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Enterprise risk management and firm performance: Role of the risk committee

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ABSTRACT

In recent years, there have been increasing efforts in the corporate world to invest in risk management and governance processes. In this paper, we examine the impact of Enterprise Risk Management (ERM) on firm performance by examining whether firm performance is strengthened or weakened by the establishment of a board-level risk committee (BLRC), an important governance mechanism that oversees ERM processes. Based on 260 observations from FTSE350 listed firms in the UK during 2012–2015, we find the effectiveness of ERM significantly and positively affects firm performance. We also find strong BLRC governance complements this relationship and increases the firm performance effects of ERM. Our findings suggest the mere formation of a BLRC is not a panacea for ERM oversight; however, existence of a structurally strong BLRC is crucial for effective ERM governance.

1. Introduction

Recent events, including the corporate downfalls of the early 2000s and the Global Financial Crisis (GFC)[1] of 2007–09, have led to increased international regulatory efforts to enhance risk management (RM) practices. In the UK, the Walker Report (2009) and guidelines from the Financial Reporting Council (FRC, 2011, 2014a,b) suggest listed firms should adhere to sophisticated RM practices, including the creation of a holistic RM framework and greater involvement from boards of directors in risk governance. An increasing number of UK listed firms now adhere to these recommendations, which focus on the establishment of an Enterprise Risk Management (ERM)[2] process and the establishment of a board-level risk committee (BLRC)[3] to enhance the board's risk oversight function. This paper contributes to the literature on ERM by examining the impact of ERM on UK firm

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[1] Inefficient RM practices are considered to have led to the subprime meltdown and global recession. In reaction to losses and to stem contagion effects, regulators recommended firms improve RM practices (Brown et al., 2009). In the UK, GFC effects resulted in economic recession, corporate bankruptcies, and lower returns due to extreme volatility in markets (Fraser and Simkins, 2010).

[2] COSO (2004) defines ERM as a process that recognizes potential firm risk events, management of firm risks within risk appetite and tolerance levels, and provides assurance on the achievement of organisational objectives.

[3] By forming a standalone risk committee or creating a combined audit and risk committee, see Subramaniam et al. (2009) and Hines et al. (2015).

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performance, particularly whether this relationship is strengthened or weakened by the adoption of a BLRC. To date, research investigating the roles and outcomes of a BLRC is scarce. This study focuses on evidence from UK listed firms to provide key insights into this emerging issue.

Our study, motivated by key corporate governance guidelines, considers the impact of ERM process adoption (including the structural strength of BLRC) on firm performance in UK FTSE350 firms. We apply Tobin's Q as our firm performance measure based on prior research (Baxter et al., 2013; Farrell and Gallagher, 2015; Hoyt and Liebenberg, 2011; Lin et al., 2012; McShane et al., 2011) and adopt the Gordon et al. (2009) ERM index as a composite measure of the effectiveness of ERM processes. Previous studies measure the presence of ERM activity using a binary variable (Hoyt and Liebenberg, 2011; Lechner and Gatzert, 2018; Lin et al., 2012; Pagach and Warr, 2010). In contrast, the Gordon et al. (2009) index reflects the presence of an ERM function in a firm and measures the effectiveness of ERM processes regarding business strategy, operations, reporting, and compliance (COSO, 2004). BLRC structural strength is measured using six dimensions related to its structure and composition, drawing on risk governance guidelines and prior research on the effectiveness/efficacy of board-level committees with a similar monitoring role to the BLRC (Goodwin and Seow, 2002; Xie et al., 2003; Zaman et al., 2011).

Our empirical findings suggest ERM is positively associated with UK firm performance. The results suggest ERM is an efficient form of "internal" RM and if overseen by the BLRC should maximize shareholders' wealth. The findings suggest a structurally strong BLRC (a committee with high levels of monitoring and diligence comprised of financial experts exhibiting gender diversity) strengthens ERM impact on firm performance. This implies BLRC adoption by itself is insufficient to achieve ERM oversight. However, BLRC structural strength is identified as necessary for effective ERM governance. As BLRC formation is an emerging ERM practice (Brown et al., 2009; Hines et al., 2015), our study addresses a gap in current RM literature by examining whether a BLRC strengthens or weakens the impact of ERM on firm performance providing an important contribution to the field.

This paper proceeds as follows. Section 2 presents the study background and Section 3 develops hypotheses. Section 4 discusses research methods, variables, and analysis techniques. Section 5 presents and discusses empirical findings, and Section 6 concludes with a summary of findings, implications, and limitations.

2. Background

In the UK, the Walker (2009) report and FRC guidelines (FRC, 2011, 2014a,b) recommend UK listed firms should adopt a holistic approach to ERM. The guidelines suggest UK listed firms adopt a multifaceted approach to risk identification and risk assessment, and consider all the principal risks faced by the entity. An effective RM infrastructure adopted and governed by a high-level risk governance structure (a BLRC) promotes a strong risk culture at all levels of the firm, approves enterprise risk strategy and risk appetite, and monitors organisational risk mitigation plans. Taken together, the FRC (2014b) suggests listed firms should adopt a robust and effective RM system to safeguard against major risks that could seriously affect organisational performance, future prospects, or damage firm reputation. As a result of the clear guidance provided for risk committees in the UK, our study focuses on revealing whether BLRCs in listed firms are found to be structurally sufficient to support the ERM oversight functions outlined in the Walker (2009) report. We are motivated to gather evidence of the relationship between ERM and firm performance using UK data for the following reasons. After the GFC, demand for firm-level risk oversight increased in the UK and internationally. The Walker (2009) report contributed to this demand by encouraging the formation of a BLRC and driving the adoption of an ERM function in listed UK firms.

In the US, the Dodd-Frank Act (2010) also mandated similar requirements for US listed firms but did not provide the same level of detailed prescription regarding the role, responsibilities, and processes of a BLRC compared to UK regulations. Prior research has examined this relationship in US settings using various proxies for ERM. ERM research has not reached a consensus to date, with results indicating ERM is both value relevant (Gordon et al., 2009; Grace et al., 2015; McShane et al., 2011) and not value relevant (Beasley et al., 2008; Lin et al., 2012; Pagach and Warr, 2010). In Europe, two recent studies (Florio and Leoni, 2017; Lechner and Gatzert, 2018) find ERM is positively associated with firm performance. Due to this lack of consensus in the literature, we are motivated to examine the impact of ERM on firm performance using UK data to consider whether ERM is value relevant and whether it is associated with improved firm performance, especially when related to the adoption of a BLRC as an ERM governance mechanism.

In a US based study, Gordon et al. (2009) propose the impact of ERM-driven firm performance is dependent upon the proper match between monitoring by the board[4] and ERM processes. They posit how participation and encouragement from the board is essential for effective ERM adoption, a perspective shared by Kleffner et al. (2003) and Sobel and Reding (2004). Our study contributes by extending the findings of Gordon et al. (2009) across two dimensions. First, we recognise responsibility for ERM oversight is usually delegated to the BLRC, a sub-committee of the full board. Second, we examine how risk committee structural characteristics influence ERM effectiveness and consequently firm performance.

Prior literature suggests a newly emerging BLRC generally assists the board in carrying out its ERM responsibilities, such as risk oversight, fostering risk culture, and improving the quality of risk monitoring and reporting (Aebi et al., 2012; Brown et al., 2009; COSO, 2004). RM literature in the UK provides evidence of risk reporting patterns in listed firms (Linsley and

[4] This is among other factors including environmental uncertainty, industry competition, firm size, and firm complexity as contingency variables considered by Gordon et al. (2009).

Shrives, 2005, 2006). However, the links between corporate governance and risk reporting (Abraham and Cox, 2007), and the effects of traditional RM[5] on firm value (Panaretou, 2014), demonstrate there is a paucity of UK empirical evidence investigating the impact of ERM practices and the influence of a BLRC oversight on firm performance.

Our paper contributes to international RM literature in the following ways. First, UK RM research focused on the incentives of risk reporting (Elshandidy et al., 2018).[6] Our paper extends prior research by focusing on the informativeness[7] of UK ERM practices (Baxter et al., 2013; Gordon et al., 2009; Florio and Leoni, 2017; Hoyt and Liebenberg, 2011; Lechner and Gatzert, 2018; Pagach and Warr, 2010). RM has received considerable attention from both professional and regulatory UK bodies, including improved RM guidelines from the FRC (FRC, 2011, 2014b). Panaretou (2014) examines the valuation impacts of derivative usage (a practice in financial RM) in UK firms and finds hedging practices are weakly or non-significantly associated with firm performance. We extend the study of Panaretou (2014) by examining the valuation impacts of the effectiveness of ERM processes. Our study contributes to the literature examining the risk-related corporate governance mechanisms that affect firm performance (Aebi et al., 2012; Ames et al., 2018; Brown et al., 2009; Florio and Leoni, 2017; Tao and Hutchinson, 2013). Previous studies suggest the presence of a BLRC represents strong RM (Aebi et al., 2012), indicating greater levels of ERM implementation and integration of RM in corporate governance mechanisms (Florio and Leoni, 2017). We extend these studies by investigating the impact of six key structural characteristics of a BLRC on firm performance effects of ERM.

3. Hypotheses development

3.1. Impact of ERM on firm performance

ERM consists of methods and processes through which organisations manage risks and capture opportunities consistent with their strategic objectives. ERM assists boards to assess whether management is actively identifying and evaluating risks across the organisation. Brown et al. (2009) consider effective ERM processes result in fewer earnings surprises by assisting management to exploit opportunities, enhance information processing and communication, increasing firm reputation, accountability, assurance and governance, and contributing to improved firm planning and performance. ERM encourages disclosure of risk related issues at the board-level, which in turn should improve transparency and lead to better management of the business (Brown et al., 2009). It aims to deliver organisational benefits by reducing volatility of earnings and equity prices, increasing investment efficiency, and creating synergy in the overall RM process (Pagach and Warr, 2010). Liebenberg and Hoyt (2003) argue strong ERM processes improve board-level decision-making, which improves strategy, effective operations, decreased costs, and positive cash flows. Additionally, Nocco and Stulz (2006) discuss the macro and micro level benefits of ERM. At the macro level, ERM aims to create value by focusing on the quantification and management of organisational risk-return trade-offs, which facilitates market accessibility and other resources for corporate strategy. At a micro level, ERM ensures decision-making is not centralised amongst top managers, but occurs at all organisational levels, ensuring every business unit evaluates risk as part of its decision-making processes. Belmont (2004) and Lam (2014) discuss how a successful ERM program should increase firm performance through improved governance and efficient chain of command.

A number of empirical studies support the theoretical claims in relation to ERM. Most of the empirical research concerning ERM and firm performance is US based. Gordon et al. (2009) find the appropriate match between ERM and contingency variables (environmental uncertainty, industry competition, firm complexity, firm size, and board monitoring) improves firm performance. Hoyt and Liebenberg (2011) report successful ERM implementation increases shareholders' wealth by at least 20 percent. Baxter et al. (2013) find US firms with higher ERM quality exhibit a stronger financial position and higher market value, and ERM processes are strongly associated with improved firm performance after the GFC. Farrell and Gallagher (2015) find ERM maturity levels are positively associated with firm value, with a maximum magnitude of 25 percent. Upon decomposition of ERM maturity, they report top-down executive engagement and organisational ERM culture are important elements from a value generation perspective. Grace et al. (2015) find ERM increases cost and revenue efficiency, and report ERM initiatives increase efficiency where there is a link between the economic capital model and dedicated RM reporting to the board or CEO. However, the empirical research on the ERM and firm performance relationship is very limited in Europe, with adoption of ERM increasing firm value in Germany (Lechner and Gatzert, 2018) and Italy (Florio and Leoni, 2017). Our study extends this literature and provides evidence in the UK setting. Therefore, consistent with the extensive literature on the usefulness of ERM and its links to firm performance, we test the following hypothesis:

H1: *ERM is positively associated with firm performance*

3.2. Role of a BLRC in the ERM and firm performance relationship

According to the FRC (2014b), the board has ultimate responsibility for overall organisational RM. However, to support and exercise its risk oversight role, the board usually delegates this function to a board-level committee and continues its

[5] Traditional RM focuses on managing financial risks through hedging and insurance. This is different from ERM and ignores the holistic view of RM.

[6] See Solomon (1999), Solomon et al. (2000), Linsley and Shrives (2005, 2006), Abraham and Cox (2007), Hill and Short (2009), and Elshandidy et al. (2013).

[7] Elshandidy et al. (2018) define informativeness as the impact of RM practices on market indicators.

monitoring role by establishing the right "tone at the top" to ensure the overall RM function is matched with business strategy and operating decisions. The main purpose of the board-level committee is to oversee the functions of RM, review the process of ERM, and receive regular reports from management. This committee communicates with the full board concerning the firm risk profile and provides recommendations on any strategic risk-informed decisions (FRC, 2014b; Walker, 2009). Traditionally, this risk oversight function is delegated to the audit committee (AC); however, recent corporate collapses (due to inefficient RM practices) cast doubt on the effectiveness of the AC RM oversight (Bates and Leclerc, 2009; Brown et al., 2009). Thus, the adoption by UK firms of a BLRC specifically for RM and oversight purposes has garnered significant post-GFC attention and appears to be due to the Walker (2009) recommendations.

In ERM, the main BLRC functions are to assist the board on risk oversight, foster RM, and improve the quality of risk reporting and monitoring (Baxter et al., 2013; COSO, 2009). KPMG (2001) describes the BLRC as a committee that updates the board on the state of organisational ERM processes, makes recommendations on entity risk appetite, risk tolerance and risk strategy, acknowledges risk oversight ownership, and reviews organisational risk reports. Recent literature identifies the "risk committee" as an integral component of ERM. The risk committee provides the risk department with a "holistic view", helps to foster a risk monitoring and reporting culture, and provides a critical resource to meet board-level ERM responsibilities (Aebi et al., 2012; Brown et al., 2009; Deloitte, 2015; Protiviti, 2011). The BLRC bridges ERM operational gaps by establishing direct connections with employees at different levels to gain deeper understanding of organisational opportunities and threats (RIMS, 2015; Subramaniam et al., 2009). The BLRC assures the organisation is adhering to effective and efficient RM practices (Bugalla et al., 2012). It is directly responsible for communicating recommendations to the board on ERM processes that consider financial risks and oversight of policies and procedures (COSO, 2004). Choi (2013) considers the BLRC is responsible for developing annual ERM strategy and adding value by elevating the RM oversight function to the highest organisational level by promoting a strong risk awareness culture, monitoring excessive risk-taking behaviour, and improving risk communication across different levels. We provide illustrative examples of ERM reporting responsibility undertaken by BLRCs in FTSE350 firm annual reports in Appendix A.

We predict a structurally strong BLRC should increase the effectiveness of ERM processes. Fig. 1 illustrates the proposed relationship, demonstrating how a BLRC should increase the impact of ERM processes on firm performance. The empirical literature provides evidence that supports this view. Ng et al. (2013) find BLRC size and independence are negatively associated with underwriting risk. Tao and Hutchinson (2013) identify BLRC structure is positively associated with market risk, which in turn affects firm performance. They discuss how the overlap between the BLRC and compensation committees reduces information asymmetry. Al-Hadi et al. (2016) find BLRC presence and attributes are positively associated with risk information generation, which delivers higher market risk disclosures. Recently, Ames et al. (2018) discuss BLRC presence and its association with higher financial strength ratings and long-term financial performance. While empirical research linked to the effectiveness (strength) of the BLRC is scant, our expectation regarding the positive impact of BLRC structural strength and composition on the ERM and firm performance relationship follows prior studies on the impact of the quality of corporate governance processes. Osma and Guillamón-Saorín (2011) develop an index to measure strong and weak governance. They find boards of strong governance firms have effective monitoring and limit the manipulation of narrative disclosures and impression management. Zaman et al. (2011) apply an index to measure AC effectiveness and find effective ACs undertake higher monitoring and achieve higher audit quality. Considering the prior literature, we expect a strong (effective) BLRC should positively influence the overall effectiveness of the ERM function, which in turn should increase the firm performance implications of ERM. We test the following hypothesis:

H2: *The effectiveness of ERM on firm performance increases in the presence of a strong BLRC.*

4. Methods

4.1. Sample selection and data collection

FTSE350 firms listed on the London Stock Exchange (LSE) during the period 2012 to 2015 are selected as the target population for this study. This period is chosen as it is after the issuance of the FRC (2011) guideline in September 2011 which discusses the role of board and board-level committees in RM processes. Sample selection occurs in two stages. First, a list of firms who had implemented ERM processes during the study period is identified using keyword searching for ERM processes (including ERM, chief risk officer, enterprise-wide RM, risk committee, and corporate, integrated, strategic, and holistic risk management)[8] in annual reports. This approach is consistent with prior research (Beasley et al., 2008; Gordon et al., 2009; Hoyt and Liebenberg, 2011; Pagach and Warr, 2010). Sentences (containing keywords) are considered in detail to develop a better understanding of whether firms are actually following a COSO (2004) ERM approach. Appendix B provides illustrative examples of our successful ERM search hits. A total of 410 firm-years with ERM activity are identified during the study period (Table 1). In the second stage of sample selection, this is reduced to 275 firm-years including both ERM utilisation and BLRCs. After elimination of missing firm observations, the final sample consists of 260 firm-years. Observations are categorised as missing due to

[8] In the case of a Chief Risk Officer (CRO) or risk committee (including non-board-level), Beasley et al. (2005) argue their presence could indicate the presence of organisational ERM. Organisations need an individual or a group to be responsible for the ERM oversight to ensure relevant information is communicated to the board. Liebenberg and Hoyt (2003) discuss the CRO or a risk committee as complementary to a greater level of ERM implementation.

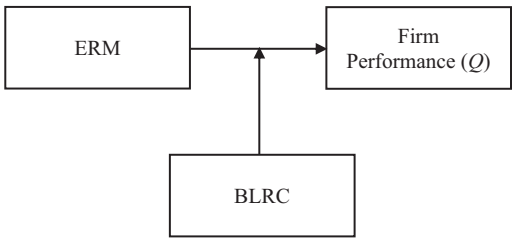


Fig. 1. Visual depiction of how the BLRC influences the impact of ERM on firm performance.

Table 1
Sample selection.

Description	2012	2013	2014	2015	*N*
Firms using ERM processes	73	94	102	141	410
Less firms without a BLRC	(24)	(33)	(35)	(43)	(135)
ERM based firms with a BLRC	49	61	67	98	275
Less Missing Information					(15)
Firm-year observations (4-years)					260

unavailability of data on BLRC characteristics and other variables. Our primary source of data is corporate annual reports; however, we also use the Datastream database for firm market data.

4.2. Selection, discussion, and measurement of the variables

4.2.1. Measure of firm performance (Q)

Based on ERM value relevance arguments, prior researchers have employed different measures to test the performance and valuation implications of ERM. Beasley et al. (2008) find no immediate significant market response to the announcement of hiring ERM senior managers. While the advantages of ERM implementation are not likely to be evident in the short-term (Hoyt and Liebenberg, 2011), a number of subsequent studies investigating the ERM valuation impacts employ Tobin's Q as a firm performance measure. This choice occurs because it reveals the future expectations of investors and reflects long-term firm performance (Baxter et al., 2013; Farrell and Gallagher, 2015; Hoyt and Liebenberg, 2011; Lin et al., 2012; McShane et al., 2011). Due to the support for this measure in the literature, we adopt Tobin's Q as our firm performance measure based on the following grounds. This measure has been extensively employed in ERM research because it provides a future-oriented view of firm performance and is not sensitive to managerial manipulation and does not require any risk adjustments or standardisation (Hoyt and Liebenberg, 2011; Lindenberg and Ross, 1981). Tobin's Q ratio is most suitable for this study as it focuses on capturing future expectations of shareholders and long-term performance rather than emphasizing historical performance. This is consistent with the notion of ERM adoption where the benefits become apparent in the long-term. Following relevant literature, we measure Tobin's Q ratio as the market value of equity plus book value of debt divided by book value of assets.

4.2.2. ERM index (ERM)

To proxy for ERM, some researchers have relied upon keyword searching, such as "enterprise risk management", "chief risk officer", and "risk committee" to test pre and post effects of ERM adoption (Beasley et al., 2008; Pagach and Warr, 2010) or to quantify the presence of ERM processes in the form of a dummy variable (Hoyt and Liebenberg, 2011; Lechner and Gatzert, 2018; Lin et al., 2012). Other researchers have used more sophisticated measures of ERM adoption, such as S&P ERM Ratings (Baxter et al., 2013; McShane et al., 2011) or RIMS ERM Maturity Levels (Farrell and Gallagher, 2015). However, as ERM ratings for FTSE350 firms are not available, we measure the effectiveness of ERM processes by adopting the Gordon et al. (2009) ERM index as it provides a complex measure of the level of ERM adoption. The index consists of two independent measures of each of the four COSO ERM[9] objectives (COSO, 2004) and aggregates the eight individual constructs into one combined measure that quantitatively and objectively reflects the effectiveness of a firm's ERM program. There are advantages to applying this index in our study. First, the raw data needed to calculate the index consist of financial variables, which makes the index replicable in any study setting. Second, the RM models of the sample firms in our study are focused on COSO's (2004) ERM components. Finally, the COSO (2004) ERM framework itself provides the basis against which different ERM programs can

[9] These four objectives are: goal oriented strategy; effective and efficient operations; reliable reporting; and compliance with applicable laws and regulations.

be evaluated (Bowling and Rieger, 2005). The internal structure and components of the Gordon et al. (2009) ERM Index are as follow.

$$ERM = \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operations_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$$

According to COSO (2004), the first objective of an ERM program is to improve the firm's strategy. Gordon et al. (2009) define strategy as the ability of a firm to position itself in the market relative to its competitors. $Strategy_1 = (Sales_i - \mu_{Sales})/\sigma_{Sales}$, where $Sales_i$ is total sales of a firm in each year, μ_{Sales} is average industry sales each year, and σ_{Sales} is the standard deviation of the sales of all firms in an industry. It measures how a firm competes within an industry in terms of maximizing its sales opportunities. $Strategy_2 = (\Delta\beta_i - \mu_{\Delta\beta})/\sigma_{\Delta\beta}$, where $\Delta\beta_i$ is the change in the beta of a firm, $\mu_{\Delta\beta}$ is the average change in industry beta, and $\sigma_{\Delta\beta}$ is the standard deviation of the change in beta of all firms in the industry. It reflects the ability of a firm within the industry to lower its systematic risk. We use FTSE sectorial distribution to calculate industry averages.

The second objective of COSO (2004) is to improve a firm's operations and increase its performance through proficient allocation of capital resources. Gordon et al. (2009) consider operations as the firm operating efficiency in terms of the input–output relationships. $Operations_1$ is the ratio of total sales or revenue to total assets, and measures the efficiency of a firm's assets in terms of generating sales. $Operations_2$ is the ratio of total sales or revenue to total number of employees, representing an input–output relationship in terms of sales generated per employee.

The third objective of COSO (2004) is the reliability of a firm's reporting framework. This is considered as one of most important factors affecting a firm's overall risk. Gordon et al. (2009) measure reporting reliability as: $Reporting_1 = (MaterialWeakness) + (AuditorOpinion) + (Restatement)$, where each of the factors is rated as −1 or 0 in terms of its presence or absence. $Reporting_2$ represents the ratio of normal accruals to total accruals, where abnormal accruals are estimated using the Jones (1991) accruals estimation model.

Finally, COSO (2004) promotes firm's compliance with applicable laws and regulations. Gordon et al. (2009) measure compliance as: $Compliance_1$ is the ratio of auditor fees to total assets. $Compliance_2$ is the ratio of settlements gains or losses to total assets. We combine cross-sectional standardized scores of each construct and then add them into one index that reflects the effectiveness of firm's ERM processes in achieving the COSO (2004) ERM objectives.

4.2.3. Measure of the BLRC (RCPCA)

The notion of firm-level corporate governance is a latent and abstract phenomenon rather than a concrete measure (Black et al., 2017). However, researchers have applied a number of observable measures to proxy for firm-level risk governance,[10] but these measures have been constrained by the level of subjectivity and availability of data (Zaman et al., 2011). Therefore, the strength of the BLRC is not a construct that is readily available for empirical testing and requires the development of a suitable measure based on prior research and governance guidelines.

We measure the strength of the BLRC using six dimensions related to BLRC structure and composition, specifically the committee's size, independence, number of meetings, financial expertise, gender diversity, and multi-committee directorships. These dimensions are the focus of risk governance guidelines in the UK (FRC, 2012; FRC, 2014a; Walker, 2009), and important elements for a successful risk oversight function (Deloitte, 2014; FRC, 2011). In particular, Protiviti (2011) argues that without proper structure and composition, a BLRC will lack effectiveness.

Literature investigating the effectiveness (strength) of board-level committee has identified structural characteristics improve monitoring efficacy. Goodwin and Seow (2002) argue that the effectiveness (strength) of an AC is determined by its size, diligence, independence, and accounting and financial expertise. Their findings indicate that ACs with strong structure and composition improve external audit effectiveness, reduce financial statement errors, and increase detection of management fraud. In a similar vein, Zaman et al. (2011) develop a measure of AC effectiveness based on structural characteristics, including the committee size, independence, financial expertise, and diligence. They find that effective ACs undertake increased monitoring that increases external audit scope. Other researchers applied similar measurement approaches to proxy for the strength or effectiveness of the AC (Lary and Taylor, 2012; Pucheta-Martínez and De Fuentes, 2007; Rainsbury et al., 2009; Song and Windram, 2004) and the remuneration and compensation committee (Kanapathippillai et al., 2016; Sun et al., 2009; Tao and Hutchinson, 2013).

Using the methodology identified in corporate governance literature (Bertrand and Mullainathan, 2001; Ellul and Yerramilli, 2013; Gompers et al., 2003; Larcker et al., 2007; Magee et al., 2019; Osma and Guillamón-Saorín, 2011; Tao and Hutchinson, 2013), we determine a common factorial measure based on BLRC characteristics by using the Principal Component Analysis (PCA) technique.

PCA has been utilised in corporate governance research to extract common factors and develop indices using small and large numbers of governance variables (Black et al., 2017; Diacon and O'Sullivan, 1995; Ellul and Yerramilli, 2013; Magee

[10] Magee et al. (2019) measure the level of risk governance as: presence or absence of a CRO; risk committee size; risk committee independence; presence or absence of a risk committee financial expert; and presence or absence of a board financial expert. They use principal component analysis technique to extract a common factorial measure as the risk governance index.

et al., 2019). PCA extracts common factors by decomposing eigenvalues of the correlations. It reduces data dimensionality and creates linearly uncorrelated components that extract the most variance in a set of variables. To construct our BLRC common component, we use varimax matrix rotation in PCA. The varimax rotation is based on orthogonal rotation that maximizes the sum of variances of the squared loadings of the factor matrix (Hair et al., 2014). This method also reduces the potential threat of multicollinearity.[11] Thus, our common factor captures the joint impact of the multiple dimensions of the BLRC related to its structure and composition.

We apply this common factor to divide our sample firms into strong and weak BLRCs groupings. A strong BLRC is allocated a value of "1" if its common factor score is greater than the median value. If the common factor score is less than the median value, it is considered to be a weak BLRC and is allocated a value of zero. This grouping process is based on Osma and Guillamón-Saorín (2011) and clearly delineates the sample based on the strength of the entity's BLRC structural characteristics. The selection of BLRC characteristics relevant to ERM effectiveness included in the PCA factor score is discussed as follows.

- *BLRC size (RCSIZE).* BLRC size is used as a proxy for a firm's willingness to invest board-level resources to improve ERM processes. Bédard et al. (2004) identify that a large BLRC provides strength and a corresponding diversity of opinion via the inclusion of external independent directors in the committee structure. Ng et al. (2013) and Magee et al. (2019) discuss how BLRC size enhances ERM functions. Prior literature identifies some negative consequences of large committees such as free rider problems (Karamanou and Vafeas, 2005) and reduced efficiency (Dalton et al., 1999). We contend a large BLRC is likely to enhance the effectiveness of ERM as the committee is likely to fulfil other good governance criteria such as increased independence, gender diversity, expertise of directors, and inter-committee directorships.
- *BLRC independence (RCIND).* The composition of the board is considered to be an important element associated with monitoring of management in an organisation. Agency theory postulates that a higher number of independent board directors is usually associated with greater monitoring which in turn prevents managers from pursing self-interested behaviour such as fraudulent reporting or information concealing (Jensen and Meckling, 1976). Higher levels of monitoring are linked to lower agency costs, which in turn increases firm profitability. For instance, the AC literature suggests firms benefit from independent directors being on board sub-committees by lowering the chances of false reporting from the committee and reducing management influence on committee processes (Abbott et al., 2004; Goodwin and Seow, 2002; Mangena and Pike, 2005; Xie et al., 2003; Zaman et al., 2011). In BLRC context, Protiviti (2011) highlights that the addition of independent directors to the BLRC is necessary for building objective communication between the board and management in relation to the firm's ERM activities. Magee et al. (2019) suggest that BLRC independence also assists ERM processes. Similarly, Ng et al. (2013) claim that an independent assessment of key risk areas by a BLRC could minimize the firm's exposure to substantial risks. We therefore posit that independent BLRCs should enhance the effectiveness of an ERM program.
- *BLRC meetings (RCMEET).* BLRC meeting frequency is commonly used to proxy for risk committee diligence. An inactive BLRC is likely to cause ineffectiveness and may result in deterioration of entity risk processes. Prior research confirms meeting frequency of a board-level sub-committee as an indication of efforts to achieve committee objectives and demonstrates a willingness of committee members to fulfil their responsibilities to support effective monitoring (Abbott and Parker, 2000; Carcello et al., 2002; Ellul and Yerramilli, 2013; Menon and Williams, 1994). ERM is considered an ongoing process that requires regular BLRC attention and board decision-making. Thus, higher meeting frequency should enhance the ability of a BLRC to effectively monitor developments in ERM.
- *BLRC financial experts (RCFIN).* Financial expertise and experience of board members has received significant attention in the corporate governance literature to date. Researchers have identified positive effects of the presence of financial experts on the board including enhanced financial reporting quality and firm value (Goodwin and Seow, 2002; Magee et al., 2019; Xie et al., 2003; Zaman et al., 2011). Bédard et al. (2004) consider the existence of at least one financial expert is likely to improve earnings management, decrease the firm's risk of failure, and positively contribute towards shareholders' wealth creation. In the UK, including a financial expert on the AC is a regulatory requirement (FRC, 2012) but there is (as yet) no legal or regulatory requirement for financial expertise on the BLRC. The Walker (2009) report suggests that the ideal BLRC should have at least one financial expert with sufficient relevant experience to achieve effective discussions with management and to contribute to the identification of principal risk issues within the boundaries of ERM. To measure BLRC financial expertise, we adopt the definition of a financial expert as provided by the FRC for ACs as having a professional qualification (in accounting or finance) and sufficient experience in corporate financial matters (FRC, 2012).
- *BLRC female members (RCFEM).* In the corporate governance literature, there is evidence supporting the benefits of female representation on boards and the positive role female board members provide to board outcomes on RM and firm performance (Dwyer et al., 2002; Francoeur et al., 2008; Lückerath-Rovers, 2013; Powell and Ansic, 1997; Srinidhi et al., 2011). Prior research argues that gender diversity in board-level committees can also bring benefits to an organisation's overall governance mechanisms compared to "all-male" board-level committees. Groom (2009) contends that female representation on the board and its sub-committees encourages effective communication, which in turn improves the

[11] In untabulated results, we find very high correlation coefficients among our BLRC characteristics.

overall monitoring capability of the board. This view is in opposition to "group thinking" which is common in male dominated boards. The FRC highlights the importance of diversity (including gender) by stating: "Essential to the effective functioning of any board is dialogue which is both constructive and challenging. The problems arising from 'groupthink' have been exposed in particular because of the financial crisis. One of the ways in which constructive debate can be encouraged is through having sufficient diversity on the board. This includes, but is not limited to, gender and race" (FRC, 2014a p. 2). Unlike 'old-boy' networks (Adams and Ferreira, 2009), women on boards are perceived to increase earnings quality through increased oversight, diligence in monitoring and transparent reporting. The literature suggests women have lower tolerance when compared to men to opportunistic behaviour in decision-making and generally avoid aggressive earnings management and excessive risk taking (Dwyer et al., 2002; Powell and Ansic, 1997). Finally, a higher level of board gender diversity acts as a positive signal to the firm's external environment (including its stakeholders) as a measure of independence and transparent decision-making (Lückerath-Rovers, 2013; Rose, 2007).

- *BLRC overlapping (RCOL).* Choi (2013) identifies two problems with establishing a BLRC. First, role conflicts can create frictions when risk governance responsibilities are attached to more than one board committee. Second, divergence of overall risk governance may occur if various committees oversee risks. Cross-committee memberships can provide benefits by fostering role clarity, preventing duplication of duties, and lowering communication gaps (Choi, 2013; Walker, 2009). As ERM requires a holistic and comprehensive approach to RM (Beasley et al., 2007; COSO, 2004), Bates and Leclerc (2009) indicate "cross-committee synergies" are a benefit of a BLRC in overall risk governance. They argue that overlapping BLRC memberships with other board-level committees may reduce the chance of risks "slipping through the cracks" and ensure coordination with other board-level committees. Therefore, a BLRC can create RM synergies by properly managing all risks. In an empirical study, Tao and Hutchinson (2013) find a positive influence on risk and firm performance when board-level risk and compensation committees overlap.

4.2.4. Control variables

We control for the following variables. First, ample evidence is available detailing the impact of board characteristics on firm performance (Gompers et al., 2003). We control for board size (*BSIZE*), board meetings (*BMEET*), and board independence (*BIND*). Second, following the previous literature (Hines et al., 2015; Hoque et al., 2013; Mura, 2007; Ng et al., 2013; O'Connell and Cramer, 2010) we control for firm size (*FSIZE*) by taking the natural log of total assets, leverage (*LEV*) as the ratio of total liabilities to total assets, number of business segments (*SEG*), extreme performance (*EXPERF*) as 1 if the firm has EPS within the top 10th percentile in the sample, and loss reporting (*LOSS*) as 1 if the firm has reported net loss during the year. Finally, we control for a combined risk committee by a dummy variable with the value of 1 if there is a combined audit and risk committee (*ACRC*). Table 2 provides further definition of the variables.

4.3. Statistical analysis

We estimate the following hierarchical multiple regressions using ordinary least square (OLS) technique to test our two hypotheses. In Step 1, we estimate the main effects, that is, the impact of ERM and BLRC (*RCPCA*, *STRONGRC*) on firm performance measured by *Q*. Thus, Model 1 and Model 2 test H1. In Step 2, we add interaction terms to test H2. Particularly, Model 4 is directly related to H2, which includes $ERM \times STRONGRC$, the interaction of a strong BLRC in the ERM and firm performance relationship. Further, as our sample contains both financial and non-financial firms, Y controls for industry specific effects.

Step 1: Main effects	$Q_{it} = \beta_0 + \beta_1 ERM + \beta_2 RCPCA + \beta_3 BSIZE + \beta_4 BIND + \beta_5 BMEET + \beta_6 FSIZE + \beta_7 LEV + \beta_8 SEG + \beta_9 EXPERF + \beta_{10} LOSS + \beta_{11} ACRC + (Y) + \mu_{it}$	Model 1
	$Q_{it} = \beta_0 + \beta_1 ERM + \beta_2 STRONGRC + \beta_3 BSIZE + \beta_4 BIND + \beta_5 BMEET + \beta_6 FSIZE + \beta_7 LEV + \beta_8 SEG + \beta_9 EXPERF + \beta_{10} LOSS + \beta_{11} ACRC + (Y) + \mu_{it}$	Model 2
Step 2: Interaction effects	$Q_{it} = \beta_0 + \beta_1 ERM \times RCPCA + \beta_2 ERM + \beta_3 RCPCA + \beta_4 BSIZE + \beta_5 BIND + \beta_6 BMEET + \beta_7 FSIZE + \beta_8 LEV + \beta_9 SEG + \beta_{10} EXPERF + \beta_{11} LOSS + \beta_{12} ACRC + (Y) + \mu_{it}$	Model 3
	$Q_{it} = \beta_0 + \beta_1 ERM \times STRONGRC + \beta_2 ERM + \beta_3 STRONGRC + \beta_4 BSIZE + \beta_5 BIND + \beta_6 BMEET + \beta_7 FSIZE + \beta_8 LEV + \beta_9 SEG + \beta_{10} EXPERF + \beta_{11} LOSS + \beta_{12} ACRC + (Y) + \mu_{it}$	Model 4

5. Results

5.1. Descriptive statistics and common factor extraction

Table 3a presents the descriptive statistics for the continuous and binary variables. Our sampled firms are on average overvalued, as the mean value of *Q* is 1.533. The *ERM* is the index value, which demonstrates the ability of sample firms

Table 2
Definition of variables.

Variable	Measurement
Firm performance variables	
Q	Market value of equity plus total liabilities divided by total assets
MTB	Market value of equity divided by total assets
ERM variables	
ERM	ERM Index (=strategy + operations + reporting + compliance) adopted from Gordon et al. (2009)
ERM_DUMMY	Dummy variable equals to 1 if firm has disclosed ERM processes in its annual report, 0 otherwise
BLRC variables	
RCPCA	Principal component analysis (PCA) factor based on the six BLRC variables
STRONGRC	Dummy variable equals to 1 if firm's *RCPCA* is greater than its median value; 0 otherwise
RCSIZE	Total number of BLRC directors
RCIND	Total number of independent directors on BLRC
RCMEET	Total number of BLRC meetings in a financial year
RCFIN	Total number of financial experts on BLRC
RCFEM	Total number of female directors on BLRC
RCOL	Total number of BLRC directors in other board-level committees
Interaction variables	
ERM × *RCPCA*	Interaction of *ERM* and *RCPCA*
ERM × *STRONGRC*	Interaction of *ERM* and *STRONGRC*
Control variables	
BSIZE	Total number of directors on board
BIND	Total number of independent directors on board
BMEET	Total number of board meetings in a financial year
FSIZE	The natural log of firm total assets
LEV	The ratio of total liabilities to total assets
SEG	Total number of business segments
EXPERF	Dummy variable to measure extreme performance equals to 1 if firm has earnings per share (EPS) within top 10th percentile in the sample; 0 otherwise
LOSS	Dummy variable equals to 1 if firm has reported net loss during the year; 0 otherwise
ACRC	Dummy variable equals to 1 if firm has a combined audit and risk committee; 0 otherwise

Table 3a
Descriptive statistics.

Variable-continuous *(N = 260)*	Mean	Median	Std. Dev.	Min.	Max.
Q	1.533	1.170	0.997	0.364	9.294
MTB	0.891	0.605	1.074	0.006	9.041
ERM	0	−0.212	3.144	−7.720	20.769
RCSIZE	4.638	4	1.457	2	10
RCIND	4.226	4	1.477	0	9
RCMEET	5.115	5	1.870	1	13
RCFIN	2.353	2	1.203	1	6
RCFEM	1.142	1	0.899	0	4
RCOL	3.865	4	1.735	0	10
BSIZE	10.703	11	2.630	4	23
BIND	6.530	6	2.122	3	15
BMEET	8.546	9	2.842	3	26
ASSETS (£ million)	111991.312	4214.246	303823.527	156.350	1832177.180
LEV	0.642	0.692	0.263	0.006	1.023
SEG	4.519	5	2.153	1	10
Variable-binary *(N = 260)*	Coding	Observations	% of Sample		
EXPERF	1	26	10%		
LOSS	1	27	10.3%		
ACRC	1	143	55%		

Q: market value of equity plus total liabilities divided by total assets; ***MTB***: Market value of equity divided total assets; ***ERM***: ERM Index (=strategy + operations + reporting + compliance) adopted from Gordon et al. (2009); ***RCSIZE***: total number of BLRC directors; ***RCIND***: total number of independent directors on BLRC; ***RCMEET***: total number of BLRC meetings in a financial year; ***RCFIN***: total number of financial experts on BLRC; ***RCFEM***: total number of female directors on BLRC; ***RCOL***: total number of BLRC directors in other board-level committees; ***BSIZE***: total number of directors on board; ***BIND***: total number of independent directors on board; ***BMEET***: total number of board meetings in a financial year; ***ASSETS***: book value of total assets in £ millions; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the financial year, 0 otherwise; ***ACRC***: dummy variable equals to 1 if firm has a combined audit and risk committee, 0 otherwise.

Table 3b
Principal component analysis of the BLRC measures (N = 260).

Panel A: KMO and Bartlett's test	
Kaiser-Meyer-Olkin	0.808
Bartlett's Test	696.196***
Panel B: Extraction communalities of the BLRC variables	
RCSIZE	0.835
RCIND	0.782
RCMEET	0.817
RCFIN	0.548
RCFEM	0.525
RCOL	0.788

Panel C: Eigen values of the BLRC variables

Component	Eigenvalues	
	Total	Cumulative %
RCSIZE	3.239	53.980
RCIND	1.056	71.584
RCMEET	0.767	84.371
RCFIN	0.473	92.255
RCFEM	0.261	96.601
RCOL	0.204	100.000

Panel D: Pearson correlation between the common factor and the BLRC variables

RCPCA	1
RCSIZE	0.899***
RCIND	0.884***
RCMEET	0.206***
RCFIN	0.675***
RCFEM	0.613***
RCOL	0.880***

RCSIZE: total number of BLRC directors; ***RCIND***: total number of independent directors on BLRC; ***RCMEET***: total number of BLRC meetings in a financial year; ***RCFIN:*** total number of financial experts on BLRC; ***RCFEM***: total number of female directors on BLRC; ***RCOL***: total number of BLRC directors in other board-level committees; ***RCPCA***: principal component analysis (PCA) factor based on the BLRC variables using varimax rotation.
*** $p < 0.01$.

Table 3c
Descriptive statistics among strong and weak BLRCs.

	Mean	Median	Std. Dev.	Min	Max
Panel A: Firms having strong BLRC governance					
RCSIZE	5.515	5	1.484	3	10
RCIND	5.176	5	1.302	2	9
RCMEET	5.715	6	2.043	2	13
RCFIN	2.992	3	1.242	1	6
RCFEM	1.676	2	0.873	0	4
RCOL	4.969	5	1.519	2	10
Panel B: Firms having weak BLRC governance					
RCSIZE	3.761	4	0.713	2	6
RCIND	3.276	3	0.931	0	5
RCMEET	4.515	4	1.458	1	11
RCFIN	1.715	2	0.739	1	4
RCFEM	0.607	1	0.535	0	2
RCOL	2.761	3	1.133	0	5

Panel C: Mean differences among strong and weak BLRCs

	RCSIZE	*RCIND*	*RCMEET*	*RCFIN*	*RCFEM*	*RCOL*
$\Delta\bar{x}$*t-stat.*	1.753***	1.900***	1.200***	1.276***	1.070***	2.207***
	(12.139)	(13.525)	(5.450)	(10.074)	(11.898)	(13.280)

RCSIZE: total number of BLRC directors; ***RCIND***: total number of independent directors on BLRC; ***RCMEET***: total number of BLRC meetings in a financial year; ***RCFIN***: total number of financial experts on BLRC; ***RCFEM***: total number of female directors on BLRC; ***RCOL***: total number of BLRC directors in other board-level committees.
*** $p < 0.01$.

Table 4
Hierarchical multiple regression: ERM, BLRC, and firm performance (*Q*).

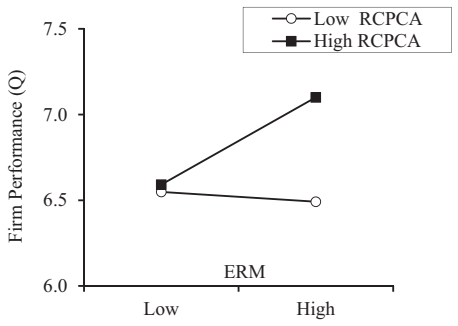
Variable	Exp. Sign	(1) St. Coeff. (*t*-stat.)	(2) St. Coeff. (*t*-stat.)	(3) St. Coeff. (*t*-stat.)	(4) St. Coeff. (*t*-stat.)
Step 1: Main effects – Impact of ERM and BLRC on firm performance					
ERM	+	0.114*	0.103*	0.121**	0.111*
		(1.869)	(1.664)	(1.988)	(1.793)
RCPCA	+	0.163**	0.142**		
		(2.566)	(2.162)		
STRONGRC	+			0.185***	0.171***
				(3.000)	(2.671)
BSIZE	+	0.039	0.020	0.044	0.026
		(0.486)	(0.238)	(0.553)	(0.310)
BMEET	+	0.043	0.067	0.030	0.052
		(0.736)	(1.099)	(0.513)	(0.847)
FSIZE	?	−0.538***	−0.525***	−0.530***	−0.514***
		(−5.716)	(−5.406)	(−5.684)	(−5.363)
LEV	–	0.046	0.024	0.034	0.007
		(0.638)	(0.306)	(0.479)	(0.087)
SEG	?	−0.042	−0.017	−0.038	−0.013
		(−0.662)	(−0.261)	(−0.607)	(−0.199)
EXPERF	+	0.221***	0.225***	0.208***	0.211**
		(3.157)	(2.707)	(2.972)	(2.527)
LOSS	–	−0.034	−0.023	−0.026	−0.017
		(−0.566)	(−0.385)	(−0.448)	(−0.281)
ACRC	?	−0.042	−0.040	−0.049	−0.053
		(−0.632)	(−0.521)	(−0.744)	(−0.697)
Industry dummies	?	Excluded	Included	Excluded	Included
R^2		0.228	0.240	0.236	0.248
F-Stat		7.366***	5.147***	7.671***	5.359***
Step 2: Interaction effects – Impact of ERM on firm performance moderated by the BLRC					
ERM × *RCPCA*	+	0.138**	0.142**		
		(2.210)	(2.229)		
ERM × *STONGRC*	+			0.120*	0.120*
				(1.750)	(1.711)
ERM	+	0.176***	0.165**	0.056	0.044
		(2.638)	(2.446)	(0.799)	(0.609)
RCPCA	+	0.169***	0.147**		
		(2.669)	(2.266)		
STRONGRC	+			0.184***	0.168***
				(2.985)	(2.629)
Control variables	?	Yes	Yes	Yes	Yes
Industry dummies	?	Excluded	Included	Excluded	Included
Observations		260	260	260	260
ΔR^2		0.015	0.015	0.009	0.009
ΔF-Stat		4.886**	4.969**	3.063*	2.929*
Highest VIF		2.861	3.026	2.850	2.997

Q: market value of equity plus total liabilities divided by total assets; ***ERM***: ERM Index (=strategy + operations + reporting + compliance) adopted from Gordon et al. (2009); ***RCPCA****:* principal component analysis (PCA) factor based on the BLRC variables using varimax rotation; ***BSIZE***: total number of directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the financial year, 0 otherwise; ***ACRC***: dummy variable equals to 1 if firm has a combined audit and risk committee, 0 otherwise; ***ERM*** × ***RCPCA***: interaction of ***ERM*** and ***RCPCA***; ***STRONGRC***: dummy variable equals to 1 if firm ***RCPCA*** is greater than its median value, 0 otherwise; ***ERM*** × ***STRONGRC***: interaction of ***ERM*** and ***STRONGRC***.

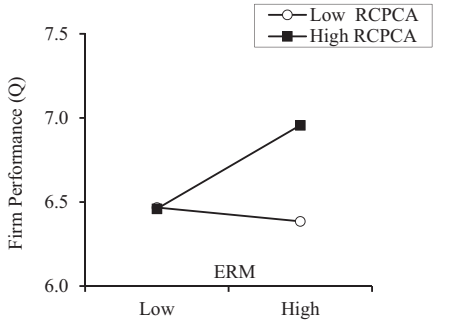
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

to achieve effectiveness in their ERM processes. The mean of *ERM* is 0,[12] however Min (Max) scores of −7.720 (20.769) indicate the most ineffective (effective) ERM programs. In relation to BLRC characteristics, Table 3a identifies that BLRCs of sample firms consist of independent directors, as mean values of *RCSIZE* and *RCIND* are 4.638 and 4.226, and the median is 4 for both variables.[13] This implies that on average there are enough outside directors on sample BLRCs to establish objective communication with management. These findings identify a higher proportion of outside directors in UK BLRCs compared to Ng et al. (2013)

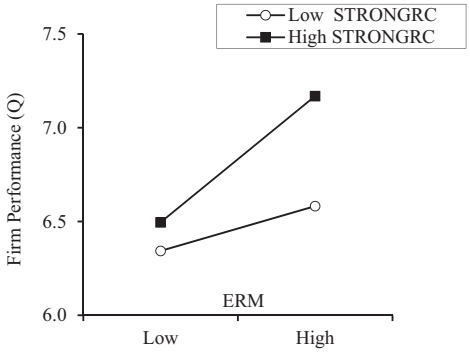
[12] The mean of ERM is 0 as all eight constructs were standardized on a cross-sectional basis before being combined to form the index.
[13] There are two BLRCs with only two members and four BLRCs with ten members.



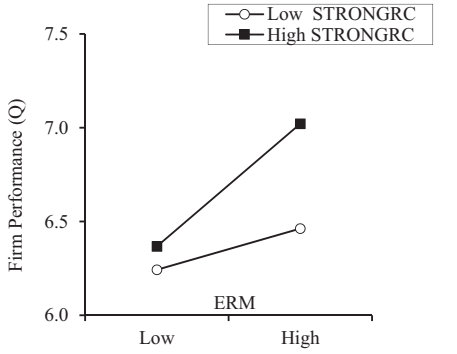
Panel A. Two-way interaction of *ERM* and *RCPCA* on *Q* before industry controls.



Panel B. Two-way interaction of *ERM* and *RCPCA* on *Q* after industry controls.



Panel C. Two-way interaction of *ERM* and *STRONGRC* on *Q* before industry controls.



Panel D. Two-way interaction of *ERM* and *STRONGRC* on *Q* after industry controls.

Fig. 2. Two-way interaction of ERM and BLRC on firm performance.

who find on average 0.512 outside members in Malaysian firm BLRCs. On average, BLRC members meet (*RCMEET*) 5.115 times per year, and have 2.353 financial experts (*RCFIN*). This is consistent with Ellul and Yerramilli (2013) who find US firm BLRC's meet 5.369 times each year. Our result indicates BLRCs are fulfilling Walker (2009) report recommendations including regular annual meetings and sufficient members with financial expertise. Our sample firm BLRCs have on average 1.142 female directors (*RCFEM*) as members which equates to approximately 75% of our BLRCs including at least one female board member, which is consistent with FRC (2014a) guidance highlighting the benefits of gender diversity on boards.

The descriptive statistics for the control variables are presented in Table 3a. Board size (*BSIZE*) ranges between 4 and 23 directors with a mean of 10.703, with an average of 6.530 outside directors (*BIND*). Boards of our sample on average meet (*BMEET*) 8.546 times annually. Average total assets (*ASSETS*) are £111991.312 million with leverage (*LEV*) of 0.642. Furthermore, Table 3a presents data for binary variables, demonstrating that 26 (10%) firms are categorized in the extreme financial performance (*EXPERF*) bracket, while 27 (10.3%) reported a net loss during the period. In addition, 143 (55%) firms have a combined audit and risk committee (*ACRC*) during the sample period.

Table 3b presents results of the common factor extraction using our BLRC measures. Factor analysis is performed using the Varimax method with principal components extraction. This method uses orthogonal rotation and assumes that the extracted factors are not correlated. Panel A of Table 3b shows that the Kaiser-Meyer-Olkin (KMO) value is 0.808, which is sufficiently greater than the minimum threshold of 0.6 identified by Tabachnick and Fidell (2007) and Hair et al. (2014). The Bartlett's Test statistic is highly significant (χ^2 = 696.196, $p < 0.01$). The results suggest that there is sufficient variability among our BLRC measures and the data is adequate for factor analysis. Further, Panel B of Table 3b identifies extraction communalities of the variables that demonstrate the proportion of common variance shared by our common factor. This shows that all the communalities are above the minimum threshold of 0.30, meaning that our common factor significantly represents variances of all the BLRC measures (Hair et al., 2014; Tabachnick and Fidell, 2007). Panel C of Table 3b presents the eigenvalues of the reduced correlation matrix of the items. Our extracted component explains 54% of variance of the original BLRC measures. Panel D shows that all the BLRC measures are significantly and highly correlated with our extracted common factor.

Using the BLRC common factor, we divide our sample into strong and weak BLRCs. If a firm has a value greater than the sample median of the common factor (*RCPCA*), it is categorised as a strong BLRC. Table 3c compares the descriptive statistics for the two groups and demonstrates that firms with strong BLRCs have higher values for all characteristics, i.e. BLRCs are larger, more independent, meet more frequently, have more financial and female directorships, and demonstrate higher overlap with other board committees. Particularly, we observe that independence (*RCIND*) is a highly differentiating factor, with strong BLRCs having on average 1.9 additional independent directors compared to weaker BLRCs. In addition, Panel C of Table 3c identifies significant differences among the mean values of the measures of the two groups. For instance, the

Table 5
Hierarchical multiple regression: ERM, BLRC, and firm performance (*MTB*).

Variable	Exp. Sign	(1) St. Coeff. (*t*-stat.)	(2) St. Coeff. (*t*-stat.)	(3) St. Coeff. (*t*-stat.)	(4) St. Coeff. (*t*-stat.)
Step 1: Main effects – Impact of ERM and BLRC on firm performance					
ERM	+	0.106*	0.096*	0.112**	0.103*
		(1.869)	(1.664)	(1.988)	(1.793)
RCPCA	+	0.152**	0.132**		
		(2.566)	(2.162)		
STRONGRC	+			0.172***	0.159***
				(3.000)	(2.671)
BSIZE	+	0.036	0.018	0.041	0.024
		(0.486)	(0.238)	(0.553)	(0.310)
BMEET	+	0.040	0.062	0.028	0.048
		(0.736)	(1.099)	(0.513)	(0.847)
FSIZE	?	−0.500***	−0.487***	−0.492***	−0.478***
		(−5.716)	(−5.406)	(−5.684)	(−5.363)
LEV	–	−0.203***	−0.223***	−0.213***	−0.239***
		(−3.051)	(−3.108)	(−3.208)	(−3.313)
SEG	?	−0.039	−0.016	−0.035	−0.012
		(−0.662)	(−0.261)	(−0.607)	(−0.199)
EXPERF	+	0.205***	0.209***	0.193***	0.196**
		(3.157)	(2.707)	(2.972)	(2.527)
LOSS	–	−0.031	−0.022	−0.025	0.016
		(−0.566)	(−0.385)	(0.448)	(−0.281)
ACRC	?	−0.039	−0.037	−0.045	−0.049
		(−0.632)	(−0.521)	(−0.744)	(−0.697)
Industry dummies	?	Excluded	Included	Excluded	Included
R^2		0.334	0.304	0.340	0.351
F-Stat		12.502***	8.556***	12.855***	8.801***
Step 2: Interaction effects – Impact of ERM on firm performance moderated by the BLRC					
ERM × *RCPCA*	+	0.128**	0.132**		
		(2.210)	(2.229)		
ERM × *STONGRC*	+			0.111*	0.112*
				(1.750)	(1.711)
ERM	+	0.163***	0.153**	0.052	0.041
		(2.638)	(2.446)	(0.799)	(0.609)
RCPCA	+	0.157***	0.137**		
		(2.669)	(2.266)		
STRONGRC	+			0.171***	0.156***
				(2.958)	(2.629)
Control variables	?	Yes	Yes	Yes	Yes
Industry dummies	?	Excluded	Included	Excluded	Included
Observations		260	260	260	260
ΔR^2		0.013	0.013	0.008	0.008
Δ*F*-Stat		4.886**	4.969**	3.063*	2.929*
Highest VIF		2.861	3.026	2.850	2.997

MTB: market value of equity divided by total assets. ***ERM***: ERM Index (=strategy + operations + reporting + compliance) adopted from Gordon et al. (2009); ***RCPCA***: principal component analysis (PCA) factor based on the BLRC variables using varimax rotation; ***BSIZE***: total number of directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile in the sample, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the year, 0 otherwise; ***ACRC***: dummy variable equals to 1 if firm has a combined audit and risk committee, 0 otherwise; ***ERM*** × ***RCPCA***: interaction of ***ERM*** and ***RCPCA***; ***STRONGRC***: dummy variable equals to 1 if firm ***RCPCA*** is greater than its median value, 0 otherwise; ***ERM*** × ***STRONGRC***: interaction of ***ERM*** and ***STRONGRC***.

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table 6
Impact of ERM on firm performance (*Q*) – ERM versus non-ERM firms.

Variable	Exp. Sign	OLS		PSM	
		(1) St. Coeff. (*t*-stat.)	(2) St. Coeff. (*t*-stat.)	(3) St. Coeff. (*t*-stat.)	(4) St. Coeff. (*t*-stat.)
ERM_DUMMY	+	0.108***	0.191***	0.086**	0.185***
		(2.875)	(4.192)	(2.324)	(3.635)
BSIZE	+	0.089**	0.047	0.079	0.073
		(2.406)	(1.514)	(1.578)	(1.633)
BMEET	+	−0.003	−0.039*	0.008	−0.016
		(−0.109)	(−1.652)	(0.265)	(−0.528)
FSIZE	?	−0.418***	−0.297***	−0.369***	−0.299***
		(−7.869)	(−6.064)	(−5.378)	(−4.696)
LEV	–	0.154***	0.108***	0.072	0.073
		(4.106)	(2.816)	(1.626)	(1.586)
SEG	?	0.120***	0.094***	0.110**	0.101**
		(2.995)	(2.383)	(2.364)	(2.198)
EXPERF	+	0.081**	0.073***	0.098***	0.088***
		(2.509)	(2.822)	(2.615)	(2.851)
LOSS	–	−0.161***	−0.144***	−0.113***	−0.106***
		(−7.821)	(−7.054)	(−4.308)	(−4.001)
Industry dummies	?	Excluded	Included	Excluded	Included
Observations		892	892	620	620
R^2		0.163	0.277	0.126	0.228
F-Stat		23.390***	24.990***	11.730***	14.340***
Highest VIF		1.93	2.16	1.96	2.12

Q: market value of equity plus total liabilities divided by total assets; ***ERM_DUMMY***: equals to 1 if a firm has disclosed ERM processes in its annual report, 0 otherwise; ***BSIZE***: total number of directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile in the sample, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the year, 0 otherwise.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

independent *t*-test demonstrates stronger BLRCs are significantly larger than weaker BLRCs ($\Delta\bar{x}$ = 1.753, t = 12.139). These results suggest significant ERM oversight differences between strong and weak BLRCs.

5.2. Multivariate analysis

Table 4 reports hypotheses testing results using hierarchical multiple regression.[14] We estimate regression equations with and without controlling for industry effects. Step 1 of Table 4 provides the results of main effects, which demonstrate a significant and positive impact of *ERM* on *Q* (β = 0.114, t = 1.869), thus supporting our first hypothesis (H1). This is consistent with prior literature that positions ERM as a value creation tool (Farrell and Gallagher, 2015; Liebenberg and Hoyt, 2003; Nocco and Stulz, 2006). While we do not posit a direct relationship between the BLRC and firm performance, the results indicate our BLRC factor (*RCPCA*) is significantly and positively associated with *Q* (β = 0.163, t = 2.566). Moreover, our *STRONGRC* variable is significant and positive, and has a higher coefficient value (β = 0.185, t = 3.000) than *RCPCA*. The results illustrate that a combined audit and risk committee (*ACRC*) is negatively related to *Q*, but this relationship is insignificant. With regard to control variables, the results show that *FSIZE* is significantly and negatively associated with *Q* (β = −0.538, t = −5.716), suggesting larger firms are at greater risk of financial distress (Pagach and Warr, 2010) and face more agency related issues (such as information asymmetries) and greater bureaucratic frictions and regulations (Zou, 2010). *EXPERF* is significantly and positively associated with *Q* (β = 0.221, t = 3.157), suggesting high profitability is related to positive market reaction and attracts investment opportunities (McShane et al., 2011).

Step 2 in Table 4 presents the results for our interaction terms. In all the estimations, there is an increment of variance explained (ΔR^2), and this increment is significant (Δ*F*-Stat), thus supporting our second hypothesis (H2). The interaction of *RCPCA* and *RCSTRONG* with *ERM* is significantly and positively associated with *Q* (β = 0.138, t = 2.210 and β = 0.120, t = 1.750 respectively). The results are consistent with prior literature on the influence of risk governance on the relationship between RM and firm performance (Gordon et al., 2009; Tao and Hutchinson, 2013). Our results indicate that BLRCs with higher monitoring capacity are more active and contain more members with financial expertise and gender diversity (*RCSTRONG*), which in turn improves the impact of ERM on firm performance.

Fig. 2 provides a two-way graphical depiction of the moderation effects provided in Table 4. Panels A and B reveal that high *RCPCA* increases the impact of *ERM* on *Q*. Similarly, Panels C and D indicate a higher *ERM* and *Q* relationship in the

[14] We omit *BIND* in regression analyses due to very high correlation of this variable with *BSIZE*.

presence of high *STRONGRC*. This highlights that higher *RCPCA* and *STRONGRC* buffer for firms that have less effective ERM processes, and increase the impact of *ERM* on *Q* for firms with more effective ERM processes. To further support our findings from the two-way graphs in Fig. 2, we conduct simple slope tests to independently examine the interaction of *ERM* with *RCPCA* and *STRONGRC* on *Q*. The tests reveal that, as expected, low *RCPCA* negatively but insignificantly affects *ERM* and *Q* (β = −0.013, t = −1.558), whereas high *RCPCA* significantly and positively increases the relation between *ERM* and *Q* (β = 0.079, t = 1.993). We also find greater and stronger impact of *ERM* on *Q* in the presence of high *STRONGRC* (β = 0.104, t = 1.983) compared to low *STRONGRC* (β = 0.034, t = 1.784) respectively.

Table 5 presents hierarchal multiple regression results with the Market-to-Book (*MTB*) ratio as the dependent variable. We utilise the *MTB* ratio as a substitute for *Q* as a proxy for firm market value performance (De Andres et al., 2005). We find consistency in our results and further evidence that *ERM* is significantly and positively associated with *MTB* (β = 0.106, t = 1.869), and *RCPCA* and *STRONGRC* interactions with *ERM* significantly increase the impact of ERM on *MTB* (β = 0.128, t = 2.210 and β = 0.111, t = 1.750 respectively). Regarding the control variables, the results show that *LEV* is now significantly and negatively associated with *MTB* (β = −0.203, t = −3.051), supporting the arguments that firms with higher leverage are more likely to face higher risks of financial distress (Hoyt and Liebenberg, 2011), or difficulty fully exploiting potential investment opportunities. Consistent with our previous findings, the coefficient of *EXPERF* is significant and positive, and the coefficient of *LOSS* is negative but insignificant.

5.3. Robustness testing

5.3.1. Comparing ERM and non-ERM firms

To support the findings of H1, we compare firms with and without ERM. This involves analysing ERM using a binary variable that takes the value of 1 if a firm disclosed ERM processes in its annual report, and 0 otherwise. This results in a subsample of 892 firm-year observations comprised of 349 ERM and 543 non-ERM firms. Table 6 presents the results based on the presence of ERM processes, *ERM_DUMMY* on *Q*. The estimation results based on OLS, shown in Column 1, indicate a significant and positive impact of *ERM_DUMMY* on *Q* (β = 0.108, t = 2.875), suggesting that the presence of ERM processes

Table 7
Impact of ERM on firm performance (*Q*) – strong versus weak BLRCs.

		OLS Strong BLRC		OLS Weak BLRC		PSM Strong BLRC		PSM Weak BLRC	
Variable	Exp. Sign	(1) St. Coeff. (*t*-stat.)	(2) St. Coeff. (*t*-stat.)	(3) St. Coeff. (*t*-stat.)	(4) St. Coeff. (*t*-stat.)	(5) St. Coeff. (*t*-stat.)	(6) St. Coeff. (*t*-stat.)	(7) St. Coeff. (*t*-stat.)	(8) St. Coeff. (*t*-stat.)
ERM	+	0.188**	0.225***	0.134	0.142	0.235**	0.245**	0.132	0.126
		(2.243)	(2.658)	(1.368)	(1.361)	(2.216)	(2.328)	(0.926)	(0.847)
BSIZE	+	0.029	0.059	0.053	0.071	0.094	0.194*	0.075	0.080
		(0.271)	(0.504)	(0.465)	(0.573)	(0.935)	(1.764)	(0.574)	(0.630)
BMEET	+	0.034	0.079	0.013	0.018	0.089	0.194*	−0.034	−0.013
		(0.431)	(0.948)	(0.156)	(0.196)	(1.120)	(1.701)	(−0.393)	(−0.184)
FSIZE	?	−0.498***	−0.553***	−0.428***	−0.392***	−0.502**	−0.643***	−0.413***	−0.300*
		(−3.531)	(−3.769)	(−3.464)	(−2.944)	(−2.472)	(−2.862)	(−2.849)	(−1.718)
LEV	–	−0.109	−0.062	0.176*	0.085	−0.120	−0.031	0.036	−0.152
		(−1.103)	(−0.531)	(1.796)	(0.712)	(−0.897)	(−0.220)	(0.321)	(−0.953)
SEG	?	−0.087	−0.077	−0.072	−0.015	−0.126	−0.124	−0.105	−0.047
		(−0.901)	(−0.790)	(−0.798)	(−0.141)	(−1.149)	(−1.107)	(−0.779)	(−0.308)
EXPERF	+	0.325***	0.156	0.073	0.097	0.216***	0.036	0.032	0.083
		(3.238)	(1.133)	(0.696)	(0.778)	(3.127)	(0.598)	(0.557)	(1.172)
LOSS	–	0.093	0.087	−0.120	−0.083	0.113	0.126	−0.190***	−0.175
		(1.063)	(1.000)	(−1.366)	(−0.883)	(1.194)	(1.268)	(−2.740)	(−2.384)
ACRC	?	−0.096	−0.132	−0.017	−0.010	−0.145	−0.153	−0.006	0.012
		(−1.084)	(−1.265)	(−0.168)	(−0.092)	(−1.125)	(−1.007)	(−0.047)	(0.084)
Industry dummies	?	Excluded	Included	Excluded	Included	Excluded	Included	Excluded	Included
Observations		130	130	130	130	86	86	86	86
R^2		0.326	0.371	0.171	0.188	0.325	0.382	0.208	0.246
F-Stat		6.438***	4.840***	2.744***	1.899**	2.520**	3.140***	2.080**	3.160***
Highest VIF		3.539	3.940	2.208	2.514	3.050	3.660	2.390	2.800

Q: Market value of equity plus total liabilities divided by total assets; ***ERM***: ERM Index (=strategy + operations + reporting + compliance) adopted from Gordon et al. (2009); ***BSIZE***: total number of directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile in the sample, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the year, 0 otherwise; ***ACRC***: dummy variable equals to 1 if firm has a combined audit and risk committee, 0 otherwise.

** $p < 0.05$.

*** $p < 0.01$.

Table 8
Binary logistic regressions – profitability, ERM effectiveness, and strong BLRCs.

Variable	Exp. Sign	Dependent Var. *EFFECTIVE-ERM*			Dependent Var. *STRONGRC*		
		(1) St. Coeff. (*p*-val.)	(2) St. Coeff. (*p*-val.)	(3) St. Coeff. (*p*-val.)	(1) St. Coeff. (*p*-val.)	(2) St. Coeff. (*p*-val.)	(3) St. Coeff. (*p*-val.)
EPS	?	0.066			−0.044		
		(0.116)			(0.349)		
EPS-2YA	?		0.005			0.000	
			(0.171)			(0.955)	
EPS-5YA	?			0.107			−0.153
				(0.249)			(0.350)
BSIZE	+	−0.012	−0.021	−0.014	0.006	−0.002	0.010
		(0.872)	(0.788)	(0.853)	(0.938)	(0.979)	(0.898)
BMEET	+	0.135**	0.132**	0.137**	0.127**	0.128**	0.121**
		(0.014)	(0.015)	(0.013)	(0.025)	(0.024)	(0.033)
FSIZE	?	−0.587**	−0.586**	−0.571**	0.395	0.410	0.394
		(0.017)	(0.016)	(0.020)	(0.122)	(0.108)	(0.125)
LEV	–	−0.822	−1.083	−0.888	1.893***	1.950**	1.928***
		(0.247)	(0.136)	(0.207)	(0.009)	(0.010)	(0.008)
SEG	?	0.187**	0.209***	0.186**	−0.019	−0.023	−0.021
		(0.014)	(0.007)	(0.014)	(0.802)	(0.766)	(0.782)
EXPERF		Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
LOSS	–	0.428	0.303	0.218	−0.840	−0.687	−0.781
		(0.387)	(0.525)	(0.647)	(0.135)	(0.212)	(0.164)
ACRC	?	0.560	0.500	0.548	−0.142	−0.126	−0.132
		(0.121)	(0.165)	(0.128)	(0.697)	(0.731)	(0.717)
Industry dummies	?	Included	Included	Included	Included	Included	Included
Observations		256	256	256	256	256	256
Cox and Snell R^2		0.143	0.139	0.137	0.230	0.227	0.230

EFFECTIVE-ERM: dummy variable equals to 1 if ERM index value is greater than zero, 0 otherwise; ***STRONGRC***: dummy variable equals to 1 if firm's ***RCPCA*** is greater than its median value, 0 otherwise; ***EPS***: current earnings per share calculated as net profit after tax divided by common shares outstanding; ***EPS-2YA***: average of the earnings per share of the last two financial years; ***EPS-5YA***: average of the earnings per share of the last five financial years; ***BSIZE***: total number of directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the year, 0 otherwise; ***ACRC***: dummy variable equals to 1 if firm has a combined audit and risk committee, 0 otherwise.
** $p < 0.05$.
*** $p < 0.01$.

increases firm performance by 0.108 standard deviations. The results provided in Column 2 are consistent after controlling for industry effects.

However, as adopting ERM processes is a firm choice (Hoyt and Liebenberg, 2011), selection bias potentially exists in our analysis. We use propensity score matching (PSM) to control for the unobservable differences between ERM and non-ERM firms and account for potential self-selection bias.[15] To produce a PSM sample, we use logistic regression and regress *ERM_DUMMY* on the control variables to obtain the probabilities. We perform one-to-one matching without replacement within the caliper range of 1 percent. The PSM matched sample consists of 620 observations (with ERM = 310, without ERM = 310). The mean comparison of the variables for the matched sample is provided in Appendix C.1, demonstrating that the mean difference of the variable *PROPENSITY_SCORE* is not significant ($\Delta\bar{x} = 0.001$, $p = 0.918$), and predicted probabilities are not significantly different amongst the two groups. In addition, mean differences of all other variables are not significant between ERM and non-ERM firms. The estimation results using the PSM sample are presented in Table 6. In Column 3, the variable *ERM_DUMMY* is found to be significant and positive ($\beta = 0.086$, $t = 2.324$), suggesting the adoption of ERM processes increases firm performance. The results are consistent after controlling for industry effects in Column 4 of Table 6. In an additional robustness analysis (untabulated), we replace *Q* with *MTB* and find all results are consistent with our original results. Overall, these findings suggest that adoption of ERM processes increases firm performance, therefore giving support to our findings related to H1.

5.3.2. Comparing strong and weak BLRC firms

To ensure the validity of our findings, we divide our sample firms into strong and weak BLRC groups by using our *STRONGRC* dummy. Table 7 presents the results of a multiple regression for the impact of *ERM* on *Q* for the two groups. ERM is positively associated with *Q* in all estimations, however in firms with strong BLRCs, *ERM* is found to be significantly and positively associated with *Q* ($\beta = 0.188$, $t = 2.243$), giving support to our second hypothesis (H2). However, the *ERM* of

[15] PSM uses multiple covariates to estimate probabilities in order to match observations. It produces a sub-sample divided into a treatment group (ERM firms) and a control group (non-ERM firms) who share similar characteristics.

weak BLRCs is also positively related to Q but this relationship is not significant (β = 0.134, t = 1.368). The results indicate ERM in firms with strong BLRC's has a higher impact on firm performance. The regression estimations of strong BLRC firms have a higher variance explained (R^2) compared to weak BLRC firms. Thus sample firms with structurally strong BLRCs have more effective ERM processes. In contrast, structurally weak BLRCs deteriorate the value generation process of ERM.

Our independent t-test for equality of means (untabulated) among strong and weak BLRC groups demonstrates how strong BLRC firms have significantly larger, more diligent, and independent boards (*BSIZE*, *BMEET*, and *BIND*), are larger in size (*FSIZE*), have higher leverage (*LEV*), and are more profitable (*EXPERF*) compared to weak BLRC firms. These differences could question our early inferences, but it can be argued firms with a strong BLRC have some special firm fundamental characteristics (other than the structure of BLRC) that increase the efficiency of ERM processes. To account for this potential bias, we use PSM to control the fundamental characteristics among strong and weak BLRC groups. In the first step, we use logistic regression and regress the variable *STRONGRC* on our control variables to obtain predicted probabilities. We perform one-to-one matching without replacement within the caliper range of 1 percent, resulting in a PSM matched sample containing a total of 172 observations (with a strong BLRC = 86, with a weak BLRC = 86). The mean comparison of the matched sample is provided in Appendix C.2. This test demonstrates the mean difference of *PROPENSITY_SCORE* is not significant ($\Delta\bar{x}$ = 0.041, p = 0.161), suggesting the predicted probabilities are not significantly different. Appendix C.2 provides evidence that the mean differences of all the control variables are not significant, suggesting fundamental firm characteristics do not significantly differ among strong and weak BLRCs. The regression results based on the PSM sample are provided in Columns 5–8 of Table 7. These results show *ERM* is significantly and positively associated with Q (β = 0.235, t = 2.216) in firms with a strong BLRC. However, weak BLRC firms do not show a significant impact of *ERM* on *Q*. Overall, the results in Table 7 suggest strong risk oversight provided by a BLRC develops a "tone from the top" for effective ERM processes and fosters RM culture, risk strategy and appetite, and risk governance and monitoring.

5.3.3. Endogeneity concerns: reverse causality analysis

Prior research indicates a potential endogeneity issue in examining ERM and firm performance relationships (Ellul and Yerramilli, 2013). Florio and Leoni (2017) argue that more profitable firms have higher incentives to invest in more effective ERM processes. We test this reverse causality issue by considering whether firm profitability, measured by earnings per share (*EPS*), is associated with investment in effective ERM processes. We take three different measures of EPS: current year *EPS*, average of the last two years (*EPS-2YA*), and average of the last five years (*EPS-5YA*). In this analysis, ERM effectiveness (*EFFECTIVE-ERM*) is a dummy variable taking the value of 1 if a firm has an ERM index value greater than zero. Table 8 provides the results of this analysis using a binary logistic regression method. The results indicate the effectiveness of ERM is not associated with current and past firm profitability. However, we find board diligence (*BMEET*) and the number of business segments (*SEG*) are associated with ERM effectiveness, which is consistent with previous research (Baxter et al., 2013). It should be noted we do not posit a direct relationship between the BLRC and firm performance; we argue BLRC influences the impact of ERM processes on firm performance. However, we test this reverse causality by considering our dummy variable for strong BLRCs (*STRONGRC*) as the dependent variable against EPS measures. As shown in Table 8, no significant relationship between the existence of a strong BLRC and current and past firm profitability was found. However, the results show board diligence (*BMEET*) and leverage (*LEV*) positively and significantly determine the existence of a strong BLRC.

6. Discussion and conclusion

In recent years, there have been increased efforts in the UK to improve risk governance mechanisms. In this paper, we investigate whether a firm's RM, particularly ERM processes, is linked to firm performance. We also examine the interaction role of the BLRC, as a risk governance mechanism, in this relationship. We find effective ERM processes improve firm performance measured by Tobin's Q, thus giving support to the theoretical claims by prior researchers regarding performance implications associated with the implementation of ERM (Baxter et al., 2013; Brown et al., 2009; Florio and Leoni, 2017; Gordon et al., 2009; Liebenberg and Hoyt, 2003; Nocco and Stulz, 2006). This result infers the higher the effectiveness of a firm's ERM, the greater the ability of the firm to achieve its strategic objectives i.e. strategy, operations, reporting, and compliance (COSO, 2004). We find that a BLRC improves the ERM and firm performance relationship. In particular, the existence of a strong BLRC is essential for ERM processes to be effective enough to increase market performance.

Our study contributes to the empirical research on RM and has clear practical implications. First, the results demonstrate ERM is positively related to firm performance, and the adoption of ERM processes is more attractive for UK firms who have not yet implemented ERM. However, adoption is not sufficient – an effective ERM system needs to efficiently achieve organisational objectives and positively impact shareholders' wealth creation. Unlike traditional silo-based RM, which is isolated, fragmented, and uncoordinated (task-by-task or department-by-department) with a focus solely on financial RM, the holistic approach of ERM incorporates and integrates decision-making at multiple levels and prevents risk aggregation within the organisation. By adopting an effective ERM, a firm can create value through: 1) strategy (by maximizing its market position relative to its competitors); 2) operations (by increasing operational efficiency); 3) reliable financial reporting system; and 4) compliance with applicable laws and regulations. COSO (2004) describes ERM best practice as including (but not be limited to) a holistic method of RM, standardization of risk measures, formalization of risk ownership at all levels of the organisation, engagement of all employees in RM processes, localization of risk culture, and assurance of proper recording, documentation

and communication of risks and opportunities. We identify how adopting ERM practices in UK listed firms should more efficiently implement FRC guidelines on RM (FRC, 2011, 2014a,b). Second, since ERM is a holistic approach embedded throughout the organisation, it provides a multifaceted platform for corporate governance when focusing on value maximization through RM. We find with regard to risk governance, the BLRC supports the function of ERM. Our results indicate the valuation outcomes of ERM are affected by the structure and composition of the BLRC.

One of the key contributions of our study is how a structurally strong BLRC, larger in size, more active, and with higher independent, financial, female, and inter-committee directorships, supports a stronger ERM and firm performance relationship. Conversely, a weak BLRC could adversely affect this relationship and reduce the performance implications of ERM. Our study identifies that UK corporate regulatory bodies should introduce detailed guidelines in relation to BLRC formation and structure to promote better quality risk governance. Walker (2009) encourages firms to establish a BLRC and details their responsibilities, but does not stipulate clear guidelines on the committee's structure and composition and interactions.

Finally, our findings have international implications. Since COSO (2004) provides a globally accepted international level ERM framework (Florio and Leoni, 2017; Lechner and Gatzert, 2018), we suggest that to improve the effectiveness of ERM processes to meet a firm's strategic objectives, it is crucial to improve firm performance implications. We expect the effectiveness of ERM processes supplements the important features of ERM identified by previous researchers, such as CRO appointment (Beasley et al., 2008), ERM ratings from external agencies (McShane et al., 2011), ERM program maturity (Farrell and Gallagher, 2015), and the level of ERM implementation (Florio and Leoni, 2017). In addition, as the adoption of BLRCs is increasing globally for the oversight of RM processes (Al-Hadi et al., 2016; Florio and Leoni, 2017; Hines and Peters, 2015; Ng et al., 2013; Tao and Hutchinson, 2013) we suggest structural balance of the BLRC is important for effective risk governance.

As with all research, this study is not free from limitations. First, the small sample size limits the power of our analysis and generalizability of findings. As investments in RM and governance are continuing to increase; future researchers will be able to employ larger samples to extend this study's analysis and generalizations. Second, this study employs the Gordon et al. (2009) ERM index to measure the ERM effectiveness of a firm. This index focuses on the COSO (2004) framework and measures the strength of an ERM program, however, the index is unable to capture the maturity of the ERM program of a firm. Future studies could assist with developing a more sophisticated ERM index. Third, we ignore the independence of the ERM function. The Walker (2009) report requires an independent CRO to participate in the BLRC and the risk oversight process ultimately be accountable to the full board. A future study could further examine the risk-reporting framework of UK firms in terms of CRO reporting, accountability, and efficiency of the ERM function and BLRC monitoring.

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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.

Appendix A. BLRCs reporting ERM responsibility

Name of firm	Reference	Reported ERM responsibility
Direct Line Group	BLRC Report, 2013, p. 69	"Reviewed and approved the Enterprise-wide Risk Management ("ERM") strategy and framework document."
Royal Bank of Scotland Group	BLRC Report, 2013, p. 61	"The Committee also considered management's plans to deliver a holistic Enterprise Risk Management (ERM) framework, intended to deliver an increase in effectiveness and make risk more relevant to the operation of the business."
Petrofac PLC	BLRC Report, 2012, p. 84	"The ERM programme was advanced during 2012 by the appointment of a new Group Head of Enterprise Risk, who, following a business review, presented initial plans to the Committee to develop the ERM programme. These plans include: engaging and communicating on risk more effectively; bringing greater clarity to Petrofac's risk management strategy and risk management framework; and, in accordance with recommendations made by the Committee, introducing further consistency to the process and language of risk and control across the business service lines."

Appendix A. (*continued*)

Name of firm	Reference	Reported ERM responsibility
Lloyds Banking Group	BLRC Report, 2015, p. 78	"The purpose of the Board Risk Committee is to review the risk culture of the Group, setting the tone from the top in respect of risk management. The Committee is also responsible for ensuring the risk culture is fully embedded and supports at all times the Group's agreed risk appetite, covering the extent and categories of risk which the Board considers as acceptable for the Company."

Appendix B. ERM search hits

Name of firm	Reference	ERM search hit
AVIVA PLC	Annual Report, 2013, p. 76	"Significant work has been carried out by management to close issues raised by Internal Audit and the Group's risk policies and business standards have been mapped against the Committee of Sponsoring Organizations of the Treadway Commission's Enterprise Risk Management Framework (COSO framework) to provide a baseline position to assess where further development is required."
G4S PLC	Annual Report, 2015, p. 46	"Enterprise risk management will be embedded more tightly into operating business unit management. There will be a thorough annual review of the risk register as an integral part of the annual planning process."
RSA Insurance Group	Annual Report, 2012, p. 26	"We operate under a common framework through which risk management and control is embedded throughout the Group."
Rexam PLC	Annual Report, 2014, p. 32	"We continue to work on the development of our Enterprise Risk Management (ERM) framework."

Appendix C. Mean comparison of PSM matched samples

C.1: Mean comparison of PSM matched sample among ERM and non-ERM firms

Variable	Mean Treated (ERM = 1), *N* = 310	Mean Control (ERM = 0), *N* = 310	$\Delta\bar{x}$	*t*-stat.	*p*-value
PROPENSITY_SCORE	0.410	0.409	0.001	0.103	0.918
BSIZE	9.840	9.760	0.074	0.382	0.703
BIND	5.700	5.750	−0.048	−0.286	0.775
BMEET	8.540	8.640	−0.103	−0.444	0.657
FSIZE	9.631	9.640	−0.008	−0.141	0.888
LEV	0.588	0.595	−0.007	−0.427	0.669
SEG	4.220	4.150	0.061	0.326	0.744
EXPERF	0.080	0.090	−0.006	−0.284	0.776
LOSS	0.090	0.070	0.019	0.884	0.377

C.2: Mean comparison of PSM matched sample among strong and weak BLRC firms

Variable	Mean Treated (*STRONGRC* = 1), *N* = 86	Mean Control (*STRONGRC* = 0), *N* = 86	$\Delta\bar{x}$	*t*-stat.	*p*-value
PROPENSITY_SCORE	0.506	0.465	0.041	1.409	0.161
BSIZE	10.732	10.279	0.453	1.125	0.262
BIND	6.407	6.093	0.313	1.118	0.265
BMEET	8.407	8.581	−0.174	−0.400	0.689
FSIZE	9.806	9.655	0.151	1.138	0.257
LEV	0.665	0.621	0.043	1.188	0.237
SEG	4.232	4.407	−0.174	−0.567	0.572
EXPERF	0.058	0.058	0	0	1
LOSS	0.069	0.081	−0.011	−0.287	0.775

PROPENSITY_SCORE: predicted probabilities based on logistic regression analysis, using the caliper range of 1%; ***BSIZE***: total number of directors on board; ***BIND***: total number of independent directors on board; ***BMEET***: total number of board meetings in a financial year; ***FSIZE***: the natural log of total assets; ***LEV***: the ratio of total liabilities to total assets; ***SEG***: total number of business segments; ***EXPERF***: extreme performance dummy variable equals to 1 if firm has EPS within top 10th percentile in the sample, 0 otherwise; ***LOSS***: dummy variable equals to 1 if firm has reported net loss during the year, 0 otherwise.

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