the effectiveness of a lead independent director on the board in a virtually non-CEO-board chair environment. In addition, previous research has not analyzed the effectiveness of a lead independent director in the presence of an independent board chair versus a non-independent board chair. Furthermore, Rajkovi (2020) has called for research into the importance of lead independent director representation on the board in relation to other corporate outcomes.

In this paper, we investigate the effect of lead independent director representation on the board on managerial risk-taking, and whether managerial risk-taking interacts with a lead independent director to influence the cost of debt. Understanding how managerial risk-taking behavior is affected by the presence of a lead independent director on the board is of great interest to both practitioners and academics, because managerial risk-taking increases the cost of borrowing[3]. Unlike previous studies that focused on a lead independent director across US firms, we selected the UK setting to undertake this study because both the US and the UK have been at the forefront of corporate governance regulation in respect of the appointment of a lead independent director. However, academic evidence on the effect of a lead independent director on corporate outcomes across UK firms is non-existent[4]. In addition, the UK principles-based approach as opposed to the US rules-based approach to corporate governance has been a role model for many countries around the world (Owusu & Weir, 2016). Therefore, investigating the effect of a lead independent director on managerial risk-taking and the corresponding cost of debt provides a more complete understanding of the value of a lead independent director in two distinct corporate governance environments.

A lead independent director can have three competing effects on managerial risk-taking and the cost of debt. First, from the perspective of the compromise board leadership structure theory (Krause et al., 2017), the adoption of a lead independent director on the board provides independent oversight and counterbalances CEO-chair power in a corporate governance environment where a CEO-chair is permitted. Therefore, managerial risk-taking behavior is more likely to be constrained, leading to a lower cost of debt[5]. Similarly, in a corporate governance environment where a dual CEO-chair is discouraged by regulators, CEO power may not be tampered with if the board chair is not independent. In this scenario, the presence of a lead independent director on the board is more likely to provide independent oversight and constraint managerial risk-taking behavior, thereby reducing the cost of debt. Second, from the agency theory perspective (Fama, 1980; Jensen & Meckling, 1976), a dual CEO-chair or a non-CEO board chair may be risk averse, so a lead independent director oversight along with incentives may be required to promote managerial risk-taking (Baysinger & Hoskisson, 1990; Jensen & Murphy, 1990). In this scenario, lead independent director representation on the board is more likely to encourage excessive risk-taking and thereby increase the cost of debt.

Third, from the stewardship theory perspective (Donaldson & Davis, 1991; Bédard et al., 2008), because managers are honest and far from being opportunistic, lead independent director representation on the board in either a dual CEO-chair environment or a non-CEO board chair environment is more likely to be a symbolic management tactic to meet a regulatory requirement (Shi & Connelly, 2018). In this scenario, the presence of a lead independent director on the board is more likely to have no effect on managerial risk-taking and, therefore, the cost of debt will not be affected. Thus, given these three competing arguments, it would be interesting to investigate the following empirical question: how is managerial risk-taking and the corresponding cost of debt affected if a firm appoints a lead independent director?

We investigate our research question using a sample of the Financial Times Stock Exchange (FTSE) All Share Index firms listed on the London Stock Exchange over the study period 2009–2018. Our results show that the presence of a lead independent director on the board is significantly and negatively related to managerial risk-taking. In a subsample analysis, we find that a lead independent director exerts a more significant constraint on managerial risk-taking for firms without an independent board chair than for firms with an independent board chair. Further, we document that decreased managerial risk-taking leads to a corresponding reduction in the cost of debt for firms when there is lead independent director representation on the board. Our results are consistent with the US evidence that lead independent director representation on the board is an effective governance mechanism (Chen & Ma, 2017; Lamoreaux et al., 2019). The results are robust to alternative measures of managerial risk-taking (i.e., market-based and strategic expenditure risk-taking measures), the cost of debt (i.e., accounting type and market-based measure), econometric specifications, and endogeneity analysis.

We contribute to the literature that focuses on lead independent director representation on the board and corporate outcomes in several aspects. First, our study is the first to test the effectiveness of lead independent director representation on the board in a setting where a dual CEO-chair is discouraged by regulators or virtually non-existent. Not only does this allow us to investigate whether the presence of a lead independent director on the board provides balanced power when the board chair is not independent, we are also able to assess the effectiveness of a lead independent director in the presence of an independent board chair. Tests capturing firms with non-independent board chairs versus those with independent board chairs in the presence of a lead independent director provide insights beyond studies that have focused on the mere representation of a lead independent director on the board. We show that managerial risk-taking is weaker in the presence of a lead independent director for firms with a non-independent board chair than for firms with an independent board chair.

Second, few studies have examined the effect of a lead independent director on a variety of corporate outcomes (see for example, Chen & Ma, 2017; Krause et al., 2017; Lamoreaux et al., 2019; Rajkovic, 2020). We extend these studies by providing new evidence regarding the effect of a lead independent director on managerial risk-taking, and how managerial risk-taking and a lead independent director jointly influence the cost of debt. Our analyses take place in a setting where a dual CEO-chair is discouraged by regulators, enabling a more far-reaching understanding of the link between a lead independent director and corporate outcomes.

Finally, even though previous studies have analyzed the effect of board independence on (1) managerial risk-taking (Bargeron et al., 2010; Bradley & Chen, 2015; Akbar et al., 2017), and (2) the cost of debt

[2] In their US study, Lamoreaux et al. (2019) report that 51% of firms have a dual CEO-chair compared with 1.5% of our sample UK firms with a dual CEO-chair.

[3] Bradley and Chen (2015) find that managerial risk-taking proxied by equity volatility is associated with a higher cost of debt. Using research and development investment (R&D risk) as a proxy for managerial risk-taking, Shi (2003) and Chen et al. (2016) find a positive association between R&D risk and the cost of debt.

[4] The existing literature well documents that both US and UK regulators in the early 2000s introduced a lead independent director role as part of a board leadership structure (Combined Code, 2003; Dalton & Dalton, 2005).

[5] Existing research suggests that managerial risk-taking is a function of CEO tenure (Miller, 1991; Levinthal & March 1993; Luo et al., 2014). For example, Ali and Zhang (2015) document that managerial risk-taking (i.e., earnings overstatements) is a function of the CEO's career cycle.

(Bhojraj & Sengupta, 2003; Anderson et al., 2004; Ertugrul & Hegde, 2008; Lorca et al., 2011; Bradley & Chen, 2015)[6], they have not always analyzed how the presence of a lead independent director on the board affects managerial risk-taking and the corresponding cost of debt. In this respect, we investigate the effect of a lead independent director on managerial decisions in risk-taking and the corresponding cost of debt. Our results provide new insights into debtholders' valuation of the relationship between a lead independent director and managerial risk-taking.

The rest of the paper is structured as follows. Section 2 undertakes a literature review to motivate our hypotheses. Section 3 describes the sample selection procedure, data sources, and our method of analysis. Section 4 presents our empirical results, while section 5 concludes the study.

2. Theoretical framework and hypotheses development

2.1. Theoretical framework

Several theories, including compromise board leadership structure theory, agency theory, and stewardship theory, can broadly be used to explain the effect of a lead independent director on managerial risk-taking and the corresponding cost of debt. First, compromise board leadership structure theory believes that lead independent director representation on the board provides balanced power when the CEO and the board chair positions are combined (Krause et al., 2017)[7]. In this respect, the presence of a lead independent director on the board is more likely to counterbalance the CEO-chair power to constrain managerial risk-taking behavior, thereby reducing the cost of debt. In contrast, given the reputational and employment risks, agency theory recognizes that managers are risk averse (Fama, 1980; Jensen & Meckling, 1976), and that managerial incentives tied with performance are needed to promote risk-taking (Baysinger & Hoskisson, 1990; Jensen & Murphy, 1990). In this particular case, an independent oversight by a lead independent director is more likely to promote excessive risk-taking, thereby increasing the cost of debt. On the other hand, stewardship theory argues that managers are honest and not opportunistic, hence, they make decisions that are consistent with the firm's objectives to benefit all interested parties (Donaldson & Davis, 1991; Bédard et al., 2008). In this regard, the presence of a lead independent director on the board in either a dual CEO-chair environment or a non-CEO board chair environment will not have any effect on managerial risk-taking and the corresponding cost of debt. In summary, the existing board leadership structure theories provide three distinct predictions for how managerial risk-taking and the corresponding cost of debt is affected by the presence of lead independent director on the board.

2.2. Empirical research

Previous literature documents that a lead independent director is associated with various corporate outcome measures, including forced CEO turnover, firm performance, and investment efficiency. Chen and Ma (2017) undertook a US study in which they investigate whether lead independent directors have an influence on the effectiveness of board monitoring proxied by the performance-sensitivity of forced CEO turnover. Their most important finding is that the propensity of a CEO dismissal to poor stock performance is higher for firms with a lead independent director than it is for other firms. Building on the seminal work of Finkelstein and D'Aveni (1994) who called for research on board compromise as a power-balancing mechanism in resolving conflicts, Krause et al. (2017) developed a new compromise board leadership structure theory and showed that lead independent director representation on US boards reflects the balance of power on the board and under the right condition has a positive impact on firm performance. This evidence is supported by Lamoreaux et al. (2019) who report that lead independent director representation on US boards enhances firm value and corporate governance quality. Rajkovic (2020) also built on the compromise board leadership structure theory developed by Krause et al. (2017) and examined the association between lead independent director representation on US boards and investment efficiency. Her most important finding is that the presence of a lead independent director on the board is positively associated with investment efficiency.

The preceding discussion suggests that lead independent director representation on the board is related to corporate outcomes in the US. However, the literature has exclusively focused on the effect of a lead independent director on corporate outcomes, such as forced CEO turnover, firm performance, and investment efficiency, without considering managerial risk-taking behavior. Understanding how managerial risk-taking behavior is influenced by the presence of a lead independent director on the board is very important because managerial risk-taking is more likely to affect the cost of borrowing (Shi, 2003; Chen et al., 2016). Consequently, research into lead independent director and corporate outcomes is not complete without examining how managerial risk-taking behavior is affected by the presence of a lead independent director on the board.

Meanwhile, researchers have begun to examine the impact of board independence (i.e., proxied by the proportion of independent directors on the board) on managerial/corporate risk-taking, but the results are less than conclusive. In their study on corporate risk-taking post-Sarbanes Oxley Act of 2002 changes, the most important finding of Bargeron et al. (2010) is that board independence discourages corporate risk-taking. Bradley and Chen (2015) also undertook a US study post-Sarbanes Oxley Act of 2002 changes in which they examined the association between board independence and managerial risk-taking behavior. In contrast with Bargeron et al. (2010), their most important finding is that an increase in board independence leads to an increase in managerial risk-taking. In their study on board structure and corporate risk-taking in the UK financial sector, the most important finding from Akbar et al. (2017) is that board independence reduces corporate risk-taking practices. A significant limitation of these studies is that they focused exclusively on the proportion of board independence and disregarded the effect of a lead independent director in their analysis. Therefore, we take these studies forward by investigating the relation between the presence of a lead independent director and managerial risk-taking.

2.3. Managerial risk-taking effect of a lead independent director

The preceding discussion makes it clear that the relationship between a lead independent director and managerial risk-taking is an empirical question. Therefore, given that the presence of a lead independent director on the board provides a compromise solution to balance managerial autonomy with the necessary monitoring (Krause et al., 2017), we would expect a lead independent director on the board to guide managerial decisions relating to risk-taking, thereby constraining managerial risk-taking. This argument leads one to predict that managerial risk-taking will decrease if a firm appoints a lead independent director. However, this expectation contradicts the traditional agency

[6] These studies use the percentage of independent directors on the board and the percentage of independent directors on audit committee to proxy board independence. In contrast, we focus on a lead independent director representation on the board to proxy board leadership independence.

[7] Even though the compromise board leadership structure theory developed by Krause et al. (2017) focuses on a dual CEO-board chair corporate governance environment, we believe that the theory's argument will hold in a corporate governance environment where the CEO and the board chair positions are occupied by separate individuals, but the board chair is not independent. In this scenario, the presence of a lead independent director has the propensity to counterbalance the CEO and the board chair powers to constraint managerial risk-taking, thereby reducing the cost of debt than for firms with an independent board chair.

theory, which assumes that managers are risk-averse given the reputational and employment risks (Jensen & Meckling, 1976; Fama, 1980; Akbar et al., 2017), and that independent oversight along with incentives is needed to promote risk-taking (Baysinger & Hoskisson, 1990; Jensen & Murphy, 1990). These arguments lead us to predict that managerial risk-taking will increase if a firm appoints a lead independent director. In contrast, stewardship theory believes that managers are honest and not opportunistic, and that facilitating and empowering structures, such as allowing a dual CEO-chair and a substantial number of executive directors on the board, benefit the firm (Donaldson & Davis, 1991; Bédard et al., 2008). Consistent with this argument, one can predict that the presence of a lead independent director on the board will have no effect on managerial risk-taking.

In summary, drawing on compromise board leadership structure theory, and given more consistent evidence regarding the effectiveness of a lead independent director, our first hypothesis is stated in an alternative form as follows:

H_1 Ceteris paribus, the presence of a lead independent director on the board is negatively related to managerial risk-taking.

2.4. Cost of debt effect of managerial risk-taking and a lead independent director

In our study, we also test the previously unexamined joint effect of managerial risk-taking and a lead independent director on the cost of debt. Prior empirical research has exclusively focused on the association between board independence and the cost of debt while disregarding the role of a lead independent director, but their results are less than conclusive (e.g., Bhojraj & Sengupta, 2003; Anderson et al., 2004; Ertugrul & Hegde, 2008; Lorca et al., 2011; Bradley & Chen, 2015). While Bhojraj and Sengupta (2003), Anderson et al. (2004), and Ertugrul and Hegde (2008) find a negative association between board independence and the cost of debt, Lorca et al. (2011) find no association between board independence and the cost of debt. A more recent study by Bradley and Chen (2015) also did not find a significant overall effect of board independence on the cost of debt. However, in a further analysis, they show that board independence decreases (increases) the cost of debt when the credit conditions of a firm are strong (poor).

To the extent that managerial risk-taking increases the cost of debt (Shi, 2003; Bradley & Chen, 2015; Chen et al., 2016), we would expect that such an effect should be less pronounced for firms with a lead independent director on the board because debtholders favor independent monitoring that are more likely to reduce managerial risk-taking and consequently their risk premium (Lorca et al., 2011). As discussed and hypothesized earlier, our expectation is that a lead independent director on the board is negatively related to managerial risk-taking. If indeed a lead independent director decreases managerial risk-taking, then we would expect a lead independent director to alleviate the adverse effect of managerial risk-taking on the cost of debt.

Overall, firms with a lead independent director could benefit from decreased managerial risk-taking through independent monitoring and, therefore, we would expect a corresponding reduction in the cost of debt. Hence, our second hypothesis is stated in an alternative form as follows:

H_2 Ceteris paribus, the positive association between managerial risk-taking and the cost of debt is weaker for firms with a lead independent director.

3. Sample, data, and method

3.1. Sample construction and data sources

Our sample consists of the FTSE All Share Index firms listed on the London Stock Exchange over the study period 2009–2018[8]. Using the FTSE All Share Index firms in the UK is important because the UK Corporate Governance Code encourages the appointment of a lead independent director on the board on a comply or explain basis, but their effectiveness is yet to be established. Our primary data source is the Bloomberg database. We use Bloomberg to establish the presence of a lead independent director on the board, and for the data on board characteristics and equity volatility. This was supplemented by the BoardEx database for data on a lead independent director and board characteristics. In addition, we obtained our financial data for the control variables from Thomson Reuters Worldscope database.

As Table 1 shows, we merged the corporate governance and the equity volatility datasets with the financial data, resulting in a total sample of 6,130 firm-year observations. As in previous literature (e.g., Bargeron et al., 2010), we deleted 1,014 firm-year observations from the financial services industry, because these firms have different regulations and particular financial reporting requirements. Next, we deleted 2,340 firm-year observations with missing information relating to the lead independent director, board characteristics, equity volatility, and financial data. Finally, we excluded 156 firm-year observations of companies that are not listed throughout the study period. Our final sample consists of 262 unique firms with a balanced panel of 2,620 firm-year observations over the study period 2009–2018 for the empirical analysis. Finally, to minimize the impact of outliers, we winsorized all the continuous variables at the 1st and 99th percentile.

3.2. Empirical model

To test hypothesis 1, we estimate the impact of a lead independent director on managerial risk-taking. Consistent with previous risk-taking literature (e.g., Harjoto & Laksmana, 2018), we employed a standard ordinary least square (OLS) regression model with both firm and year level clustered robust standard errors to correct the residual dependence caused by firm and year-specific effects (Petersen, 2009). Equation (1) presents our baseline regression model for testing the first hypothesis as follows:

$$MRT_t = \beta_0 + \beta_1 LeadIndDir_t + \beta_2 IndDir_t + \beta_3 IndAC_t + \beta_4 BordSize_t + \beta_5 FEMCEO_t + \beta_6 CEOAGE_t + \beta_7 CEOCOMP_t + \beta_8 CEOTenure_t + \beta_9 CEOWN_t + \beta_{10} CEODUALITY_t + \beta_{11} INSTOWN_t + \beta_{12} ROA_t + \beta_{13} CASHOLD_t + \beta_{14} SIZE_t + \beta_{15} MTBV_t + \beta_{16} LEV_t + \beta_{17} Z\text{-}score_t + \beta_{18} SALEG_t + \beta_{19} FIRMAGE_t + \beta_{20} CAPEX_t + \beta_{21} R\&D_t + \beta_{22} YEAR\_FE_t + \beta_{23} IND\_FE_t + \varepsilon_t \quad (1)$$

where, our dependent variable in equation (1) is managerial risk-taking (*MRT*), measured as the natural logarithm of the standard devi-

Table 1
Sample construction procedure.

	Firm Years
Total sample from 2009 to 2018	6,130
Less financial services firms	(1,014)
Less firms with missing data	(2,340)
Less firms not continuously listed from 2009 to 2018	(156)
Final sample	**2,620**

[8] Our study period 2009–2018 is influenced by data availability for our sample firms at the time of data collection.

ation of daily stock returns for at least 260 days over the year. Consistent with previous literature (e.g., Brick et al., 2012; Bradley & Chen, 2015), we use equity volatility as a measure of managerial risk-taking. Our test variable in equation (1) is *LeadIndDir*, which is set to one if a firm has a lead independent director on the board, and zero if otherwise.

To isolate the impact of a lead independent director on managerial risk-taking, we follow previous managerial/corporate risk-taking literature (e.g., Bargeron et al., 2010; Ntim et al., 2013; Bradley & Chen, 2015; Belghitar & Clark, 2015; Chen et al., 2016; Faccio et al., 2016; Akbar et al., 2017) and include numerous control variables. First, given that board characteristics are found to have a significant impact on managerial/corporate risk-taking, we control for board independence (*IndDir*), independent audit committee (*IndAC*), board size (*BordSize*), CEO gender (*FEMCEO*), CEO age (*CEOAGE*), total CEO compensation (*CEOCOMP*), CEO tenure (*CEOTenure*), CEO ownership (*CEOWN*), and CEO duality (*CEODUALITY*). Second, because several firm characteristics have been found to influence managerial/corporate risk-taking, we control for return on assets (*ROA*), cash holding (*CASHOLD*), firm size (*SIZE*), market-to-book value (*MTBV*), leverage (*LEV*), credit conditions (*Z-score*), sales growth (*SALESG*), firm age (*FIRMAGE*), capital expenditure (*CAPEX*), and research and development expenses (*R&D*). Third, we follow Chung et al. (2002) and include institutional shareholding (*INSTOWN*) to capture institutional monitoring. Finally, we control for year (*YEAR_FE*) and industry (*IND_FE*) fixed effects to account for differences in *MRT* across years and industries.

To test hypothesis 2, we estimate the joint effect of *MRT* and *LeadIndDir* on the cost of debt. In line with managerial risk-taking, board independence, and the cost of debt literature (e.g., Lorca et al., 2011; Chen et al., 2016), we used the OLS regression model with robust standard errors clustered at both firm and year level to address the residual dependence caused by firm and year-specific effects (Peterson, 2009). Equation (2) provides our baseline regression model for testing the second hypothesis as follows:

$$COD_t = \beta_0 + \beta_1 MRT_t + \beta_2 LeadIndDir_t + \beta_3 MRT_t \times LeadIndDir_t + \beta_4 IndDir_t + \beta_5 IndAC_t + \beta_6 BordSize_t + \beta_7 CEOWN_t + \beta_8 INSTOWN_t + \beta_9 ROA_t + \beta_{10} CASHOLD_t + \beta_{11} SIZE_t + \beta_{12} MTBV_t + \beta_{13} LEV_t + \beta_{14} Z\text{-}score_t + \beta_{15} FIRMAGE_t + \beta_{16} YEAR\_FE_t + \beta_{17} IND\_FE_t + \varepsilon_t (2)$$

where, our dependent variable in equation (2) is the accounting-based measure of the cost of debt (*COD*)[9]. We follow previous literature (e.g., Pittman & Fortin, 2004; Francis et al., 2005; Lorca et al., 2011; De Moura et al., 2020) and defined the accounting-based measure of the cost of debt as the interest expense scaled by interest-bearing debt. Our main test variable of interest in equation (2) is the interaction between managerial risk-taking and lead independent director (*MRT* × *LeadIndDir*). We hypothesize that firms with constrained managerial risk-taking exhibit a lower cost of debt induced by a lead independent director representation on the board, therefore, we expect the coefficient β_3 to be significantly negative. As in previous literature (e.g., Lorca et al., 2011; Bradley & Chen, 2015; Chen et al., 2016), we control for board and firm-level characteristics that are found to influence the cost of debt, including board independence (*IndDir*), independent audit committee (*IndAC*), board size (*BordSize*), CEO ownership (*CEOWN*), institutional shareholding (*INSTOWN*), return on assets (*ROA*), cash holding (*CASHHOLD*), firm size (*SIZE*), market-to-book value (*MTBV*), leverage (*LEV*), credit conditions (*Z-score*), and firm age (*FIRMAGE*). We also control for year (*YEAR_FE*) and industry (*IND_FE*) fixed effects to account for differences in *COD* across years and industries. Table 2 contains the definitions of all our variables.

[9] As in subsection 4.6, we use a market-based measure of the cost of debt to undertake robustness test.

Table 2
Variable definitions.

Variable	Definition
MRT	Managerial risk-taking is the natural logarithm of the standard deviation of daily stock returns for at least 260 days over the year, as suggested by Brick et al. (2012) and Bradley and Chen (2015)
COD	Interest expense scaled by the interest-bearing debt to proxy accounting-based measure of the cost of debt
LeadIndDir	Dummy variable coded 1 if a firm has a lead independent director on the board, and 0 otherwise
IndDir	The percentage of independent directors to total board size
IndAC	Dummy variable that is set to one if all the audit committee members are independent directors, and 0 otherwise
BordSize	The number of directors serving on the board
FEMCEO	Dummy variable coded 1 if the CEO is a woman, and 0 otherwise
CEOAGE	The natural logarithm of the CEO age in years
CEOCOMP	The natural logarithm of the total CEO compensation
CEOTenure	The natural logarithm of the current CEO tenure in years
CEOWN	The percentage of shares held by a CEO
CEODUALITY	Dummy variable coded 1 if one person occupies the position of The CEO and the chairman, and 0 otherwise
INSTOWN	Dummy variable coded 1 if the institutional shareholding of a firm is greater than the median, and 0 otherwise
ROA	Net income scaled by lagged total assets
CASHOLD	Cash and cash equivalent scaled by total assets
SIZE	The natural logarithm of the total assets
MTBV	Market capitalization scaled by the book value of common equity
LEV	Total debt scaled by the sum of total debt plus common equity
Z-score	A composite score indicating a distance to financial default estimated from Altman's Z-score
SALESG	The natural logarithm of annual rate of growth of sales
FIRMAGE	The natural logarithm of the number of years from the date of incorporation
CAPEX	Capital expenditure for the year scaled by book value of total assets, in line with Bargeron et al. (2010)
R&D	Research and development expenses for the year scaled by book value of total assets, in line with Bargeron et al. (2010)
INVEST	The sum of the capital expenditure and research and development expenses for the year scaled by book value of total assets, in line with Bargeron et al. (2010)
YEAR_FE	Year fixed effects indicator variables
IND_FE	Industry fixed effects indicator variables

4. Empirical results

4.1. Descriptive statistics

Table 3 presents the descriptive statistics of the key variables for the full sample and the sub-samples of firms. On average, 72% of our full sample firms have lead independent directors on the board (median = 1.000; standard deviation = 42.33%). As Panel A of Table 3 indicates, the mean managerial risk-taking (*MRT*) for the whole sample is 3.470. On average, the cost of debt in our full sample is around 7.60%, which is similar to the 7.78% reported by Lorca et al. (2011) across Spanish listed firms. The average percentage of independent directors on the boards is 58.98%, which is significantly lower than the 68% reported by Bradley and Chen (2015) across US listed firms. This suggests that the US rules-based approach to corporate governance appears to encourage greater independent director representation on the board than the UK's comply or explain approach to corporate governance. However, the UK listed firms appear stronger than the US listed firms in terms of having a 100% independent audit committee membership. On average, 81.70% of our sample firms have a 100% independent audit committee membership relative to 76% reported by Bradley and Chen (2015) across US listed firms. The mean board size of our sample firms is approximately 9, and on average, around 6% of CEOs are females.

Panel B of Table 3 reports the descriptive statistics of firms with and without lead independent directors on the board. Panel B also illustrates the test for differences in mean for all our variables across the two firm sub-samples. The managerial risk-taking measure for firms with lead independent directors is around 12% lower than for firms without lead

Table 3
Test for differences in MRT and control variables between firms with and without a lead independent director.

	Panel A: Full Sample			Panel B: Test for Differences in Mean						
	Full Sample (n = 2,620)			(1) *LeadIndDir = 0* (n = 730)			(2) *LeadIndDir = 1* (n = 1,890)			*t*-test
Variable	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	(1)-(2)
MRT	3.470	3.415	0.404	3.795	3.783	0.444	3.399	3.362	0.357	0.396***
COD	0.076	0.042	0.185	0.106	0.054	0.233	0.068	0.040	0.170	0.038***
IndDir (%)	58.98	60.000	14.064	52.088	50.000	17.811	60.219	60.000	12.902	−8.131***
IndAC	0.817	1.000	0.386	0.438	0.000	0.497	0.933	1.000	0.250	−0.495***
BordSize	8.633	8.000	2.286	8.00	7.500	2.928	8.749	9.000	2.128	−0.749***
FEMCEO	0.056	0.000	0.231	0.039	0.000	0.195	0.062	0.000	0.241	−0.022**
CEOAGE	3.947	3.951	0.129	3.909	3.932	0.157	3.955	3.951	0.122	−0.046***
CEOCOMP	14.196	14.141	0.930	13.670	13.629	0.923	14.288	14.224	0.899	−0.617***
CEOTenure	1.398	1.558	1.061	1.291	1.466	1.085	1.416	1.558	1.056	−0.125*
CEOWN (%)	1.393	0.070	5.806	1.619	0.150	4.720	1.331	0.060	6.070	0.288
CEODUALITY	0.015	0.000	0.122	0.020	0.000	0.141	0.014	0.000	0.117	0.007
INSTOWN	0.576	1.000	0.494	0.650	1.000	0.478	0.554	1.000	0.497	0.096***
ROA	0.055	0.054	0.101	0.021	0.037	0.143	0.065	0.058	0.084	−0.044***
CASHOLD	0.098	0.066	0.103	0135	0.082	0.143	0.088	0.062	0.085	0.048***
SIZE	7.244	7.169	1.811	6.235	6.324	1.920	7.530	7.348	1.672	−1.295***
MTBV	3.453	2.173	5.247	2.981	1.847	4.767	3.557	2.271	5.343	−0.576**
LEV	0.224	0.192	0.196	0.231	0.176	0.223	0.223	0.193	0.189	0.008
Z-score	3.483	2.739	3.113	3.509	2.494	3.949	3.477	2.817	2.891	0.032
SALESG	0.072	0.056	0.340	0.107	0.067	0.604	0.065	0.053	0.261	0.042**
FIRMAGE	3.029	2.996	1.121	2.685	2.565	1.258	3.114	3.045	1.066	−0.430***
CAPEX	0.039	0.029	0.040	0.040	0.027	0.045	0.038	0.027	0.038	0.001
R&D	0.012	0.000	0.036	0.017	0.000	0.050	0.011	0.000	0.030	0.007***

Note This table contains descriptive statistics for the variables in the regression models and the tests for differences between means of firms with and without lead independent directors. *, **, and *** denote significant at 0.10, 0.05, and 0.01 levels, respectively. All variables are defined in Table 1.

independent director representation, and the cost of debt measure is 55.88% higher for firms without a lead independent director than for firms with a lead independent director. These preliminary results suggest strong evidence of a negative relationship between a lead independent director and both managerial risk-taking and the cost of debt. With the exception of CEO ownership, CEO duality, leverage, financial conditions, and capital expenditure, the mean differences between the two sub-samples for all variables is statistically significance at the 10% level or better.

4.2. Correlation analysis

To identify and address multicollinearity issues in our dataset used for our baseline regression analysis, we perform a correlation analysis as reported in Table 4. As expected, we find that the correlation coefficient on (-0.36) *LeadIndDir* is significant and negatively associated with *MRT*. We also find that the correlation coefficient on (0.07) *MRT* is significant and positively associated with *COD*, while the correlation coefficient on (-0.08) *LeadIndDir* is significant and negatively associated with *COD*. As Table 4 shows, the highest correlation coefficient of 0.64 between firm size and board size is below the threshold of 0.80, which may indicate multicollinearity (see Sharma et al., 2017; Owusu et al., 2022; Owusu and Zalata, 2023). We also check the variance inflation factor (VIF) values from our baseline regressions for both *MRT* and *COD*, and find the highest VIF to be around 4.20 in relation to firm size (*SIZE*). However, the highest VIF of 4.20 is lower than the threshold of 10 (Kennedy, 2008; Owusu et al., 2022), indicating that our results in Tables 5 to 10 are not impacted by multicollinearity issues.

4.3. Lead independent director and managerial risk-taking

In this subsection, we investigate the relationship between lead independent director representation on the board and managerial risk-taking. Panel A of Table 5 presents the baseline regression results from estimating equation (1) for the full sample firms. The results in column (1) of Panel A show a negative and statistically significant (at 1% level) coefficient β_1, suggesting that lead independent director representation on the board is negatively related to managerial risk-taking. The coefficient estimates of the control variables are broadly consistent with the previous managerial/corporate risk-taking literature (e.g., Bradley & Chen, 2015; Chen et al., 2016; Faccio et al., 2016). For example, the coefficient estimates are significantly positive for board independence, CEO ownership, CEO duality, cash holdings, leverage, and capital expenditure, and significantly negative for full independent audit committee membership, female CEO, CEO age, CEO compensation, institutional shareholdings, return on assets, firm size, firm age, and research and development expenses. Our results are also economically significant, because holding all other variables fixed, managerial risk-taking (*MRT*) decreases by 7.2% when lead independent director (*LeadIndDir*) moves from 0 to 1.

Panel B of Table 5 differentiates between two alternative scenarios – firms with an independent board chair versus firms without an independent board chair – and test the effectiveness of a lead independent director in restricting managerial risk-taking. Given that lead independent directors provide independent oversight to balance CEO-chair power in the absence of board leadership independence, we argue that their appointment in the presence of an independent board chair is more likely to be a box-ticking exercise to meet a regulatory requirement. Therefore, its relationship with managerial risk-taking should be stronger for firms with a non-independent board chair than for firms with an independent board chair. To investigate this conjecture, we split our sample into firms with and without an independent board chair and re-estimate equation (1) for these subsamples. In column (2) of Panel B under Table 5, the coefficient estimate for the lead independent director for firms with an independent board chair is negative but not statistically significant. In contrast, column (3) of Panel B shows that the coefficient estimate for the lead independent director for firms without an independent board chair is negative and statistically significant at 5% level, which suggests that our result is more pronounced for firms with a non-independent board chair. In addition, we exclude around 1.5%

Table 4
Pearson correlation matrix for dependent, explanatory, and control variables (n = 2,620).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1. MRT	1																						
2. LeadIndDir	**−0.36**	1																					
3. IndDir	**0.18**	**0.21**	1																				
4. IndAC	**−0.19**	**0.54**	**0.39**	1																			
5. BordSize	**0.20**	**0.12**	**0.14**	**0.05**	1																		
6. FEMCEO	**−0.06**	**0.04**	0.03	**0.06**	0.03	1																	
7. CEOAGE	**−0.16**	**0.13**	**0.09**	**0.09**	**0.15**	**−0.04**	1																
8. CEOCOMP	**−0.39**	**0.24**	**0.36**	**0.19**	**0.45**	**0.06**	**0.16**	1															
9. CEOTenure	0.02	0.04	**−0.07**	**0.05**	−0.02	**−0.08**	**0.23**	0.02	1														
10.CEOWN	**0.10**	−0.02	**−0.08**	−0.03	**−0.07**	**−0.05**	**0.05**	**−0.19**	**0.15**	1													
11.CEODUALITY	**0.02**	−0.03	**−0.09**	**−0.06**	−0.03	−0.02	**0.13**	**−0.06**	**0.06**	**0.23**	1												
12. ROA	**−0.32**	**0.18**	−0.02	**0.12**	**0.05**	−0.01	**−0.01**	**0.19**	**0.09**	**0.06**	0.03	1											
13. SIZE	**−0.33**	**0.30**	**0.38**	**0.25**	**0.64**	**0.08**	**0.16**	**0.62**	**−0.07**	**−0.10**	−0.03	**0.07**	1										
14. MTBV	**−0.08**	**0.04**	0.01	**0.05**	0.03	0.01	**−0.06**	**0.06**	0.02	0.01	−0.02	**0.27**	**−0.11**	1									
15. LEV	**0.09**	−0.02	**0.05**	**−0.08**	**0.20**	0.03	0.04	0.01	**−0.06**	**−0.05**	**0.04**	**−0.28**	**0.35**	**−0.23**	1								
16. Z-score	0.02	−0.01	**−0.09**	−0.01	**−0.14**	**−0.07**	**−0.08**	**−0.07**	0.03	**0.07**	0.03	**0.36**	**−0.35**	**0.36**	**−0.56**	1							
17. SALESG	0.01	**−0.05**	**−0.08**	−0.02	**−0.04**	−0.02	**−0.07**	0.04	0.01	0.02	0.02	**0.05**	**−0.04**	0.03	**−0.09**	**0.08**	1						
18. FIRMAGE	**−0.22**	**0.15**	**0.08**	**0.15**	0.01	**−0.04**	**0.05**	**0.06**	**0.05**	**−0.09**	0.01	0.03	**0.09**	**−0.09**	**−0.01**	**−0.13**	**−0.09**	1					
19. CAPEX	**0.14**	−0.01	0.02	**0.08**	**0.10**	−0.02	**−0.04**	**−0.05**	**−0.06**	**0.05**	−0.03	**−0.08**	**0.06**	−0.02	**0.17**	**−0.06**	**−0.05**	**−0.08**	1				
20. R&D	**−0.15**	**−0.08**	0.03	−0.01	**−0.09**	**−0.08**	**0.05**	**−0.15**	**−0.05**	0.01	0.02	**−0.25**	**−0.26**	**0.05**	**−0.23**	**0.16**	−0.01	−0.03	**−0.06**	1			
21. COD	**0.07**	**−0.08**	**−0.05**	**−0.07**	**−0.09**	0.01	−0.03	**−0.08**	−0.01	−0.02	−0.01	**0.05**	**−0.13**	0.01	**−0.17**	**−0.18**	0.01	−0.02	−0.03	0.04	1		
22. INSTOWN	**−0.06**	**−0.08**	−0.02	**−0.04**	**−0.05**	−0.01	0.03	−0.01	0.03	**−0.06**	−0.02	**0.06**	0.04	0.01	**0.05**	−0.02	−0.03	**0.06**	−0.03	**−0.06**	−0.02	1	
23.CASHOLD	**0.25**	**−0.19**	−0.02	**−0.10**	**−0.12**	−0.04	**−0.11**	**−0.10**	**−0.05**	0.03	−0.02	**−0.07**	**−0.29**	**0.15**	**−0.28**	**0.34**	−0.01	**−0.18**	**−0.04**	**0.31**	**0.12**	**−0.07**	1

Notes: The correlations which denote statistically significance of at least 5 per cent level are reported in bold. All variables are defined in Table 1

equivalent firm-year observations (39) with a dual CEO-chair from the subsample of firms without an independent board chair and re-estimate equation (1), however, our results (untabulated) are unchanged. This evidence suggests that our result for firms with a non-independent board chair is not sensitive to a dual CEO-chair[10].

Overall, there is statistically strong evidence from the results presented in this subsection that having a lead independent director on the board is negatively related to managerial risk-taking, implying that hypothesis 1 is supported. This evidence contradicts the arguments of agency and stewardship theories. However, it provides support for the compromise board leadership structure theory, which suggests that the presence of a lead independent director on the board provides a compromise solution to balance managerial autonomy with the necessary monitoring (Krause et al., 2017). Our empirical results also provide support for Chen and Ma (2017) and Lamoreaux et al. (2019) evidence in the US that a lead independent director is an effective governance mechanism.

4.4. *Robustness tests*

Our baseline regression results in subsection 4.3 show that having lead independent directors on boards is negatively related to managerial risk-taking. In this subsection, we report on several robustness checks performed to validate our main findings. First, because there is a potential lag effect of lead independent director monitoring on managerial decisions on risk-taking, we use a 1-year lag lead independent director measure instead of the contemporaneous lead independent director variable. This is important because while the contemporaneous lead independent director may influence managerial decisions, the effect of lead independent director monitoring on risk-taking may be observed in the following year. Therefore, we re-estimate equation (1) using a 1-year lagged OLS and report our results in columns (3) to (6) of Panel C in Table 5. We find that having lead independent directors on boards has a negative and significant impact on managerial risk-taking and the result is more noticeable for firms with a non-independent board chair. These results provide strong support for our baseline regression results reported in columns (1) to (3) of Panels A and B in Table 5.

Second, we follow Bargeron et al. (2010) and used three strategic expenditure risk-taking measures as alternative managerial risk-taking measures: 1) research and development (*R&D*) risk, defined as R&D expenses for the year scaled by the book value of total assets; 2) capital expenditure (*CAPEX*) risk, defined as the capital expenditure for the year scaled by book value of totals assets; and 3) investment (*INVEST*) risk, defined as the sum of *R&D* and *CAPEX*. We re-estimate equation (1) using these alternative measures as our dependent variables and report our OLS (columns 1, 3, and 5) and 1-year lagged OLS (columns 2, 4, and 6) results in Table 6. The results show that having lead independent directors on boards has a significant and negative impact on all the strategic expenditure risk-taking measures. Overall, the results provide robust support for our baseline regression results reported in Table 5 (columns 1 and 4).

Third, we re-estimate equation (1) by controlling for firm-level fixed effects in addition to year and industry fixed effects. This allows us to address unobserved, time-invariant firm-level heterogeneity. Our results (untabulated) are consistent with the baseline regression results reported in Table 5. Fourth, because board independence forms an integral part of a firm's internal corporate governance system and affects managerial risk-taking (Bargeron et al., 2010; Bradley & Chen, 2015), we re-estimate equation (1) by excluding the board independence variables of *IndDir* and *IndAC*. Although untabulated, our conclusions from the baseline regression results in Table 5 is unaffected. Fifth, we acknowledge that our investigation coincides with the period of

[10] Due to an inadequate sample size, we could not test the effectiveness of a lead independent director for the subsample of firms with a dual CEO-chair.

Table 5
Regression results of Lead independent director and managerial risk-taking analyses.

	Panel A	Panel B: IndChair Subsample Analysis		Panel C: Using 1-year lagged LeadIndDir		
	Full Sample	Firms with IndChair	Firms without IndChair	Full Sample	Firms with IndChair	Firms without IndChair
Variables	(1) OLS	(2) OLS	(3) OLS	(4) Lagged OLS	(5) Lagged OLS	(6) Lagged OLS
Intercept	4.883***	4.710***	4.781***	4.736***	4.613***	4.789***
	(18.98)	(14.52)	(10.21)	(17.65)	(9.97)	(14.55)
LeadIndDir	−0.072***	−0.010	−0.084**	−0.079***	−0.044	−0.076***
	(−3.06)	(−1.21)	(−2.53)	(−4.02)	(−1.02)	(−3.00)
IndDir	0.001*	0.002	0.003*	0.001*	0.002	0.002*
	(1.75)	(1.50)	(1.92)	(1.81)	(1.30)	(1.72)
IndAC	−0.030*	−0.018	−0.082*	−0.032**	−0.001	−0.006**
	(−1.78)	(−0.39)	(−1.91)	(−2.05)	(−0.23)	(−2.15)
BordSize	0.001	0.004	−0.005	0.001	0.003	−0.002
	(0.14)	(0.68)	(−0.77)	(0.26)	(0.44)	(−0.82)
FEMCEO	−0.024**	−0.019	−0.003**	−0.032**	−0.021	−0.030*
	(−1.99)	(−0.63)	(−2.05)	(−2.17)	(−0.67)	(−1.88)
CEOAGE	−0.108*	−0.011	−0.138*	−0.101*	−0.018	−0.111*
	(−1.88)	(−0.14)	(−1.79)	(−1.90)	(−0.23)	(−1.85)
CEOCOMP	−0.043***	−0.058***	−0.032*	−0.030***	−0.058***	−0.033*
	(−4.32)	(−4.54)	(−1.81)	(−3.16)	(−4.70)	(−1.91)
CEOTenure	0.002	0.002	−0.003	0.002	0.002	−0.003
	(0.35)	(0.48)	(−0.26)	(0.42)	(0.26)	(−0.27)
CEOWN	0.004***	0.004*	0.004**	0.003**	0.003*	0.004**
	(2.97)	(1.68)	(2.18)	(2.56)	(1.65)	(2.29)
CEODUALITY	0.113**	0.177***	−0.031	0.197**	0.200***	−0.030
	(2.16)	(4.24)	(−0.27)	(2.42)	(5.89)	(−0.24)
INSTOWN	−0.003**	−0.015*	0.006	−0.003**	−0.015	0.010
	(−2.21)	(−1.95)	(0.27)	(−2.24)	(−0.96)	(0.42)
ROA	−0.009***	−0.009***	−0.009***	−0.009***	−0.009***	−0.009***
	(−9.18)	(−7.31)	(−3.54)	(−7.53)	(−6.74)	(−3.44)
CASHOLD	0.587***	0.494***	0.555***	0.571***	0.471***	0.572***
	(7.26)	(4.94)	(3.52)	(6.84)	(4.52)	(3.51)
SIZE	−0.067***	−0.075***	−0.037**	−0.066***	−0.072***	−0.041**
	(−8.53)	(−7.44)	(−2.16)	(−8.07)	(−7.16)	(−2.48)
MTBV	−0.002	−0.001	0.002	−0.003*	−0.001	0.001
	(−0.94)	(−0.18)	(0.53)	(−1.94)	(−0.41)	(0.40)
LEV	0.361***	0.339***	0.230**	0.416***	0.365***	0.245**
	(6.06)	(4.34)	(2.10)	(6.57)	(4.70)	(2.23)
Z-score	0.001	−0.004	0.004	0.004	−0.004	0.003
	(0.28)	(−1.05)	(0.66)	(1.15)	(−0.95)	(0.48)
SALESG	0.006	0.004	−0.023	0.003	0.004	−0.038
	(0.22)	(0.11)	(−0.26)	(0.12)	(0.15)	(−0.44)
FIRMAGE	−0.055***	−0.056***	−0.057***	−0.050***	−0.055***	−0.067***
	(−7.19)	(−6.38)	(−3.50)	(−6.90)	(−6.14)	(−3.90)
CAPEX	0.757***	1.262***	0.182	0.873***	1.296***	0.093
	(3.59)	(4.29)	(0.45)	(3.76)	(4.36)	(0.23)
R&D	−0.626**	−0.239	−2.190*	−0.446**	−0.204	−2.339**
	(−2.71)	(−1.01)	(−1.94)	(−2.05)	(−0.87)	(−1.99)
YEAR_FE	YES	YES	YES	YES	YES	YES
IND_FE	YES	YES	YES	YES	YES	YES
Adj R^2	0.503	0.497	0.517	0.480	0.495	0.517
Firm years	2,620	1,452	1,168	2,358	1,307	1,051

Notes: This table presents the regression results of the managerial risk-taking analyses. The dependent variable is MRT in six columns. Column 1 reports the OLS results for the full sample. Columns 2 and 3 report the OLS results for the subsample of firms with independent board chair (IndChair) and those without one. Columns 4 to 6 report the lagged *LeadIndDir* results. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. The OLS regression models are estimated with dual clustered robust standard errors (both firm and year). T-statistics are in parentheses under the coefficients. All variables are defined in Table 1.

economic recovery following the global 2007–2009 financial crisis, therefore, our main results may be influenced by the general decline in equity volatility we use as a measure of managerial risk-taking. To address these concerns, we split our sample into early economic recovery period (2009–2013) and late economic recovery period (2014–2018) and re-estimate equation (1) for these subsamples. Our results (untabulated) are not sensitive to the economic recovery period.

Finally, given that female CEOs reduce corporate risk-taking (Faccio et al., 2016), we investigate whether CEO gender plays any significant role on the relationship between a lead independent director being on the board and managerial risk-taking. In our sample, 48 firms had at least one female CEO during the period under consideration while 214 firms had no female CEOs. We re-estimate equation (1) for these two subsamples but our results (untabulated) are not sensitive to CEO gender.

4.5. Addressing endogeneity concerns

Our results showing that having lead independent directors on boards is negatively related to managerial risk-taking may be subject to potential endogeneity concerns, because Panel B of Table 3 largely shows significant dissimilarities between the variables of firms with and without lead independent directors. Given that constrained managerial risk-taking only becomes observable following the appointment of a lead independent director, the managerial risk-taking of firms without lead independent directors becomes unobservable. Thus, making the choice of a lead independent director an endogenous variable. In addition, firms could appoint a lead independent director in response to the

Table 6
Lead independent director and alternative measures of managerial risk-taking.

Variables	R&D (1) OLS	(2) Lagged OLS	CAPEX (3) OLS	(4) Lagged OLS	INVEST (5) OLS	(6) Lagged OLS
Intercept	0.048*	0.033	0.074**	0.127***	0.057***	0.097*
	(1.81)	(1.35)	(2.15)	(3.24)	(2.78)	(1.96)
LeadIndDir	−0.012***	−0.010***	−0.003*	−0.003*	−0.022***	−0.015***
	(−3.40)	(−3.04)	(−1.83)	(−1.89)	(−3.61)	(−3.06)
IndDir	0.001***	0.001***	0.012*	0.001**	0.001***	0.001***
	(5.11)	(4.63)	(1.95)	(2.01)	(4.32)	(3.83)
IndAC	0.004*	0.003	0.010***	0.007**	0.015***	0.010**
	(1.74)	(1.21)	(3.06)	(1.99)	(3.32)	(2.19)
BordSize	0.001***	0.001***	0.003***	0.003***	0.004***	0.004***
	(3.16)	(2.94)	(5.06)	(5.26)	(5.97)	(6.12)
FEMCEO	−0.007***	−0.007***	−0.002*	−0.002*	−0.009***	−0.009***
	(−4.99)	(−4.95)	(−1.81)	(−1.66)	(−3.23)	(−3.08)
CEOAGE	0.018***	0.019***	−0.018**	−0.026***	−0.004	−0.010
	(3.03)	(2.99)	(−2.30)	(−2.98)	(−0.41)	(−0.87)
CEOCOMP	−0.001	−0.001	0.003*	0.001	0.003*	0.001
	(−1.14)	(−0.64)	(1.92)	(0.70)	(1.66)	(0.63)
CEOTenure	−0.002***	−0.002***	−0.001*	−0.001	−0.004***	−0.004***
	(−2.82)	(−2.95)	(−1.69)	(−1.60)	(−2.92)	(−2.85)
CEOWN	0.000*	0.000**	0.001**	0.000**	0.001**	0.001**
	(1.83)	(2.13)	(2.25)	(1.99)	(2.58)	(2.54)
CEODUALITY	−0.016**	−0.017***	−0.009	−0.001	−0.030**	−0.019**
	(−2.33)	(2.63)	(−1.50)	(−0.16)	(−3.03)	(−2.11)
INSTOWN	−0.004***	−0.004***	−0.003	−0.002	−0.008***	−0.008***
	(−2.57)	(−2.67)	(−1.33)	(−1.22)	(−3.01)	(−3.02)
ROA	−0.001***	−0.001***	−0.000	−0.000	−0.002***	−0.001***
	(−3.46)	(−3.67)	(−1.23)	(−0.69)	(−2.91)	(−3.25)
CASHOLD	0.064***	0.063***	−0.020	−0.019	0.053**	−0.052*
	(3.79)	(3.70)	(−1.59)	(−1.58)	(1.98)	(1.94)
SIZE	−0.004***	−0.004***	−0.004***	−0.004***	−0.010***	−0.009***
	(−5.44)	(−4.92)	(−3.73)	(−3.02)	(−6.21)	(−5.32)
MTBV	0.000	0.000	0.000	0.000	0.001*	0.001
	(0.78)	(1.49)	(1.45)	(0.55)	(1.84)	(1.45)
LEV	−0.021***	−0.020***	0.021**	0.016	0.005	0.004
	(−3.94)	(−3.55)	(2.34)	(1.56)	(0.32)	(0.18)
Z-score	0.001***	0.001*	0.001**	0.001	0.003**	0.003**
	(1.64)	(1.87)	(2.20)	(1.10)	(2.12)	(2.04)
SALESG	0.003	0.004	−0.014**	−0.005	−0.005	0.011
	(0.43)	(0.46)	(−2.56)	(−1.03)	(−0.25)	(0.60)
FIRMAGE	−0.002**	−0.002**	−0.003***	−0.003***	−0.006***	−0.006***
	(−2.50)	(−2.35)	(−3.72)	(−3.08)	(−4.30)	(−3.86)
YEAR_FE	YES	YES	YES	YES	YES	YES
IND_FE	YES	YES	YES	YES	YES	YES
Adj R^2	0.411	0.412	0.250	0.244	0.247	0.243
Firm years	2,620	2,358	2,620	2,358	2,620	2,358

Notes: This table presents the regression results of the alternative measures managerial risk-taking analyses. The dependent variables are research and development risk (R&D) in column 1, capital expenditure risk (CAPEX) in column 2, and investment risk (INVEST) in column 3. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. The OLS regression models are estimated with dual clustered robust standard errors (both firm and year). T-statistics are in parentheses under the coefficients. All variables are defined in Table 1.

regulator's expectations, but they may also have boards that are capable of providing effective monitoring to constrain managerial risk-taking behavior. Therefore, the observed constrained managerial risk-taking behavior reported in subsection 4.3 might not be related to having lead independent directors on boards. Consequently, we employ a propensity score matching (PSM) analysis, a dynamic panel data estimation method (i.e., generalized method of moments [GMM]), and an instrumental variable (IV) two-stage least squares (2SLS) estimation method to address these endogeneity concerns in this subsection.

As in previous literature (e.g., Rosenbaum & Rubin, 1983; Lennox et al., 2012; Bradley & Chen, 2015), we employ PSM to address the dissimilarities between firms with and without lead independent directors. Specifically, we split our sample firms into a treatment group (i.e., firms with a lead independent director) and the control group (i.e., firms without a lead independent director). Because the assumption of similarity between both groups is less likely to be satisfied, we follow Rosenbaum and Rubin (1983) and match the treatment group with the control group based on a propensity score. In the process, we re-estimate equation (1) using a logistic regression on the treatment and control groups, and report our pre-matched sample results in Panel A (column 1) of Table 7. As expected, the results largely show significant coefficients with a Pseudo R-squared of 0.374.

To remove dissimilarities from the treatment and control groups, and to ensure that the two groups are identical, we use the nearest neighbor method and match each firm in the treatment group with a firm in the control group. Whenever there are multiple matches, we hold the pair with the smallest difference in the propensity score, where in all cases the maximum difference of each firm should not be more than 0.1% in value. We then use three diagnostic tests to confirm that the observable characteristics in the treatment group are similar to those in the control groups, through the following process. First, we re-estimate the logistic regression for the post-matched sample. The results reported in Panel A (column 2) of Table 7 finds no significant coefficients in most cases, suggesting less noticeable differences between the treatment and the control groups. Second, the coefficients of the post-matched sample are mostly smaller than the pre-matched sample firms, with the Pseudo R-

Table 7
Propensity Score Matching estimation.

Panel A: Pre-match and post-match regressions

Variables	Pre-match (1)	Post-match (2)	Post-match OLS (3)
	LeadIndDir		MRT
Intercept	24.118***	23.975***	4.909***
	(3.03)	(2.61)	(25.07)
LeadIndDir	–	–	−0.091***
	-	-	(−2.97)
IndDir	0.041***	0.035**	0.002***
	(2.91)	(2.37)	(4.87)
IndAC	0.998*	0.859	−0.196***
	(1.86)	(1.06)	(−9.13)
BordSize	−0.179**	−0.123	0.018
	(−2.28)	(−1.08)	(1.11)
FEMCEO	1.182**	1.098	−0.030**
	(2.40)	(1.58)	(−2.05)
CEOAGE	−2.315**	−2.201	−0.127***
	(−2.52)	(−1.57)	(−2.71)
CEOCOMP	−0.055	−0.047	−0.033***
	(−0.22)	(−0.25)	(−4.48)
CEOTenure	0.120*	0.113	−0.025***
	(1.88)	(0.76)	(−5.34)
CEOWN	0.034	0.028	0.005***
	(1.00)	(0.85)	(5.77)
CEODUALITY	−0.329**	−0.182	0.004
	(−2.26)	(−0.14)	(0.12)
INSTOWN	0.393**	0.424	−0.037***
	(2.48)	(1.26)	(−3.49)
ROA	0.077***	0.062***	−0.009***
	(3.95)	(3.07)	(−11.63)
CASHOLD	−0.024**	−0.536	0.512***
	(−2.26)	(−0.89)	(7.27)
SIZE	0.140***	0.117	−0.086***
	(2.72)	(0.92)	(−18.65)
MTBV	−0.034**	−0.026	−0.008***
	(−2.22)	(−1.26)	(−8.07)
LEV	3.924***	3.232***	0.145***
	(2.84)	(2.98)	(3.55)
Z-score	0.085	0.068	−0.001
	(1.00)	(1.40)	(−0.38)
SALESG	−0.351)	−0.330	−0.083***
	(−0.73)	(−0.60)	(−3.42)
FIRMAGE	0.269***	0.261	−0.040***
	(2.64)	(1.53)	(−7.64)
CAPEX	0.107	−0.602	0.965***
	(0.12)	(−0.16)	(6.28)
R&D	−4.982**	−4.176	−0.433**
	(−2.16)	(−0.95)	(−2.33)
YEAR_FE	YES	YES	YES
IND_FE	YES	YES	YES
Pseudo R^2	0.374	0.189	0.535
Firm Years	2,620	712	712

Panel B: Test of differences in firms characteristics

Variables	Treatment	Control	Diff	t-stat
IndDir	60.121	60.046	0.075	0.57
IndAC	0.833	0.808	0.025	0.86
BordSize	8.12	8.41	−0.29	−0.35
FEMCEO	0.041	0.037	0.004	0.98
CEOAGE	3.926	3.949	−0.023	−1.26
CEOCOMP	14.184	14.237	−0.053	−0.84
CEOTenure	1.429	1.377	0.052	1.41
CEOWN	1.288	1.216	0.072	1.33
CEODUALITY	0.011	0.019	−0.008	−0.19
INSTOWN	0.567	0.563	0.004	0.24
ROA	0.038	0.104	−0.066	−1.55
CASHOLD	0.091	0.083	0.008	0.21
SIZE	7.747	7.619	0.128	1.62
MTBV	3.722	3.839	−0.117	−1.22
LEV	0.212	0.231	−0.019	−0.21
Z-score	3.315	3.213	0.102	1.11
SALESG	0.048	0.034	0.014	0.55
FIRMAGE	3.166	3.243	−0.077	−0.89
CAPEX	0.096	0.032	0.064	0.77
R&D	0.016	0.011	0.005	0.99

Notes: This table presents the results of the propensity score matching in Panels A and B. Columns 1 and 2 of Panel A report the logits of the control variables explaining *LeadIndDir* for the pre and post-matched sample, and column 3 of Panel A presents the matched sample regression results of *LeadIndDir* explaining managerial risk-taking. Panel B reports the differences in firm characteristics for the treatment and the control sub-samples. Z-statistics are in parentheses under the coefficients. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. All variables are defined in Table 1.

Table 8
Dynamic GMM Estimation.

Variables	MRT coefficients (t-statistics)
Intercept	13.889*** (6.12)
LeadIndDir	−0.380*** (−2.77)
IndDir	0.013** (2.34)
IndAC	−0.271*** (−2.70)
BordSize	0.020** (2.26)
FEMCEO	−1.561** (−2.40)
CEOAGE	−2.071** (−2.45)
CEOCOMP	−0.111** (−2.50)
CEOTenure	0.008 (0.22)
CEOWN	0.010*** (2.99)
CEODUALITY	0.428* (1.85)
INSTOWN	−0.013*** (−2.57)
ROA	−0.011*** (−2.76)
CASHOLD	0.157** (2.53)
SIZE	−0.242*** (−2.79)
MTBV	−0.014 (−0.86)
LEV	0.281** (2.56)
Z-score	0.007 (0.26)
SALESG	0.213 (1.16)
FIRMAGE	−0.158*** (−3.04)
CAPEX	0.718*** (2.62)
R&D	−3.818* (−1.84)
AR1	−3.04***
AR2	−1.37
Hansen J Statistics	0.24
No. of Instruments	59
YEAR_FE	YES
IND_FE	YES
Firm Years	2,620

Notes: This table presents the dynamic generalized moment of method results of the managerial risk-taking analyses. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. All variables are defined in Table 1.

squared dropping from 0.374 to 0.189 for the post-matched sample firms. Third, using the average treatment effect on the treated (ATT), the test of differences in mean values across the variables reported in Panel B of Table 7 also shows no statistically significant differences between the treatment and control groups. In general, these diagnostic tests suggest that the PSM process has removed all the observable differences in firm characteristics from the post-matched sample firms.

Panel A (column 3) of Table 7 contains the regression results of the PSM-matched sample firms. The results in column (3) show a negative and significant (at the 1% level) coefficient on *LeadIndDir*, suggesting that firms with lead independent directors are more likely to experience reduced managerial risk-taking behavior. These results provide strong support for our baseline regression results reported in Table 5 (Column 1). Moreover, these results are not sensitive to the observable differences across the two groups of firms.

Next, we follow the guidance from the previous literature (e.g., Wintoki et al., 2012; Abdallah et al., 2015) and employ the two-step system GMM estimation method to address the endogeneity concerns associated with omitted variables, simultaneity, and dynamic endogeneity. The two-step system GMM (Arellano & Bover, 1995; Blundell & Bond, 1998) is implemented by using equations in levels and the

Table 9
2SLS Regression Results.

Variables	MRT coefficients (Z-statistics)
Intercept	5.094*** (18.69)
IV_LeadIndDir	−0.193*** (-3.26)
IndDir	0.002* (1.81)
IndAC	−0.041** (-2.36)
BordSize	0.002** (2.35)
FEMCEO	−0.018** (-2.08)
CEOAGE	−0.109* (-1.92)
CEOCOMP	−0.045*** (-4.25)
CEOTenure	0.005 (0.88)
CEOWN	0.004*** (2.86)
CEODUALITY	0.098** (2.07)
INSTOWN	−0.002** (-2.10)
ROA	−0.011*** (-8.12)
CASHOLD	0.602*** (7.08)
SIZE	−0.064*** (-7.47)
MTBV	−0.002 (-1.23)
LEV	0.330*** (5.16)
Z-score	0.002 (0.47)
SALESG	0.006 (1.20)
FIRMAGE	−0.055*** (-7.17)
CAPEX	0.757*** (3.52)
R&D	−0.522** (-2.43)
YEAR_FE	YES
IND_FE	YES
Adj R^2	0.501
Firm years	2,620

Notes: This table presents the second stage results of the managerial risk-taking analyses. The key explanatory variable of interest is *IV_LeadIndDir* instrumented by 1-year lagged *LeadIndDir*. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. All variables are defined in Table 1.

equations in first differences. In the process, the first difference variables are used as instruments for the equations in levels, while the lagged levels of variables are used as instruments for the equations in the first difference. Using Roodman (2009) Stata module 'xtabond2' to implement the two-step system GMM, its stability depends on two conditions. First, to satisfy the condition of serial independence of the residuals, the first difference residuals should be serially correlated (*AR1*), while the second difference residuals should not be serially correlated (*AR2*). Second, to satisfy the condition of the validity of the instruments, the Hansen J statistic of over-identifying restrictions, which tests the null hypothesis of the validity of the instruments, should not be significant. To add to the consistency of the Hansen J statistic, the number of firms in the panel should be greater than the number of instruments used in the model.

Our diagnostic tests reported in Table 8 show that *AR1* is significant at 1% level, while *AR2* is not significant. In addition, the Hansen J statistic is not significant with the number of instruments (i.e., 59) being lower than the number of firms (i.e., 262). These suggest that our model is well fitted. In Table 8, we report our results from the two-step system GMM estimation which provides strong support for our baseline regression results reported under Table 5 (column 1). Specifically, *LeadIndDir* is negatively associated with managerial risk-taking (*MRT*). Therefore, after controlling for the omitted variable, simultaneity, and dynamic endogeneity, the two-step system GMM estimation provides robust support for our main conclusion reported under subsection 4.3.

Finally, we follow previous lead independent director studies (Lamoreaux et al., 2019; Rajkovic, 2020) and use the instrumental variables (IV) 2SLS estimation method to further address the issue of causation. Given that 2SLS estimation depends on instrumental variables, and consistent with the recommendations by previous literature that a 1-year lagged board variables are powerful instruments to predict the current year's board variables (Caramanis & Lennox, 2008; Lorca et al., 2011), we instrument for our main test variable, *LeadIndDir*, using a 1-year lagged lead independent variable ($LeadIndDir_{t-1}$) alongside the control variables in equation (1). Using the 'ivregress' command in Stata, the results from the second stage of the 2SLS regression are

Table 10
Managerial risk-taking, lead independent director and the cost of debt.

Variables	Panel A: COD		Panel B: WACOD	
	OLS	Lagged OLS	OLS	(4) Lagged OLS
Intercept	0.149**	0.112**	0.277***	0.339***
	(2.56)	(2.03)	(3.34)	(3.62)
MRT	0.086***	0.047**	0.250**	0.277***
	(3.35)	(2.49)	(2.43)	(3.30)
LeadIndDir	−0.049***	−0.111**	−0.411***	−0.111**
	(-2.62)	(-2.46)	(-2.70)	(-2.42)
MRT × *LeadIndDir*	−0.020***	−0.023***	−0.031***	−0.055***
	(-2.73)	(-3.01)	(-3.14)	(-3.37)
IndDir	−0.001*	−0.001*	−0.006**	−0.006**
	(-1.84)	(-1.69)	(-2.43)	(-2.34)
IndAC	−0.039**	−0.031*	−0.119***	−0.087**
	(-2.00)	(-1.71)	(-2.69)	(-2.11)
BordSize	−0.001**	−0.001**	0.044**	0.049**
	(-2.51)	(-1.99)	(2.35)	(2.28)
CEOWN	−0.002**	−0.002***	−0.006	−0.004
	(-2.41)	(-2.88)	(-0.80)	(-0.55)
INSTOWN	−0.014***	−0.015***	0.117**	0.131**
	(-2.59)	(-2.63)	(1.96)	(2.17)
ROA	−0.010	−0.007	0.016***	0.016***
	(-0.19)	(-0.14)	(3.59)	(3.50)
CASHOLD	0.219***	0.163**	−1.103***	−0.711***
	(2.72)	(2.06)	(-2.89)	(-1.77)
SIZE	−0.001	−0.001	0.043	0.044
	(-0.21)	(-0.31)	(1.35)	(1.32)
MTBV	−0.009	−0.008	0.005	0.003
	(-0.99)	(-1.04)	(1.16)	(0.66)
LEV	−0.155***	−0.133***	2.220***	2.146***
	(-3.48)	(-3.11)	(9.20)	(8.59)
Z-score	0.008	0.007	−0.115***	−0.111***
	(1.08)	(0.98)	(-8.70)	(-8.48)
FIRMAGE	0.002	0.001	0.057*	0.055*
	(0.54)	(0.23)	(1.98)	(1.84)
YEAR_FE	YES	YES	YES	YES
IND_FE	YES	YES	YES	YES
Adj R^2	0.077	0.075	0.345	0.305
Firm years	2,620	2,358	2,620	2,358

Notes: This table presents the regression results of the cost of debt analyses. The dependent variables are COD in Panel A and WACOD in Panel B. WACOD is a weighted average cost of debt calculated by Bloomberg based on a debt adjustment factor that captures the average yield spread between corporate bonds for a particular credit class and governance bonds. Columns 1 and 2 report the contemporaneous levels and 1-year lagged regression results based on COD. Columns 3 and 4 present the contemporaneous levels and 1-year lagged regression results based on WACOD. *, **, and *** denote significant at the 0.10, 0.05, and 0.01 levels, respectively. The OLS regression models are estimated with dual clustered robust standard errors (both firm and year). T-statistics are in parentheses under the coefficients. All variables are defined in Table 1.

reported under Table 9. Our results show that the coefficient on *IV_LeadIndDir* is negative and statistically significant at 1% level, providing robust support to our baseline regression results reported under Table 5 (column 1).

4.6. Managerial risk-taking, lead independent director and the cost of debt

In this subsection, we report our investigation of the implications of reduced managerial risk-taking in the presence of a lead independent director for the cost of debt. As discussed in subsection 3.2, we interact managerial risk-taking with a lead independent director and investigate their joint effect on the cost of debt. We estimate equation (2) and our baseline regression results from the OLS and the 1-year lagged OLS are contained in Table 10 (columns 1 and 2). The results in columns (1) and (2) show that the coefficient on the interaction term (*MRT* × *LeadIndDir*) is negatively and significantly related to the accounting-based measure of the cost of debt (*COD*). The coefficient estimates of the control variables are largely consistent with the previous cost of debt literature (e.g., Lorca et al., 2011). Specifically, the coefficients are significant and negative for board size and CEO ownership, but not significant for return on assets, firm size, and market-to-book value. The coefficient estimate of a significant negative for leverage is also consistent with Bradley and Chen's (2015) cost of debt study.

As a robustness check, we follow a recent study by Owusu et al. (2022) and download the weighted average cost of debt (*WACOD*) directly from the Bloomberg terminal to proxy the market-based measure of the cost of debt. *WACOD*, according to the Bloomberg calculation, is based on a debt adjustment factor that captures the average yield spread between corporate bonds for a particular credit class and governance bonds. We then replace *COD* with *WACOD* as the dependent variable and re-estimate equation (2). Our results reported in columns (3) and (4) of Table 10 are largely consistent with the results in columns (1) and (2) of the same Table[11].

Overall, our results in this subsection show that decreased managerial risk-taking leads to a reduction in the cost of debt for firms with lead independent directors on the board. These results suggest that the debt market values the observed negative relationship between a lead independent director and managerial risk-taking, which translates into a lower cost of debt. Our results are also consistent with the argument that an independent monitoring by a lead independent director has the propensity to constrain managerial risk-taking, and debtholders consider this to be an effective governance mechanism and, therefore, take this into account when assessing their risk premium. This implies that a lead independent director plays an important role in mitigating the adverse effect of managerial risk-taking on the cost of debt and, therefore, hypothesis 2 is supported.

5. Conclusion, implications, and limitations

In this paper, we investigate the effect of lead independent directors on the board of directors on managerial risk-taking, and whether managerial risk-taking interacts with a lead independent director to jointly influence the cost of debt. Previous literature has investigated the importance of lead independent director representation on the board for corporate outcomes, such as forced CEO turnover (Chen & Ma, 2017), firm performance (e.g., Krause et al., 2017; Lamoreaux et al., 2019), and investment efficiency (Rajkovic, 2020), in the US, where a dual CEO-chair is permitted. However, it is still not clear whether the effectiveness of a lead independent director will manifest in other jurisdictions, especially in the UK where a dual CEO-chair is discouraged by regulators. This is important because the adoption of a lead independent director in the US is suggested to be a compromise solution to avoid a dual CEO-chair separation (Krause et al., 2017). Therefore, it also important to analyze its effectiveness in a setting where a dual CEO-chair is discouraged by regulators or virtually non-existent empirically.

We contribute to the literature by showing that the presence of a lead independent director on the board is significantly and negatively related to managerial risk-taking. In addition, we show that a lead independent director exerts more significant constraints on managerial risk-taking for firms with a non-independent board chair than for firms with an independent board chair. We also document that decreased managerial risk-taking leads to a reduction in the cost of debt for firms with lead independent directors. These results are robust to alternative measures of managerial risk-taking (i.e., market-based and strategic expenditure risk-taking measures), alternative cost of debt (i.e., accounting type and market-based measure), alternative econometric specifications, and endogeneity analysis.

The policy implication of our results is that boards should be encouraged to appoint a lead independent director through which firms can benefit from reduced managerial risk-taking, along with a corresponding reduction in the cost of debt. Given that the UK Corporate Governance Code encourages the appointment of a lead independent director on the board on a comply or explain basis, our results are important and timely because we show that a lead independent director is an effective governance mechanism in a setting where a dual CEO-chair is discouraged by regulators. Therefore, firms, regulators, and investors should take note that a lead independent director is an effective governance mechanism to constraint managerial risk-taking, especially when the board chair is not independent.

One important limitation of our paper is that we focus on FTSE All Share Index firms listed on the London Stock Exchange over the period 2009–2018. Therefore, the generalization of our findings to other firms outside the UK is limited. Future research could investigate whether the results will hold for firms in other countries where there are significant differences in their corporate governance environment. In addition, our study is limited to the debt market valuation of the relationship between a lead independent director and managerial risk-taking. The joint effect of a lead independent director and managerial risk-taking on the cost of equity has not yet been analyzed. Future research could consider investigating how the equity market values the relationship between a lead independent director and managerial risk-taking. Finally, investigating the importance of lead independent directors on the board regarding financial reporting quality would be an interesting area for future research.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We appreciate the valuable comments and suggestions received from Robert Larson (Editor-in-Chief) and two anonymous referees on the earlier version of this paper.

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[11] In addition, we interact each of the strategic expenditure risk-taking measures of *R&D, CAPEX*, and *INVEST* with a lead independent director to check their joint effect on our cost of debt measures. Our results (untabulated) are qualitatively similar to those reported in columns 1 to 4 of Table 10.

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