J. Account. Public Policy 28 (2009) 301–327

Contents lists available at ScienceDirect

J. Account. Public Policy

journal homepage: www.elsevier.com/locate/jaccpubpol

Enterprise risk management and firm performance: A contingency perspective

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ARTICLE INFO

Keywords:
Enterprise risk management
Firm performance
Contingency theory
Management control systems

ABSTRACT

In recent years, a paradigm shift has occurred regarding the way organizations view risk management. Instead of looking at risk management from a silo-based perspective, the trend is to take a holistic view of risk management. This holistic approach toward managing an organization's risk is commonly referred to as *enterprise risk management* (ERM). Indeed, there is growing support for the general argument that organizations will improve their performance by employing the ERM concept. The basic argument presented in this paper is that the relation between ERM and firm performance is contingent upon the appropriate match between ERM and the following five factors affecting a firm: environmental uncertainty, industry competition, firm size, firm complexity, and board of directors' monitoring. Based on a sample of 112 US firms that disclose the implementation of their ERM activities within their 10Ks and 10Qs filed with the US Securities and Exchange Commission, empirical evidence confirms the above basic argument. The implication of these findings is that firms should consider the implementation of an ERM system in conjunction with contextual variables surrounding the firm.

1. Introduction

Managing risk is a fundamental concern in today's dynamic global environment. In recent years, however, a paradigm shift has occurred regarding the way to view risk management. Instead of looking at risk management from a silo-based perspective, the trend is to take a holistic view of risk

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doi:10.1016/j.jaccpubpol.2009.06.006

management. This holistic approach toward managing an organization's risk is commonly referred to as *enterprise risk management* (ERM). A general argument gaining momentum in the literature is that the implementation of an ERM system will improve firm performance (e.g., see Barton et al., 2002; Lam, 2003; Stulz, 1996, 2003; COSO, 2004; Nocco and Stulz, 2006; Hoyt and Liebenberg, 2009). The findings by Hoyt and Liebenberg (2009), for example, based on data from the insurance industry and using Tobin's Q as the measure of performance, support this argument.[1] The fact that many firms have adopted ERM (e.g., see Gates and Hexter, 2005) lends additional support to the view that ERM will improve firm performance. Nevertheless, empirical evidence confirming this relation between ERM and firm performance is quite limited and is not based on a robust measure of ERM.

The primary objective of the study reported in this paper is to examine empirically the argument that ERM is related to firm performance. We argue that the ERM-firm performance relation is contingent upon the appropriate match between a firm's ERM system and several key firm-specific factors. Based on the relevant literature, we identify five specific firm factors that are believed to have an impact on the ERM-firm performance relation. These factors are: (1) environmental uncertainty, (2) industry competition, (3) firm complexity, (4) firm size, and (5) board of directors' monitoring. In pursuing the above objective, we also develop an ERM index. To our knowledge, we are the first to develop such an index.

The analyses presented in this paper are based on an empirical study of 112 US firms that disclose their ERM activities in their 10K and/or 10Q reports for 2005 with the US Security and Exchange Commission (SEC). The findings from this study provide strong evidence that there is a positive relation between ERM and firm performance, but that this relation is contingent upon the appropriate match between a firm's ERM system and the five factors noted above. These findings are robust to such concerns as the self-selection problem, the effectiveness of a newly constructed ERM Index, different measures for monitoring by the firm's board of directors, and different measures of firm performance.

The remainder of this paper will proceed as follows. In section two we develop the basic argument and research design underlying the empirical study discussed in this paper. The empirical study designed to test this argument is discussed in the third section of the paper. The fourth section of the paper presents the main results of the empirical study. The fifth section provides robustness checks for the main findings. The sixth section of the paper provides some concluding comments.

2. Basic argument and research design

2.1. Basic argument

An increasing number of scholars view ERM as the fundamental paradigm for managing the portfolio of risks confronting organizations (e.g., see Lam, 2003; Liebenberg and Hoyt, 2003; Nocco and Stulz, 2006; Beasley et al., 2008; Hoyt and Liebenberg, 2009). Driving this trend is the belief that ERM offers companies a more comprehensive approach toward risk management than the traditional silo-based risk management perspective. By adopting a systematic and consistent approach (or process) to managing all of the risks confronting an organization, ERM is presumed to lower a firm's overall risk of failure and thus increase the performance and, in turn, the value of the organization. The presumed link between a holistic approach to risk management and an organization's performance/value is clearly noted in the following definition of ERM provided by the Casualty Actuarial Society Committee on Enterprise Risk Management (2003, p. 8):

> ERM is the discipline by which an organization in an industry assesses, controls, exploits, finances, and monitors risks from all sources for the purpose of increasing the organization's short- and long-term value to its stakeholders.

[1] Exceptions to this argument, however, do exist. For example, see Pagach and Warr (2009).

One of the most popular definitions of ERM used in the literature (e.g., see Beasley et al., 2005; Lin and Wu, 2006; Moeller, 2007) is the one provided by COSO[2] (2004). COSO (2004, p. 2) defines ERM as:

> Enterprise risk management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives.

According to COSO (2004), an organization's ERM system should be geared toward achieving the following four objectives: (1) Strategy: high-level goals, aligned with and supporting the organization's mission. (2) Operations: effective and efficient use of the organization's resources. (3) Reporting: reliability of the organization's reporting system. (4) Compliance: organizational compliance with applicable laws and regulations.

The preceding four objectives of ERM specified by COSO (2004) expand upon, but clearly incorporate, COSO's (1992) narrower framework for internal control (IC). More to the point, COSO's (2004) notion of ERM includes a strategy objective not included in its IC framework. Audit Standard No. 5 (AS No. 5), published by the Public Company Accounting Oversight Board (2007), also emphasizes the importance of a broad view of risk management for firms listed with the US Security Exchange Commission. In the UK, the 2005 report of the Financial Reporting Council (prepared by the Turnbull Review Group and widely known as the Turnbull Guidance), while setting out best practice on internal control for UK listed companies, focuses on the broad concept of an organization's risk management.

In developing its ERM framework, COSO (2004) recognizes that the appropriate ERM system will likely vary from firm to firm. In essence, COSO suggests a contingency perspective toward the appropriate ERM system for a particular organization. The fact that there is no universally ideal ERM system is, of course, intuitive and has been suggested elsewhere (e.g., The Financial Reporting Council's Report, 2005; Beasley et al., 2005; Moeller, 2007; and AS No. 5). Furthermore, the contingency view of enterprise risk management systems is consistent with the literature that examines the more generic notion of management control systems[3] (e.g., Gordon and Miller, 1976; Otley, 1980; Gordon and Narayanan, 1984; Merchant, 1984; Chenhall and Morris, 1986; Evans et al., 1986; Gordon and Smith, 1992; Mia and Chenhall, 1994; Shields, 1995; Chenhall and Langfield-Smith, 1998; Chenhall, 2003; Luft and Shields, 2003; Gerdin and Greve, 2004, 2008).

The above notwithstanding, determining which are the key factors in the contingency relation between a firm's ERM system and its performance is far from an exact science. In fact, there is no general theoretical framework or model that can predict the key factors influencing the relation between a firm's ERM and its performance. However, based on the extant literature, there seems to be a parsimonious set of five factors that are critical to understanding the relation between ERM and firm performance. These five factors are: environmental uncertainty, industry competition, firm size, firm complexity, and board of directors' monitoring. The rationale underlying the selection of each of these factors is developed below.[4]

2.1.1. Environmental uncertainty

Environmental uncertainty (*EU*) creates difficulties for organizations due to the increasing unpredictability of the future events affecting the organization. Thus, the risks associated with a firm, and the appropriate response to such risks, will likely vary depending on the *EU* confronting the firm. The importance of considering the *EU* confronting an organization when designing management

[2] The acronym COSO stands for the Committee of Sponsoring Organizations of the Treadway Commission.

[3] An organization's ERM system is, in essence, part of the organization's management control system. For an excellent discussion of the generic notion of an organization's management control systems, see Otley and Berry (1980).

[4] Although a theoretical framework or model for selecting the key factors influencing the relation between a firm's ERM and its performance does not exist, it needs to be emphasized that we did not randomly or capriciously pick five variables for consideration in the current study. Indeed, as discussed in the body of the paper, there is strong support for including each of these variables in the study.

control systems is well established in the accounting literature (e.g., see Gordon and Miller, 1976; Gordon and Narayanan, 1984; Evans et al., 1986; Mia and Chenhall, 1994; Chenhall, 2003). An ERM system, which is a subset of an organization's management control system, is intended to identify and manage future uncertain events that may adversely affect an entity's performance. Thus, *EU* is one of those mediating variables that will likely impact the ERM-Performance relation.

One manifestation of a firm's *EU* is its earnings volatility. The importance of matching a firm's ERM to this measure of *EU* has already been noted in the literature. For example, Liebenberg and Hoyt (2003, p. 43) note that "... we expect that firms with higher earnings variability will value ERM more than other firms..." In a similar vein, we would expect a firm's *EU* to be positively associated with its need for an ERM system. Furthermore, and more germane to the study contained in this paper, we anticipate that the ERM-performance relation will be dependent on the proper match (i.e., alignment) between a firm's *EU* and its ERM system.

2.1.2. Industry competition

Industry competition is a fundamental concern to all organizations. At one end of the spectrum, there are many firms within an industry producing and/or selling similar products and/or services. In such a case, the products and/or services of one firm are close substitutes for another firm. Competition for sales in this type of industry is often fierce, which in turn means that the firms in the industry face substantial risk of not earning a sustainable level of profits. At the other end of the spectrum, there is only one firm within an industry producing and/or selling products and/or services. To the extent the demand for the firm's products and/or services exist in this latter industry, the firm's risk of not earning a sustainable level of profits is relatively low.

Based on the above, it seems reasonable to assume that the level of competition confronting a firm should be positively related to its need for enterprise risk management (e.g., see Casualty Actuarial Society, 2003, pp. 8–10). More to the point, the greater the level of competition for sales in an industry, the more valuable an ERM system should be for a firm within that industry. Thus, there should be positive relation between the degree of industry competition confronting a firm and its need for an ERM system.[5] Furthermore, and more germane to the study contained in this paper, we anticipate that the ERM-performance relation will be dependent on the proper match (i.e., alignment) between the level of industry competition confronting a firm and its ERM system.

2.1.3. Firm size

The relation between firm size and organizational structure has been a primary consideration in the organization theory literature for some time (e.g., see Lawrence and Lorsch, 1967). In accounting, researchers have also found firm size to be an important factor when considering the design and use of management control systems (e.g., Haka et al., 1985; Myers et al., 1991; Shields,1995). With respect to an ERM system, Beasley et al. (2005) and Hoyt and Liebenberg (2009) found firm size to be positively related to the adoption of ERM. Beasley et al. (2008) found that the market reaction to the adoption of an ERM system is positively related to firm size, where the adoption of an ERM system is signaled by the hiring of a Chief Risk Officer.[6] COSO (2004) also notes the importance of firm size when designing an ERM system.

The above noted literature suggests that there should be a positive relation between the size of a firm and its need for an ERM system. Furthermore, and more germane to the study contained in this paper, we anticipate that the ERM-performance relation will be dependent on the proper match (i.e., alignment) between the size of a firm and its ERM system.

[5] It could be argued that the relation between the need for an ERM and the degree of competition is best viewed as an inverted U (i.e., as the competition increases, the need for an ERM system increases at a decreasing rate and eventually decreases due to extreme levels of competition). For purposes of this paper, we assume that the extreme cases of competition are non-existent.

[6] The hiring of a Chief Risk Officer as a signal that a firm has implemented an ERM system has been used in other studies on ERM (e.g., Liebenberg and Hoyt, 2003). However, this approach for identifying the adoption of ERM is problematic, as noted by Beasley et al. (2008) in the conclusion section to their paper. Accordingly, as discussed in the next section of this paper, it is not used in our study.

2.1.4. Firm complexity

Greater firm complexity (i.e., diversity of business transactions) will likely cause less integration of information and more difficulties in management control systems within an organization. Ge and McVay (2005) and Doyle et al. (2007), for example, find material weaknesses in internal controls (which are a key part of ERM systems) are more likely for firms that are more complex. In terms of directly considering an ERM system, Hoyt and Liebenberg (2009) find that complexity is positively related to the use of ERM.

The above noted literature suggests that there should be a positive relation between the complexity of a firm and its need for an ERM system. Furthermore, and more germane to the study contained in this paper, we anticipate that the ERM-performance relation will be dependent on the proper match (i.e., alignment) between the complexity of a firm and its ERM system.

2.1.5. Monitoring by board of directors

COSO (2004) and Sobel and Reding (2004), note that an effective ERM system is dependent on active participation by an organization's board of directors. Kleffner et al. (2003) found that adoption of an ERM strategy is associated with encouragement from the board of directors. Beasley et al. (2005) found that the proportion of independent board members is positively related to the stage of ERM adoption. In addition, the New York Stock Exchange (NYSE, 2003) Corporate Governance Rules include explicit requirements for NYSE registrants' audit committees to assume specific responsibilities with respect to "risk assessment and risk management," including risks beyond financial reporting.

The above noted literature suggests that there should be a positive relation between the monitoring by a firm's board of directors and its use of an ERM system. Furthermore, and more germane to the study contained in this paper, we anticipate that the ERM-performance relation will be dependent on the proper match (i.e., alignment) between the monitoring by a firm's board of directors and its ERM system.

The preceding discussion argues that, from a performance perspective, a firm's choice of ERM system should be properly matched with several key firm-related factors. Hence, the basic argument underlying the study proposed upon in this paper can be stated as follows (Fig. 1 illustrates this argument).[7]

> The relation between a firm's ERM and its performance is contingent on the proper match between a firm's ERM and the following five firm-related variables: environmental uncertainty, industry competition, firm size, firm complexity and board of directors' monitoring.

2.2. Research design

The basic argument of this study can be empirically tested in terms of Eqs. (1) and (2) specified below. The coefficients in Eq. (1) are estimated based on firms with high performance (i.e., successful firms). It describes the proposed best practice match between ERM and the firm-related factors (variables) discussed above.[8] Eq. (2) considers the relation between a firm's performance and the appropriate "match." Eq. (2) is based on a residual analysis, whereby the absolute values of residuals (*ARES*) from Eq. (1) are regressed on firm performance

$$ERM = \beta_0 + \beta_1 EU + \beta_2 CI + \beta_3 FS + \beta_4 FC + \beta_5 MBD + \varepsilon, \quad (1)$$

where *ERM* = effectiveness of enterprise risk management,[9] *EU* = environmental uncertainty, *CI* = industry competition, *FS* = firm size, *FC* = firm complexity, *MBD* = monitoring by firm's board of directors, β_i = various model parameters, $i = 0$ to 5, and ε = error term.

[7] Given that our concern is this paper is with the overall argument rather than the effect of specific factors on the argument, we state this as the "basic argument" rather than a "basic hypothesis." However, in light of the empirical study and statistical tests used in the study, we could have stated the argument as a hypothesis.

[8] An implicit assumption of the model shown in Eq. (1) is that the five factors all have a linear impact on the best practice of ERM. Given the exploratory nature of this study, we believe that this assumption is justified. Of course, future research on this topic could, and probably should, test whether this assumption is valid.

[9] The *ERM* variable describes the effectiveness of ERM and will later be measured as the ERM index in equation (5).

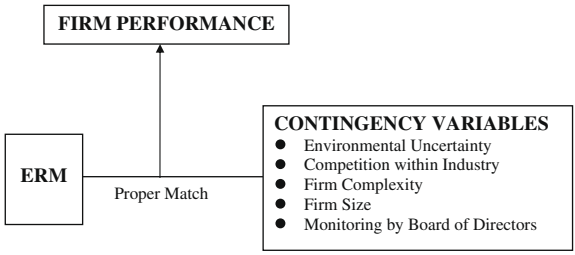

Fig. 1. Impact on firm performance of proper match between ERM and contingency variables.

$$P = \beta_0 + \beta_1 ARES + \varepsilon, \tag{2}$$

where P = firm performance, $ARES$ = absolute value of residuals from Eq. (1), β_i = various model parameters, i = 0–1, and ε = error term.

The premise underlying the residual analysis model is that the residuals derived from Eq. (1) represent a "lack of fit" in the match between ERM and the five firm-related variables shown in that equation (Drazin and Van de Ven, 1985; Duncan and Moores, 1989; Gordon and Smith, 1992).[10,11] If the basic argument in this paper is correct, the absolute value of the residuals (i.e., lack of fit) in Eq. (1) should show a "significant" negative association with firm performance in Eq. (2).[12]

3. Empirical study

3.1. Sample

The sample used for this study was derived from the US Security and Exchange Commission's EDGAR database. The study began with a search for companies that indicated they were utilizing the ERM concept in their 10Ks and/or 10Qs covering their fiscal year 2005. Following Hoyt and Liebenberg (2009), firms were initially identified as using the ERM concept based on a search of the following key terms: enterprise risk management, strategic risk management, corporate risk management, risk management committee, risk committee, and chief risk officer. The sentences that contain the key words were read to get a better sense of whether or not the ERM concept is actually being used. Appendix A provides three examples of disclosures concerning the implementation of ERM in firms. Those cases where firms are only implementing a partial risk management approach were eliminated from our sample. For example, in the case of a search for the term "risk committee," terms like "foreign exchange risk committee," "operation risk committee," and "financial risk committee" often appeared,

[10] The purpose of this study is to investigate the argument that the match of ERM to firm related factors is significantly related to firm performance and not to provide an explanation of firm performance. The capital asset pricing model assumes that risk is the consistent predictor of (stock market) performance. Accordingly, since we adjust the performance measures for the risk adjusted market return (as discussed in the next section), a full model which explains performance is not necessary.

[11] As an alternative to residual analysis, an interactive specification of the model could be utilized. Such a model would hypothesize that performance is a function of ERM, the additional firm-related factors, and their interactions (see Gerdin and Greve, 2004, for an excellent discussion of the different models specifying interactive terms). Apart from the difficulties in interpreting results with multiple firm related variables, Drazin and Van de Ven (1985) point out that interactive terms specifically model an acceleration effect on the dependent variable. Furthermore, our interest is not with the way individual contingency variables interact with ERM in affecting firm performance. Instead, it is on the holistic perspective concerning the way contingency factors interact with ERM in affecting firm performance (Drazin and Van de Ven, 1985; Gerdin and Greve, 2004). Thus, we believe the residual analysis is a better test of the holistic relation being considered in this study. More will be said about this point later in the paper.

[12] By deriving coefficients for Eq. (1) based on the high performing firms in our sample, we clearly expect the residuals resulting from regressing the performance of the remaining firms in the sample to be negative (i.e., the derived coefficients are based on "minimizing" the sum of the squared deviations of the residuals from the high performing firms). Thus, it is the statistical significance of this negative association between the absolute value of the residuals and performance in Eq. (2) that is critical in assessing the "lack of fit" between an ERM system and the contingency variables.

and these cases were not considered to be applying the ERM concept as we defined it. Firms that are risk management service providers were also eliminated from the sample.

Based on the keywords searching process, 273 US firms were identified as having implemented ERM in 2005.[13] Of these 273 firms, 159 were eliminated due to missing data. Most of the deleted firms are from the banking industry (i.e., with 60 and 61 as the first two digits of SIC codes, according to the industry classification in Fama and French (1997))[14]. Two additional firms were also deleted because they are subsidiaries of firms already in the sample. Thus, a final sample of 112 (i.e., 273-159-2) firms is used for the empirical analysis reported in this paper (a list of these firms is provided in Appendix B). These firms represent 22 industries, with the utility industry comprising the largest percentage (i.e., 34.82%) of firms identified (see Table 1).[15]

3.2. Measurement of variables

3.2.1. Firm performance

ERM focuses on the risk and return tradeoff. Accordingly, firm performance is measured in this study by the one-year excess stock market return to shareholders for 2005, as shown below in equation (3).[16] Data to measure the excess return is obtained from the Compustat database

$$P_i = R_i - [R_f + \beta_i(R_m - R_f)], \tag{3}$$

where, P_i = Performance for firm i, R_i = Return for firm i, R_m = Return for the market, R_f = Risk free rate of return, and β_i = Beta for the firm i.[17] The excess market return is a risk-adjusted performance measure, because the market returns are risk-adjusted (see Kolodny et al., 1989; Gordon and Smith, 1992). Other risk-adjusted performance metrics in the ERM literature include: risk-adjusted return on capital (RAROC), economic income created (EIC), and shareholder value-added (SVA) (see Lam, 2003, pp. 113–115).[18] These measures, however, are problematic for the following reasons. First, they are accounting-based and mainly describe past performance (lagging indicators). Second, the calculation of these measures requires subjective judgments from management.[19] Strategy-oriented performance measures for ERM have also been suggested in the literature (e.g., the balanced scorecard proposed by Beasley et al. (2006)). Although it focuses on strategy and takes a holistic view of ERM, the balanced scorecard (BSC) is not appropriate for our study due to its large number of measures and the difficulty of finding a proper approach to combine BSC's measures (Kaplan and Norton, 2001).

[13] Although our sample is only from 2005, Lam (2003, p. 45) indicates that the implementation of ERM is usually an ongoing and multiyear initiative. This implies that the identified ERM sample in our paper has a high probability of continuing ERM in the next few years.

[14] Liebenberg and Hoyt (2003) also find a high percentage (58%) of firms in the banking industry in their ERM-adoption sample. Further, Beasley et al. (2005) document that the banking industry has the largest extent of ERM implementation among industries.

[15] Due to the large percentage of firms from the utility industry, we conducted the analysis discussed in the next section of the paper without such firms. The results from this alternative set of analyses are similar and are available from the authors upon request.

[16] A one year total stock return could be used as an alternative firm performance measure due to the problems of using excess stock market returns (e.g., see Barber and Lyon, 1997; Kothari and Warner, 1997). We also considered this measure of performance. The results from using a one year total stock return are similar to using an excess return as the performance measure and therefore are not reported in this paper.

[17] The return to the market (R_m) is estimated as the one-year return to investors for S&P 500. While this overstates the market return, the overstatement is consistent across firms and provides a more conservative measure of excess performance. The risk free rate (R_f) is calculated as the five-year US government treasury bill rate. Betas (β_i) were measured as the 5-year sensitivity of a company's stock price to the overall fluctuation in the S&P 500 Index Price. More specifically, beta is the β_i derived from the following market model: $R_i = \alpha_i + \beta_i R_m + \varepsilon_i$, where R_i is the return on firm i's security; R_m is the S&P 500 Index; β_i is the systematic risk of firm i's security, equals to $COV(R_j, R_m)/VAR(R_m)$; α_i is a constant; and ε_i is the error term (see Sharpe, 1963).

[18] According to Lam (2003), RAROC = (Risk-adjusted Return)/(Economic Capital). EIC = (Risk-adjusted return) − (Hurdle rate) × (Economic Capital), and SVA = (Economic capital)[(RAROC − g)/(Hurdle rate − g) − 1], where g = growth rate.

[19] For example, economic capital represents the amount of financial resources that the institution must theoretically hold to ensure the solvency of the organization at a given confidence level and given the risks that it is expected to take (Lam, 2003). Therefore, the confidence level and the expected risk factors should be determined before a firm can calculate its economic capital.

Table 1
Industry distribution of the sample.

Industry	Number of observations	Percentage
Utility	39	34.82
Financial Trading	13	11.61
Business Service	9	8.04
Insurance	9	8.04
Drugs	6	5.36
Lab Equipment	5	4.46
Energy	4	3.57
Food	4	3.57
Autos	3	2.68
Health	3	2.68
Construction	2	1.79
Machinery	2	1.79
Retail	2	1.79
Steel	2	1.79
Transportation	2	1.79
Chips	1	0.89
Meals	1	0.89
Miscellaneous	1	0.89
Paper	1	0.89
Telecommunication	1	0.89
Toys	1	0.89
Wholesale	1	0.89
Total	112	100.00

Note: Industry classification is based on Fama and French industry classification for SIC two-digit codes (see Appendix A of Fama and French (1997)).

3.2.2. Environmental uncertainty (EU)

Environmental uncertainty is defined as the change or variability in the organization's external environment. Following Kren (1992), environmental uncertainty is measured as the combination of the following three metrics: (1) Market – Coefficient of variation of sales (Compustat #12), (2) Technological – Coefficient of variation of the sum of R&D (Compustat #46) and capital expenditures (Compustat #128) divided by total assets (Compustat #6), and (3) Income – Coefficient of variation of net income before taxes (Compustat #170). For each firm, the coefficient of variation is calculated over the 2001–2005 period based on first differences[20]. The composite measure of *EU*, and the individual coefficients are computed as shown in equation (4) below.

$$EU = \log\left(\sum_{k=1}^{3} CV(X_k)\right), \tag{4}$$

where $CV(X_k) = \frac{\sqrt{\sum_{t=1}^{5}\frac{(z_{k,t}-\bar{z}_k)^2}{5}}}{|\bar{z}_k|}$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty k in year t, $CV(X_k)$ = coefficient of variation of uncertainty k, t = 1,2,...,5 to represent years 2001–2005, k = 1,2,3 to represent market, technological or income uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty k. The absolute value of $\bar{z}_k$ is used as the denominator of $CV(X_k)$ to avoid the case where a negative $\bar{z}$ turns an uncertainty situation into a certainty situation.

3.2.3. Industry competition (CI)

Industry competition is measured as one minus the Herfindahl–Hirschman Index (*1-HHI*). The *HHI* is derived from the sum of squared market shares of all firms in the industry. The *HHI* measures the industry concentration, where less concentration means more competition. Market share is defined as

[20] First differences were used because they provide a better measure of discontinuities, as pointed out by Bourgeois (1985).

each firm's sales (Compustat #12) divided by the total sales of the industry. Each industry is defined as all active Compustat firms with the same first two digits of the SIC code.[21]

3.2.4. Firm complexity (FC)

As pointed out by Doyle et al. (2007), and Ge and McVay (2005), firm complexity is associated with the number of business segments within a firm. That is, more business segments are considered to increase a firm's complexity. Accordingly, we used this factor as our measure of firm complexity for each firm. The actual number of segments for each firm were derived from Compustat data. For firms with missing data about business segments, we hand-collected the information from 10-K files.

3.2.5. Firm size (FS)

Firm size in this study is measured as the natural logarithm of average total assets (Compustat #6). This metric for size is commonly used in accounting studies (e.g., Francis et al., 2004; Ge and McVay, 2005). Market value, another frequently used measure for firm size, is not chosen to measure firm size because firm performance has been measured using the information about stock prices.

3.2.6. Monitoring by board of directors (MBD)

As noted earlier in the paper, the literature has established a relation between monitoring by the board of directors and ERM. The size of the board of directors is one of the factors that has been widely examined in the corporate governance literature (e.g., see Larcker et al., 2007). In this study, we define and measure a variable Monitoring by Board of Directors by dividing the number of directors for each firm by the natural logarithm of sales ((number of directors)/log(sales)).[22] Dividing the number of directors by the log of sales adjusts for the scale effect.[23] Data for this variable were collected from the firms' 2005 10-K filings. We also consider the number of board meetings in a year as an alternative measure for board monitoring and the results from using this alternative measure are provided as a robustness check in Section 5.

3.2.7. Enterprise Risk Management Index (ERMI)

Discussions of ERM are generally devoid of any specifics on how to quantitatively measure the concept. Accordingly, we develop an ERM Index (*ERMI*) for measuring a firm's ERM used in Eq. (1). The Index is based on COSO's four objectives of ERM. In other words, we developed an index of the effectiveness of an organization's ERM based on its ability to achieve its objectives relative to strategy, operations, reporting, and compliance.[24] The basic goal of the *ERMI* is to combine the achievement of the above four objectives into one metric. Two indicators are used for measuring the achievement of each objective. The *ERMI* is then constructed by summing up all eight indicators for the above four objectives, as Eq. (5) shows

$$ERMI = \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k. \quad (5)$$

Each indicator is standardized among the sample of 112 ERM firms before being combined in Eq. (5). The definition and related data for each indicator are explained below. Whenever the industry is mentioned, the industry is measured as all active firms with the same two-digit SIC code in Compustat.

[21] The *HHI* is generally considered to be a better measure of competition intensity than a four-firm concentration ratio or the number of firms in the market because *HHI* combines information about the number of firms in a market and their size distribution (Krishnan, 2005).

[22] The percentage of outside directors on the board has been used for measuring the board's monitoring power (Bushman and Smith, 2001). However, 97% of our identified ERM firms are listed on NYSE and subject to strict rules regarding the outside directors. For example, according to NYSE (2003), Section 303 requires nominating and compensation committees to be entirely composed of outside directors. Therefore, the percentage of outside directors is unable to measure the relative monitoring by board of directors among the firms used in this study.

[23] Sales, instead of the firm's assets, are chosen for this scale effect because assets have been used for measuring the firm size.

[24] COSO (2004) provides a discussion on why an organization's ERM system should be geared toward achieving these four objectives. More will be said about the link between each of these objectives and ERM later in this section.

3.2.7.1. Strategy. Strategy refers to the way a firm positions itself in the market place relative to its competition. When executing its strategy, a firm tries to develop a competitive advantage over participants in the same industry (Porter, 2008). This competitive advantage should lower a firm's overall risk of failure, and thus increase a firm's performance and value.

All firms in the same industry compete for the sales opportunities in the same market. Thus, more sales by firm *i* relative to the industry's average sales means firm *i* is outperforming its average competitors. Hence one measure of whether or not a firm has a successful strategy is the number of standard deviations its sales (Compustat #12) deviates from the industry sales, as shown below[25]

$$Strategy_1 = \frac{Sales_i - \mu_{Sales}}{\sigma_{Sales}}$$

where $Sales_i$ = Sales of firm *i* in 2005, μ_{Sales} = average industry sales in 2005, and σ_{Sales} = standard deviation of sales of all firms in the same industry.

A second measure of whether or not a firm has a successful strategy, especially in the context of ERM, is the firm's ability to reduce its systematic risk. That is, a major benefit of implementing ERM is to diversify, and thus reduce risks, by managing a portfolio of risks arising from all sources (Tufano, 1996; Hoyt and Liebenberg, 2009; Nocco and Stulz, 2006). Thus, a strategy of managing systematic risk is important to the practice of ERM. The rationale behind this notion is that the systematic risk (i.e., beta) from the market model describes a firm's undiversified risk, and a more successful diversification strategy can reduce this risk (Thompson, 1984). Thus, our second measure of strategic success is a firm's reduction in its beta, relative to the other firms in the same industry

$$Strategy_2 = \frac{\Delta\beta_i - \mu_{\Delta\beta}}{\sigma_{\Delta\beta}},$$

where $\Delta\beta_i = -(\beta_i \text{ in } 2005 - \beta_i \text{ in } 2004)$, β_i = firm *i*'s beta (data from Compustat), $\mu_{\Delta\beta}$ = average industry $\Delta\beta$ in 2005, and $\sigma_{\Delta\beta}$ = standard deviation of $\Delta\beta$'s of all firms in the same industry.

3.2.7.2. Operations. Operations (i.e., operating efficiency or productivity) can be measured as the input–output relation within the process of a firm's operations (Banker et al., 1989). More output for a given level of input or less input for a given level of output means better operating efficiency. Higher operating efficiency should lower a firm's overall risk of failure, and thus increase it performance and value.

Thus, the turnover of assets, defined as sales (Compustat #12) divided by total assets (Compustat #6), is one measure of operating efficiency (Kiymaz, 2006). This measure is shown below

$$Operation_1 = (Sales)/(Total\ Assets)$$

Another measure of operating ratio is the input–output ratio from operations defined by dividing sales (Compustat #12) by the number of employees (Compustat #29). This measure is shown below

$$Operation_2 = Sales/(Number\ of\ Employees)$$

3.2.7.3. Reporting. The reporting concept is easiest to discuss in terms of *reporting reliability*.[26] Illegal earnings management, financial restatements, and financial fraud all provide evidence of poor financial reporting quality (Cohen et al., 2004). Poor financial reporting should increase a firm's overall risk of failure, and thus decrease it performance and value.

[25] Market share could be another measure for a firm's relative advantage to its industry competitors. In other words, larger market share implies higher competitive advantage for a firm. However, by scaling a firm's deviation from industry average sales with the standard deviation of sales of all firms in the same industry, our $Strategy_1$ considers the risks of outperforming industry average sales. Therefore, with the purpose of measuring the achievement of ERM's strategic objective, our $Strategy_1$ is considered a more appropriate measure than market share.

[26] FASB (1980)'s SFAC No. 2 paragraph 59 states "the reliability of a measure rests on the faithfulness with which it represents what it purports to represents, coupled with an assurance for the user, which comes through verification, that it has representational quality". Reporting reliability covers only the representational dimension of the reporting quality. Our *ERMI* focuses on the reliability of financial reporting following COSO's (2004) definition of reporting objectives in its discussion of ERM.

One measure for poor reporting reliability is the combination of the following three readily observed variables: *Material Weakness*, *Qualified Auditor Opinion*, and *Restatement*. Firms listed on the US stock exchanges are mandated to disclose any material weakness of internal control in financial reporting following the requirement of the Sarbanes-Oxley Act of 2002. If a firm discloses any material weakness in its annual report, the variable *Material Weakness* is set to −1, otherwise it is set to 0. Auditors express their opinions about the financial reporting of firms in their auditor reports. Firms with unqualified opinions in their auditor's report have the variable *Auditor Opinion* set equal to 0, otherwise it is set to −1. The data about *Material Weakness* and *Auditor Opinion* were collected from the 2005 annual reports in the EDGAR database. The restatement of a firm's financial statements is viewed as a reduction of a firm's reporting reliability. The US Government Accountability Office (GAO, 2006) provides a database containing a firms' announcements of financial restatements. If a firm announced a restatement in 2005, the variable *Restatement* is set to −1, otherwise it is set to 0. The range for $Reporting_1$ is therefore from −3 to 0.

$$Reporting_1 = (Material\ Weakness) + (Auditor\ Opinion) + (Restatement)$$

The absolute value of abnormal accruals has also been used to measure poor financial reporting quality (Johnson et al., 2002).[27] Thus, a second measure of a firm's reporting reliability used in this study is the relative proportion of the absolute value of normal accruals divided by the sum of the absolute value of normal and abnormal accruals.[28] Absolute values are used because both normal accruals and abnormal accruals could be negative. Thus, their relative strengths are better measured by using their absolute values.

The abnormal accruals are estimated using the cross-sectional Jones (1991) accruals estimation model, as described in DeFond and Jiambalvo (1994) and Defond and Subramanyam (1998). In this model, normal accruals are estimated as a function of the change in revenue (Compustat #12) and the level of property, plant and equipment (Compustat #8). These variables control for changes in accruals that are due to changes in the firm's economic condition. Total assets (Compustat #6) at the beginning of the year are used as the deflator for all variables in the model. The abnormal accruals are estimated from equation (6) below

$$TA_{ijt}/A_{ijt-1} = \alpha_{jt}[1/A_{ijt-1}] + \beta_{1jt}[\Delta REV_{ijt}/A_{ijt-1}] + \beta_{2jt}[PPE_{ijt}/A_{ijt-1}] + e_{ijt}, \quad (6)$$

where t = year 2005, TA_{ijt} = total accruals for firm i in industry j, A_{ijt-1} = total assets for firm i in industry j, ΔREV_{ijt} = change in net revenues for firm i in industry j, PPE_{ijt} = gross property plant and equipment for firm i in industry j, and e_{ijt} = error term for firm i in industry j.

Total accruals are defined as income before extraordinary items (Compustat #18) minus operating cash flows (Compustat #308). Industry-specific estimates are obtained from the coefficients in the ordinary least squares Eq. (6). The variable for abnormal accruals (i.e., *AbnormalAccruals*) is the error term from the regression model shown in Eq. (6). The variable normal accruals (i.e., *NormalAccruals*) is defined as Total Accruals minus (*AbnormalAccruals*). $Reporting_2$ is then measured as the following:

$$Reporting_2 = \frac{|NormalAccruals|}{|NormalAccruals| + |AbnormalAccruals|}$$

3.2.7.4. Compliance. Increased compliance with applicable laws and regulations should lower a firm's overall risk of failure, and thus increase it performance and value. O'keefe et al. (1994) found compliance with Generally Accepted Auditing Standards (GAAS) increases with audit fees. Thus, the first

[27] Johnson et al. (2002, p. 644) notes that the use of absolute values for reporting reliability depends on whether there is a priori expectation regarding the direction of managerial incentives. The measurement of reporting reliability in this study is not related to directional management incentives. Therefore the absolute value is used.

[28] As summarized by Johnson et al. (2002), the literature usually focuses on abnormal accruals, which measures the lack of reporting reliability. Thus the common measure is |*Abnormal Accruals*| / (|*Normal Accruals*| + |*Abnormal Accruals*|). This study intends to measure the strength of the reporting reliability. Therefore, we place the normal accruals in the numerator of our measure |*Normal Accruals*| / (|*Normal Accruals*| + |*Abnormal Accruals*|).

measure of *compliance* used in the study reported in this paper is the proportion of auditor's fees to net sales revenue (Compustat #12). Auditor's fees are paid mainly for the services derived from auditing financial statements, certification, examining individual and consolidated accounts, due-diligence reviews, agreed-upon procedures (e.g., confirming compliance with specific contractual agreements), and tax compliance and consultancy. The data for auditor's fees (*Auditor Fees*) are collected from proxy statements and scaled by total assets (Compustat #6).

$$Compliance_1 = \frac{Auditor\ Fees}{Total\ Assets}$$

If firms put more effort into regulation compliance, it seems reasonable to expect that they will have less settlement losses and more settlement gains. According to Shavell (1982), when a defendant commits an unlawful act that harms the plaintiff, if the plaintiff decides to bring suit, a settlement will be reached if and only if there exists some settlement amount that both sides would prefer rather than going to trial. In other words, a firm's disclosure of settlement gains or losses implies that a settlement has been reached. The reported amount of settlement gains (losses) reflects both the plaintiff's and the defendant's agreement on their ex ante evaluations. If one firm complies with regulations to a greater extent than another firm, that firm should have a better chance of being a plaintiff to file a suit and settling with higher net gains (or lower net losses). Thus, the second measure of compliance used in the study reported upon in this paper is the settlement net gains (losses) (Compustat #372) over total assets (Compustat #6)[29]

$$Compliance_2 = \frac{Settlement\ Net\ Gain\ (Loss)}{Total\ Assets}$$

The ERM Index (*ERMI*) is derived from the sum of the indicators discussed above. The definition of *ERMI* is summarized in Appendix D.

3.3. Testing method

As discussed in Section 2 of this paper, the relation between ERM and firm performance is viewed as being contingent on the proper match between a firm's ERM and its environmental uncertainty, industry competition, size, complexity, and board of directors' monitoring. Thus, following Gordon and Smith (1992), we derive the functional relation between the *ERMI* (which is used as a proxy for a firm's ERM in Eq (1)), calculated from Eq. (5), and the five contingency factors for high performing firms. High performing firms are defined as those with an excess return greater than 2%.[30] In total there are 53 high performing firms. The coefficients for the five contingency factors are derived based on these high performing firms. In other words, the high performing firms are used as the "best practice" (or benchmark) group of firms for deriving the relation between ERM and the five contingency variables. Eq. (7) is used to estimate this relation for high performing firms, and Eq. (8) represents the estimated model

$$ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \varepsilon_i \tag{7}$$

$$\widehat{ERMI}_i = \widehat{\beta_0} + \widehat{\beta_1} EU_i + \widehat{\beta_2} CI_i + \widehat{\beta_3} FC_i + \widehat{\beta_4} FS_i + \widehat{\beta_5} MBD_i. \tag{8}$$

Instead of focusing on individual contingency variables, this proposed "best practice" model emphasizes the holistic perspective concerning the way all contingency variables are related to ERM. Firms following this "best practice" model will presumably have a higher performance than those that follow a different model. To test the basic argument in this paper, residual analysis is used. Residual analysis has the advantage of using the holistic concept of fit by simultaneously including internal controls, contextual variables, and firm performance (Duncan and Moores, 1989). For all

[29] Note that Compustat #372, Settlement Net Gain (Loss), is shown as a negative number when there is a net loss.
[30] We also try other cut-offs of excess returns for the high performing firms, as discussed in Section 5 of this paper.

firms, the absolute value of the residuals (*ARES*) is calculated by utilizing the derived coefficients from high performing firms in Eq. (8). The *ARES* variable measures the deviation from the proposed best fit determined by high performing firms. That is,

$$ARES_i = \left| ERMI_i - \widehat{ERMI}_i \right| \tag{9}$$

The relationship between *ARES* and firm performance can then be tested by the following model.

$$P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i \tag{10}$$

In Eq. (10), *ARES* is expected to be negatively related to the firm performance (i.e. β_1 in Eq. (10) is expected to be negative). The reason for this expectation is that *ARES* measures the deviation from the "best practice" (or best fit) in terms of matching the firm's ERM and its contingency variables (e.g., see Drazin and Van de Ven, 1985). The greater (smaller) the deviation in this match between a firm's ERM and its contingency variables, the smaller (greater) the expected performance.

4. Empirical results

4.1. Summary statistics and univariate test

Summary statistics for the total sample, plus a break-down for the high performing firms and the other firms are provided in Table 2. Based on the cutoff of a 2% one-year excess return, there are 53 high performing firms in the sample. The average *ERMI* for the high performing group is −0.067, as compared to 0.061 for the remaining 59 firms. These two groups are not statistically different in the means of their *ERMI* (test of difference in means shows *p*-value 0.798). In addition, the means for all five contingency variables of the high performing group of firms are not statistically different than the means for the other firms. These results indicate that *ERMI* and the five contingency variables, by themselves, do not account for high performance.

Table 3 provides the Spearman and Pearson correlation analysis for all 112 firms. As shown in the table, *MBD* is highly correlated with *EU* (Pearson correlation coefficient 0.174 with *p*-value 0.067) and *FS* (Pearson correlation coefficient −0.478 with *p*-value <0.001). These strong correlations suggest the possibility of multicollinearity in the estimation of model (7). Thus, we will also check the Variance Inflation Factor (or VIF) and Tolerance along with our analysis of the model (7).[31]

4.2. Main results

Results from the regression model (7) for the total sample as well as the break-down between high performing firms and other firms, are shown in Panel A of Table 4. For the group of high performing firms, industry competition, firm complexity, firm size and board monitoring have a significant effect on the effectiveness of the ERMI (their *p*-values are 0.016, 0.081, 0.004, and 0.001, respectively). The one contingency variable not having a significant effect on the *ERMI* is environmental uncertainty (*p*-value of 0.159). For the firms which are not the high performers, none of the contingency variables shows a significant effect on the *ERMI* (*MBD* shows the smallest *p*-value of 0.124). Since contextual factors are usually exogenous variables, these results suggest high performing firms are taking contingency variables more seriously than the other firms in their implementation of ERM. The other findings shown in Table 4, Panel A, are that the VIFs (tolerances) are very low (high) for all regressors. For high performing firms, the largest VIF is 1.308 for *MBD*, which is much lower than 10, the benchmark of having multicollinearity. Thus, multicollinearity does not present a problem in the regression analysis.

[31] The VIF represents a factor by which the variance of the estimated coefficient is multiplied due to the multicollinearity in the model. Values of VIF exceeding 10 and tolerance less than 0.1 are often regarded as indicating multicollinearity (Ayyangar, 2007, p. 5) The Tolerance is the proportion of variance in a given predictor that is not explained by all of the other predictors, while the VIF is simply 1/tolerance.

Table 2
Summary statistics.

Variables	Total sample		High performing firms (excess return >2%)		The other firms (excess return ⩽2%)		Test of differences in means	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Difference	*p*-Value
P	0.988	26.905	21.748	18.604	−17.660	18.098	39.407	<0.001
ERMI	0.000	2.628	−0.067	2.273	0.061	2.928	−0.128	0.798
EU	2.115	1.170	2.203	1.358	2.036	0.975	0.167	0.454
CI	0.953	0.051	0.952	0.056	0.954	0.046	−0.002	0.823
FC	0.473	0.232	0.455	0.224	0.489	0.241	−0.034	0.442
FS	8.692	2.171	8.981	2.066	8.433	2.246	0.547	0.184
MBD	1.263	0.293	1.269	0.267	1.257	0.316	0.013	0.822
Number of observations	112		53		59			

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. *ERMI* (ERM Index) $= \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU* (Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty k in year t, k = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) and income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty k. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms.

Table 3
Sample Spearman/Pearson correlation coefficients (N = 112).

	P	*ERMI*	*EU*	*CI*	*FC*	*FS*	*MBD*
P	1	0.095 (0.319)	0.082 (0.388)	−0.037 (0.702)	−0.110 (0.251)	0.148 (0.120)	−0.045 (0.634)
ERMI	0.041 (0.669)	1	−0.190 (0.045)	−0.280 (0.003)	−0.062 (0.513)	−0.035 (0.715)	−0.286 (0.002)
EU	0.071 (0.459)	−0.198 (0.037)	1	0.060 (0.529)	−0.027(0.777)	−0.064 (0.503)	0.174 (0.067)
CI	0.126 (0.186)	−0.304 (0.001)	0.135 (0.155)	1	0.142 (0.135)	−0.103 (0.278)	0.122 (0.201)
FC	−0.044 (0.649)	−0.150 (0.114)	−0.004 (0.967)	0.171 (0.072)	1	−0.056 (0.558)	0.072 (0.454)
FS	0.198 (0.036)	−0.071 (0.457)	0.059(0.537)	0.028 (0.770)	0.028 (0.771)	1	−0.478 (<0.001)
MBD	0.088 (0.356)	−0.287 (0.002)	0.162 (0.088)	0.221 (0.019)	0.073 (0.446)	−0.353 (<0.001)	1

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. *ERMI* (ERM Index) $= \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU* (Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty k in year t, k = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) and income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty k. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms. Pearson correlations are reported above the diagonal, and Spearman correlations are reported below.

The coefficients derived from the group of high performing firms, as shown in Panel A of Table 4, represent the proposed proper match between ERM and the contingency variables. In other words, all coefficients in Eq. (8) should be replaced by the coefficients from the high performing group of firms in Table 4, based on the following equation

$$\widehat{ERMI}_i = 20.454 - 0.269EU_i - 11.423CI_i - 2.056FC_i - 0.397FS_i - 3.586MBD_i. \quad (11)$$

According to our main hypothesis, if all firms choose the "best practice" match between their ERM and the contingency variables based on the specification in Eq. (11), they would improve their opportunity for high performance. To test this hypothesis, we need to assess whether a higher deviation of a firm's *ERMI* from it's $\widehat{ERMI}$ is associated with lower (i.e., worse) firm performance. Thus, firm performance is regressed on $ARES_i$ (where $ARES_i = ERMI_i - \widehat{ERMI}$) for all firms, as shown in regression Eq. (10). The results of this residual analysis are shown in Panel B of Table 4. As hypothesized, the coefficient of *ARES* (−3.368) is negative and significant (at the level of 0.05). In other words, *ARES* is negatively associated with firm performance. Accordingly, the results in Panel B of Table 4 support the main argument that the proper match between ERM and the contingency variables is an important driver of firm performance. The importance of this proper match for firm performance is strengthened by the results in Table 2, where neither the *ERMI* nor the contingency variables by themselves show a significant difference between the high performing group of firms and the lower performing firms.

5. Robustness checks

5.1. Propensity matched sample

The propensity matched sample is created for two robustness checks. The first check is to see if firms self-select to implement ERM (Hoyt and Liebenberg, 2009). Some of the factors that are correlated with a firm's choice of adopting ERM may also be correlated with the observed effectiveness of ERM (i.e., the *ERMI* variable) and firm performance (i.e., the *P* variable). With the propensity matched sample, we can check whether our results in the main analysis are robust to adding 112 non-ERM firms with the same propensity of adopting ERM. We can also control for this self-selection choice by including in our model (Eq. (7)) another variable indicating whether a firm is implementing ERM (as discussed later and shown in Eq. (13)). In other words, we can control for a firm's self-selection of ERM in developing our proposed proper match between ERM and contingency variables, which supplies the residual analysis with the residuals (and *ARES*) that have been corrected for the self-selection problem.

Second, we can use the propensity matched sample to check whether our *ERMI*, defined as the extent of achieving the four ERM objectives in COSO (2004), is a valid measure for the effectiveness of a firm's ERM. If the main pursuit of ERM firms is the four ERM objectives in COSO and our construct of *ERMI* in Eq. (5) properly measures the achievement of those objectives (after controlling for the propensity to adopt ERM), the ERM sample of firms should have a higher *ERMI* than the non-ERM control sample of firms.

Our propensity matched sample is created by matching 112 ERM firms with the 112 non-ERM same-industry firms having the closest propensity scores of implementing ERM.[32] The propensity scores are the predicted probabilities from a probit regression model that estimates the likelihood of adopting ERM (AERM). The variables used in the probit model are *Big4*, firm size (*FS*), Z-score (*ZScore*), debt–equity ratio (*DE Ratio*), *Investment Opportunity*, and *Foreign Transaction*, as shown in Eq. (12) below

$$Prob(AERM_i = 1) = \beta_0 + \beta_1 Big4_i + \beta_2 FS_i + \beta_3 ZScore_i + \beta_4 DE\ Ratio_i + \beta_5 Investment\ Opportunity_i + \beta_6 Foreign\ Transaction_i + \varepsilon_i. \quad (12)$$

The variables in Eq. (12) are as follows. We use a dummy variable, $AERM_i$, to indicate whether firm *i* adopted ERM ($AERM_i = 1$) or did not adopt ERM ($AERM_i = 0$) at any point during 2005. We choose the six determinants in our probit regression based on the literature related to the determinants of ERM (Liebenberg and Hoyt, 2003; Beasley et al., 2005; Hoyt and Liebenberg, 2009). $Big4_i$ is a dummy variable and is set to one if firm *i*'s auditor was from a big four CPA firm, or set to zero otherwise. FS_i stands for firm size and is measured as the logarithm of firm *i*'s total assets (Compustat #6). $ZScore_i$ is the Z-score developed by Altman (1968) to proxy for firm *i*'s financial distress. $DE\ Ratio_i$ is derived

[32] Same industry firms are defined as active firms with the same first two digits SIC code in Compustat.

Table 4
Main analysis.

Number of observations	Total Sample 112		High performing firms (excess return >2%) 53		The other firms (excess return ⩽2%) 59	
Variables	Coefficients (p-value)	VIF (Tolerance)	Coefficients (p-value)	VIF (Tolerance)	Coefficients (p-value)	VIF (Tolerance)
Panel A. Regression of ERMI on contingent variables: $ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \varepsilon_i$						
β_0 (Intercept)	19.403 (<0.001)	N/A (N/A)	20.454 (<0.001)	N/A (N/A)	16.301 (0.076)	N/A (N/A)
β_1 (*EU*)	−0.293 (0.143)	1.036 (0.966)	−0.269 (0.159)	1.076 (0.930)	−0.302 (0.468)	1.127 (0.887)
β_2 (*CI*)	−12.944 (0.005)	1.039 (0.963)	−11.423 (0.016)	1.115 (0.897)	−12.271 (0.151)	1.032 (0.969)
β_3 (*FC*)	−0.213 (0.830)	1.026 (0.974)	−2.056 (0.081)	1.104 (0.905)	1.153 (0.479)	1.051 (0.951)
β_4 (*FS*)	−0.283 (0.020)	1.300 (0.769)	−0.397 (0.004)	1.207 (0.829)	−0.1182 (0.393)	1.556 (0.643)
β_5 (*MBD*)	−3.076 (0.001)	1.342 (0.745)	−3.586 (0.001)	1.308 (0.765)	−2.345 (0.124)	1.557 (0.642)
F-Statistic (p-value)	5.37 (<0.001)		7.68 (<0.001)		1.28 (0.287)	
R^2	0.202		0.450		0.108	
Variable						Coefficients (p-value)
Panel B. Residual analysis (all 112 ERM firms): $P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i$						
Intercept						6.796 (0.063)
ARES						−3.368 (0.028)
F-Statistic						4.93 (0.028)
R^2						0.043

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. *ERMI* (ERM Index) $= \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU* (Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty k in year t, k = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) and income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty k. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms. $\widehat{ERMI}_i = 20.454 - 0.269EU_i - 11.423CI_i - 2.056FC_i - 0.397FS_i - 3.586MBD_i$. $ARES_i = |ERMI_i - \widehat{ERMI}_i|$.

by dividing total debt (Compustat #9 + Compustat#34) by stockholder's equity (Compustat #216) to measure firm *i*'s financial leverage. *Investment Opportunity*$_i$ is a proxy for firm *i*'s investment opportunities and derived by summing capital expenditures (Compustat #128) and R&D expenditures (Compustat #46) scaled by the firm's total assets. *Foreign Transaction*$_i$ measures the exclusion from international business and is a dummy variable that takes on a value of one if firm *i* has foreign currency adjustments (Compustat #150) in 2005, and zero otherwise. β_0 through β_6 are estimation coefficients. ε_i is the error term. Data for all six determinants in (12) are derived from Compustat.

The probit regression model (12) is estimated using 244 ERM firms and 7232 firms in the Compustat database with available data that never disclose any ERM in their 2005 filings.[33] The results are presented in Appendix C. The propensity scores, or the predicted probabilities from the above probit model, are matched to the 112 ERM sample with non-ERM firms in the same industry and the closest propensity scores. This method, known as propensity score matching (LaLonde, 1986), creates a non-ERM control sample of 112 firms with the same predicted probabilities of adopting ERM.

Panel A of Table 5 shows the univariate test for the difference between the ERM and non-ERM firms. By looking at the test of differences in means, Performance (*P*), *ERMI*, and the five contingency variables, we do not see any significant difference between the two groups. It is worth noting that the mean of *ERMI* for the ERM group of firms (0.257) is higher than that for non-ERM group of firms (−0.257), but their difference (0.514) is not significant (*p*-value = 0.146). This evidence from the univariate test suggests that our *ERMI* is a fair, although not a perfect, index for measuring the effectiveness of ERM.

In order to control for a firm's self-selection of ERM, we use the 110 high performing firms of 224 propensity matched firms (i.e., 112 ERM firms and 112 non-ERM firms) to develop the proposed proper match, where the high performing firms are defined as $p > 2\%$, the same as in our main analysis in Section 4. We also modify our model (7) by adding the control variable $AERM_i$, as shown in Eq. (13) below

$$ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \beta_6 AERM_i + \varepsilon_i. \quad (13)$$

The results for Eq. (13) are shown in Panel B of Table 5. Some coefficients of the contingency variables are not as significant as in our main analysis in Section 4. This weakened result could be due to the fact that we include non-ERM firms in our analysis, since non-ERM firms do not implement ERM and therefore the notion of considering contingency variables for ERM is not relevant. Moreover, we want to analyze the coefficients of $AERM_i$ to check the validity of our *ERMI* construct. If our *ERMI* is a valid measure for the effectiveness of ERM, those who adopted ERM are expected to have higher *ERMI* than non-adopters, resulting in positive coefficients for *AERM*. The coefficients for $AERM_i$ are consistently positive: 0.571, 0.311, and 0.65 for the total sample, high performing firms, and the other firms, respectively. The coefficient of $AERM_i$ for the total sample is close to the 10% level of significance (*p*-value 0.103). This result confirms the evidence from our univariate test that our *ERMI* is a fair although not perfect measure for the effectiveness of ERM.

The coefficients for the high performing group in Panel B of Table 5 represent the proposed proper match between ERM and contingency variables. These coefficients are used for the residual analysis shown in Panel C of Table 5. The coefficient of *ARES* is negative and significant, suggesting that deviations from the proposed proper match are negatively related to firm performance. Therefore, after correcting for the self-selection bias, the empirical evidence still supports our basic argument that the relation between ERM and firm performance is contingent on the proper match between ERM and contingency variables considered in this paper.

5.2. Different cutoffs for high performing firms

The main analysis in this study chose a cutoff of a one-year, 2% excess return, for high performing firms (following Gordon and Smith, 1992). Since the analysis might be sensitive to a change in the

[33] As in Section III, from the keyword search we identify a total of 273 firms that disclose the implementation of ERM in their 2005 10Ks and 10Qs. Although only 112 ERM firms have available data for our main analysis, 244 among the 273 firms have available data for developing the propensity of adopting ERM (Eq. (12)).

Table 5
Propensity score matched sample.

Variables	ERM firms		Non-ERM matched sample		Test of differences in means	
	Mean	Std. dev.	Mean	Std. dev.	Difference	*p*-Value
Panel A. Univariate test of differences in means						
P	0.988	26.905	6.424	38.217	−5.436	0.220
ERMI	0.257	2.667	−0.257	2.613	0.514	0.146
EU	2.115	1.170	1.997	1.186	0.118	0.455
CI	0.953	0.051	0.948	0.089	0.006	0.564
FC	0.473	0.232	0.398	0.728	0.075	0.300
FS	8.692	2.171	8.311	2.502	0.382	0.224
MBD	1.263	0.293	1.147	3.995	0.115	0.761
Number of observations	112	112				

Number of observations	Total sample	High performing firms (excess return >2%)	The other firms (excess return ⩽2%)
	224	110	114
Variables	Coefficients (*p*-value)	Coefficients (*p*-value)	Coefficients (*p*-value)
Panel B. Regression of ERMI on contingent variables: $ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \beta_6 AERM_i + \varepsilon_i$			
β_0 (Intercept)	5.681 (0.026)	13.364 (<0.001)	4.083 (0.337)
β_1 (*EU*)	−0.404 (0.007)	−0.268 (0.100)	−0.553 (0.005)
β_2 (*CI*)	−6.177(0.022)	−13.028 (0.002)	−4.889 (0.265)
β_3 (*FC*)	−0.195 (0.765)	−0.475 (0.597)	0.172 (0.860)
β_4 (*FS*)	0.090 (0.235)	−0.026 (0.798)	0.143 (0.249)
β_5 (*MBD*)	0.044 (0.733)	0.013 (0.936)	0.025 (0.916)
β_6 (*AERM*)	0.571 (0.103)	0.311 (0.467)	0.650 (0.248)
F-Statistic (*p*-value)	2.82 (0.012)	2.90 (0.012)	1.40 (0.223)
R^2	0.072	0.145	0.073
Variable			Coefficients (*p*-value)
Panel C. Residual analysis (all 112 ERM firms and 112 non-ERM matched firms): $P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i$			
Intercept			10.913 (<0.001)
ARES			−3.861 (<0.001)
F-Statistic (*p*-value)			11.40 (<0.001)
R^2			0.049

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. $ERMI(\text{ERM Index}) = \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU* (Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty *k* in year *t*, *k* = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) or income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty *k*. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms. ERM_i is set to one if firm *i* is an ERM firm and set to zero if firm *i* is a non-MRM matched firm. $\widehat{ERMI}_i = 13.364 - 0.268EU_i - 13.028CI_i - 0.475FC_i - 0.026FS_i + 0.013MBD_i + 0.311ERM_i$. $ARES_i = |ERMI_i - \widehat{ERMI}_i|$.

cutoff for high performing firms, we also selected different cutoffs for high performing firms to address this concern. Specifically, we consider a one-year excess return cutoff from 0% to 10% (in increments of 1%). The lowest cutoff considered is a 0% one-year excess return because it makes no sense to define firms with negative excess returns as high performers. The highest cutoff we test is a 10% one-year excess return because beyond 10% the number of high performing firms is reduced to less than 32, which would result in a statistical test of low power.

Table 6 shows the results under the different cutoffs of high performing firms. Besides *EU*, the coefficients for the other four contingency variables are always significant, although this signifi-

Table 6
Different cutoffs of high performing firms.

Number of high-performers	High performing firms are firms with one-year excess return >										
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
	61	59	53	51	47	45	41	39	37	36	32
Variables	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)	Coef (*p*-value)
Panel A. Regression of ERMI on contingency variables: $ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \varepsilon_i$											
β_0 (Intercept)	21.233 (<0.001)	20.930 (<0.001)	20.454 (<0.001)	20.090 (<0.001)	19.839 (<0.001)	19.604 (<0.001)	19.536 (<0.001)	20.045 (<0.001)	14.563 (0.007)	14.611 (0.008)	13.899 (0.012)
β_1 (*EU*)	−0.191 (0.271)	−0.198 (0.261)	−0.269(0.159)	−0.257 (0.182)	−0.279 (0.129)	−0.286 (0.152)	−0.277 (0.190)	−0.248 (0.252)	−0.183 (0.400)	−0.185 (0.406)	−0.152 (0.524)
β_2 (*CI*)	−12.585 (0.001)	−12.269 (0.003)	−11.423 (0.016)	−11.210 (0.020)	−10.461(0.022)	−10.374(0.026)	−9.899 (0.042)	−9.490 (0.055)	−6.841 (0.154)	−6.890 (0.161)	−6.624 (0.190)
β_3 (*FC*)	−2.325 (0.022)	−2.221 (0.035)	−2.056(0.081)	−2.149 (0.073)	−2.144 (0.058)	−2.074(0.075)	−1.855 (0.145)	−2.214 (0.096)	−1.914 (0.131)	−1.938 (0.141)	−1.713 (0.233)
β_4 (*FS*)	−0.403 (0.001)	−0.378 (0.004)	−0.397 (0.004)	−0.367 (0.009)	−0.373 (0.006)	−0.370 (0.007)	−0.388 (0.013)	−0.428 (0.009)	−0.309 (0.057)	−0.311 (0.061)	−0.253 (0.175)
β_5 (*MBD*)	−3.274 (0.001)	−3.467(0.001)	−3.586 (0.001)	−3.6430.001)	−3.856(0.001)	−3.767 (0.001)	−3.973 (0.002)	−4.260 (0.002)	−3.0930.022)	−3.076(0.027)	−3.141 (0.031)
F-Statistic (*p*-value)	8.80 (<0.001)	8.62 (<0.001)	7.68 (<0.001)	7.47 (<0.001)	8.67 (<0.001)	7.47 (<0.001)	6.19 (<0.001)	6.20 (<0.001)	2.75 (0.036)	2.65 (0.042)	2.46 (0.059)
R^2	0.444	0.448	0.450	0.453	0.514	0.489	0.469	0.485	0.308	0.307	0.322
Panel B. Residual analysis (all 112 ERM firms): $P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i$											
Intercept	6.869 (0.058)	6.916 (0.057)	6.796 (0.063)	6.850 (0.060)	6.9500.058)	6.884(0.060)	6.9080.060)	7.164(0.050)	6.625 (0.067)	6.619 (0.067)	6.757(0.065)
ARES	−3.415(0.024)	−3.446(0.023)	−3.368(0.028)	−3.404(0.026)	−3.435(0.025)	−3.405(0.027)	−3.404(0.027)	−3.503(0.020)	−3.285(0.030)	−3.283(0.030)	−3.314(0.065)
F-Statistic (*p*-value)	5.26(0.024)	5.28(0.023)	4.93(0.028)	5.08(0.026)	5.16(0.025)	5.05(0.027)	5.04(0.027)	5.53(0.020)	4.81(0.030)	4.81(0.030)	4.83(0.030)
R^2	0.046	0.046	0.043	0.044	0.045	0.044	0.044	0.048	0.042	0.042	0.042

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. $ERMI(\text{ERM Index}) = \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. $EU(\text{Environmental uncertainty}) = \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty *k* in year *t*, *k* = 1 to 3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) or income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty *k*. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms. $\widehat{ERMI}_i = \hat{\beta}_0 + \hat{\beta}_1 EU_i + \hat{\beta}_2 CI_i + \hat{\beta}_3 FC_i + \hat{\beta}_4 FS_i + \hat{\beta}_5 MBD_i$. $ARES_i = |ERMI_i - \widehat{ERMI}_i|$.

cance is decreasing as we increase the excess return percentage for the cutoff. However, the residual analysis consistently shows negative coefficients for *ARES*, with significance levels between *p*-values 0.020 and 0.065. This robustness check demonstrates that our results in the main analysis in Section 4 are not particularly sensitive to the changes of the excess return cutoffs for high performing firms.

5.3. Alternative measure for monitoring by board of directors

In the main analysis of Section 4, we measure the monitoring by board of directors (i.e., the contingency variable MBD_i) by the number of directors. However, the frequency of board meetings has also been used in the literature to measure monitoring by the board of directors (e.g., see Vafeas, 1999). Therefore, we consider the number of board meetings in 2005 as an alternative measure for monitoring by the board. The data for the number of board meetings are obtained from the Compustat Executive Compensation database.

As shown in Panel A of Table 7, the number of ERM firms is greatly reduced when we use this alternative measure for MBD_i. The reason for this reduction in firms is due to the fact that the Compustat Executive Compensation database only contains data for roughly 2500 firms. Thus, there are only 30 high performing firms (i.e., those with an excess return greater from 2%) available for developing the proposed proper match. The reduction in sample size notwithstanding, as shown in Panel B of Table 7, the results still show a significant and negative coefficient for *ARES* (coefficient are −7.019 and *p*-value 0.005). This finding supports our basic argument that the relation between ERM and firm performance is contingent on the proper match between ERM and the contingency variables.

Table 7
Alternative measure for monitoring by board of directors.

Number of Observations	Total sample 63	High performing firms (excess return >2%) 30	The other firms (excess return ⩽2%) 33
Panel A. Regression of ERMI on contingent variables: $ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \varepsilon_i$			
β_0 (Intercept)	17.930(0.002)	10.482(0.219)	21.557(0.008)
β_1 (*EU*)	−0.534(0.026)	−0.683(0.068)	−0.767(0.028)
β_2 (*CI*)	−16.611(0.518)	−12.452(0.114)	−18.992(0.010)
β_3 (*FC*)	−0.757(0.518)	−1.996(0.216)	0.885(0.606)
β_4 (*FS*)	−0.092(0.518)	0.244(0.316)	−0.129(0.515)
β_5 (*MBD*)	−0.006(0.934)	0.065(0.444)	−0.113(0.305)
F-Statistic(*p*-value)	3.33(0.010)	2.83(0.038)	2.60(0.048)
R^2	0.226	0.371	0.325
Variable			Coefficients (*p*-value)
Panel B. Residual analysis (all 63 ERM firms): $P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i$			
Intercept			12.595(0.011)
ARES			−7.019(0.005)
F-Statistic(*p*-value)			8.63(0.005)
R^2			0.124

P (firm performance) is measured by the one-year excess stock market return at the year end of 2005. *ERMI* (ERM Index) $= \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU* (Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty k in year t, k = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) and income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty k. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of board meetings for each firm in 2005, where the data is from Compustat. $\widehat{ERMI}_i = 10.482 - 0.683 EU_i - 12.452 CI_i - 1.996 FC_i + 0.244\hat{\beta}_4 FS_i + 0.065 MBD_i$. $ARES_i = |ERMI_i - \widehat{ERMI}_i|$.

Table 8
Alternative Timing of Performance Measure.

Number of observations	Total sample 112	High performing firms (excess return >2%) 69	The other firms (excess return ⩽2%) 43
Panel A. Regression of ERMI on contingent variables: $ERMI_i = \beta_0 + \beta_1 EU_i + \beta_2 CI_i + \beta_3 FC_i + \beta_4 FS_i + \beta_5 MBD_i + \varepsilon_i$			
β_0 (Intercept)	19.403 (<0.001)	18.802 (<0.001)	20.876 (0.157)
β_1 (*EU*)	−0.293 (0.143)	−0.251 (0.233)	−0.322 (0.549)
β_2 (*CI*)	−12.944 (0.005)	−10.992 (0.022)	−16.673 (0.228)
β_3 (*FC*)	−0.213 (0.830)	−0.408 (0.747)	0.069 (0.970)
β_4 (*FS*)	−0.283 (0.020)	−0.305 (0.052)	−0.249 (0.281)
β_5 (*MBD*)	−3.076 (0.001)	−3.931 (<0001)	−1.710 (0.369)
F-Statistic(*p*-value)	5.37 (<0.001)	5.75 (<0.001)	0.68 (0.642)
R^2	0.202	0.313	0.084
Variable			Coefficients (*p*-value)
Panel B. Residual analysis (all 112 ERM firms): $P_i = \beta_0 + \beta_1 ARES_i + \varepsilon_i$			
Intercept			18.114 (<0.001)
ARES			−4.800 (0.033)
F-Statistic (*p*-value)			4.67 (0.033)
R^2			0.041

P (firm performance) is measured by the one-year excess stock market return three months after the year end of 2005. *ERMI* (ERM Index) $= \sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$, where all indicators are defined in Appendix D. *EU*(Environmental uncertainty) $= \log(\sum_{k=1}^{3} CV(X_k))$, where $CV(X_k) = \sqrt{\sum_{t=1}^{5}(z_{k,t} - \bar{z}_k)^2/5}/|\bar{z}_k|$, $z_{k,t} = (X_{k,t} - X_{k,t-1})$, $X_{k,t}$ = uncertainty *k* in year *t*, *k* = 1,2,3 to represent market (sales, Compustat #12), technological (sum of R&D Compustat #46 and capital expenditures Compustat #128 divided by total assets Compustat #6) and income (net income, Compustat #170) uncertainty, and $\bar{z}_k$ = mean of changes over 5 years of uncertainty *k*. *CI* (Industry competition) is measured as (*1-HHI*), where *HHI* represents the sum of squared market shares of all firms in the market and market share is each firm's sales (Compustat #12) divided by the total sales of the industry. *FC* (*Firm complexity*) is measured by the number of business segments (from Compustat Segments) for each firm. *FS* (*Firm size*) is measured as the natural logarithm of average total assets (Compustat #6). *MBD* (*Monitoring by board of directors*) is measured by the number of directors for each firm divided by the natural logarithm of sales, where number of directors was hand-collected from the 2005 10-K files of firms.

5.4. Alternative timing of excess returns

Another concern regarding our main analysis is the use of a one-year excess return based on the end of 2005. This concern stems from the fact that annual reports and related financial information are not usually available to the market until roughly three months after the end of the fiscal year. To address this concern, we changed the timing of one-year excess returns to three months after the end of the year.[34] Based on this new timing of excess returns, the high performing group of firms (i.e., those with an excess return greater than 2%) now includes 69 firms.

The results from regressing the *ERMI* on the contingency variables are shown in Panel A of Table 8. All five contingency variables for high performing firms have lower *p*-values than the other group of firms, suggesting that high performing firms are more concerned with the proper match between their ERM and contingency variables than the other firms. From Panel A of Table 8, the proposed proper match derived from the high performing group of firms is now derived from the following Eq. (14)

$$\widehat{ERMI}_i = 18.802 - 0.251 EU_i - 10.992 CI_i - 0.408 FC_i - 0.305 FS_i - 3.931 MBD_i \quad (14)$$

Eq. (14) is applied to all 112 firms in the sample for the residual analysis and the results can be found in Panel B of Table 8. The coefficient of the *ARES* shown in Panel B of Table 8 is negative and significant at a level of 0.05. This result is consistent with our main analysis (see Table 4) concerning the existence of the proper match. That is, a greater deviation from the proposed match between ERM and the contingency variables (Eq. (14)) is associated with lower firm performance even under the alternative timing of excess returns.

[34] The results are very similar to the results using the December 31 year end to calculate one-year excess returns and therefore are not reported here.

6. Concluding comments

Based on a sample of 112 firms disclosing the implementation of enterprise risk management (ERM) in their 2005 10K and/or 10Q reports, this paper investigates whether the relation between ERM and firm performance is contingent upon the proper match between ERM and five key contingency variables. The findings from our study confirm the argument that the ERM-firm performance relation is indeed contingent on the proper match between ERM and the following five variables: environmental uncertainty, industry competition, firm size, firm complexity, and monitoring by the board of directors. This finding is robust, even when we correct for the self-selection bias, choose different cutoffs for high performing firms, use an alternative measure for board monitoring, and consider an alternative timing for firm performance. The findings from the analyses suggest that our ERM Index (*ERMI*) is a reasonable (although not perfect) measure of the effectiveness of ERM.

As with all empirical studies in the social sciences, there are limitations to our study. The most obvious limitations to this study are as follows. First, the study only covers data from 2005. Therefore, the findings are not generalized to other time periods. A second limitation of this study relates to that fact that we use one-year excess stock market returns to measure firm performance. Other measures of performance (e.g., Tobin's Q or a five-year excess returns) could also be considered. A third limitation to this study is that a theoretical model describing which contingency variables should be considered in studies like this one does not exist. Thus, we selected contingency variables based on the way we interpret the extant literature. Of course, others could interpret the existing literature differently than we do and therefore argue for considering different variables.

Given the above limitations, the findings from this study should be interpreted as preliminary, rather than definitive. This fact notwithstanding, we believe that the results of the study reported in this paper provide important insights into the relation between ERM and firm performance. In essence, these results show that the relation between a firm's ERM and its performance is dependent on the proper match between a firm's ERM and the contextual variables surrounding firms.

Appendix A. Examples of ERM

A.1. GRACE (W R) & CO (Filing date: 2006/03/13, Form: 10K, p. F-62)

"The nature of our business requires us to deal with risks of several types. We seek to manage these risk factors so that the Company is exposed to an acceptable level of risk. We have established an **Enterprise Risk Management** function under our Chief Risk and Compliance Officer, the purpose of which is to provide assurance that management is addressing all risks facing the Company in a comprehensive and conservative way. The following are examples of how we are addressing certain categories of risks: "

A.2. POTASH CORP SASK INC (Filing date: 2006/03/09, Form: 10K, p. 23)

" Our performance and future development could be materially affected by a wide range of risk factors. Any or all of these risks could have a material adverse effect on our business, financial condition, results of operations and cash flows and on the market price of our common stock. We use an **integrated risk management framework** to identify risks across all segments of the Company, evaluate those risks, and implement strategies designed to mitigate those risks. Our strategies to mitigate these risks are described under "Managing Risk" on pages 20 through 22 in the Financial Review section of our 2005 Annual Report, attached as Exhibit 13, incorporated herein by reference

A.3. ALLSTATE CORP (Filing date: 2005/11/01, Form: 10Q, p. 26)

"The overarching intent of our catastrophe management strategy is to support profitable growth of our homeowners business. While in many areas of the country we are currently achieving returns within acceptable risk management tolerances, our goal is to find solutions that support a continued yet prudent presence in catastrophe prone markets. Allstate is introducing integrated **enterprise risk management ("ERM")** capabilities as part of our continued commitment to effective management of our capital, returns and risk profile. A principal ERM goal is to validate where and how we insure homeowners' catastrophes and to further increase our return on equity, thereby lessening our earnings volatility and capital requirements. In introducing integrated ERM capabilities, we are considering and adopting new performance measurements for managing our homeowners business. These measurements currently include establishing an exposure limit based on hurricane and earthquake losses which have a one percent probability of occurring on an annual aggregate countrywide basis, refining acceptable targeted rates of return by line and by state and evaluating potential capital impairment measurements. Actions resulting from the evaluation of these measurements will reduce our catastrophe risk and improve long-term returns."

Appendix B. List of 112 ERM firms

Company name	Company name	Company name
3M CO	FRANKLIN RESOURCES INC	PEDIATRIC SVCS AMERICA INC
ACXIOM CORP	FRIEDMN BILLINGS RMSY – CL A	PEPCO HOLDINGS INC
AGL RESOURCES INC	FTI CONSULTING INC	PEPSICO INC
AIR PRODUCTS & CHEMICALS	GATX CORP	PHOENIX COMPANIES INC
ALCAN INC	GENERAL ELECTRIC CO	PIEDMONT NATURAL GAS CO
ALCOA INC	GENERAL MOTORS CORP	PIPER JAFFRAY COS INC
ALLEGHENY ENERGY INC	GOLDMAN SACHS GROUP INC	PITNEY BOWES INC
ALLSTATE CORP	GRACE (W R) & CO	PLAINS ALL AMER PIPELNE – LP
AMERICAN ELECTRIC POWER	GREAT PLAINS ENERGY INC	PNM RESOURCES INC
AMERICAN INTERNATIONAL GROUP	HANDLEMAN CO	POTASH CORP SASK INC
AMN HEALTHCARE SERVICES	HEALTHSOUTH CORP	PPL CORP
ANWORTH MTG ASSET CORP	IDACORP INC	PROGRESS ENERGY INC
APACHE CORP	ILLUMINA INC	PUBLIC SERVICE ENTRP GRP INC
AVISTA CORP	IMPAC MORTGAGE HOLDINGS	PUGET ENERGY INC
BEAR STEARNS COMPANIES	IMPERIAL SUGAR CO	RAYMOND JAMES FINANCIAL
BEARINGPOINT INC	INDEPENDENCE HOLDING CO	REINSURANCE GROUP AMER INC
BLACK HILLS CORP	INNOSPEC INC	SAFECO CORP
BOSTON SCIENTIFIC CORP	INTERPUBLIC GROUP OF COS	SAKS INC
BUNGE LTD	INTL GAME TECHNOLOGY	SIERRA PACIFIC RESOURCES
CABOT CORP	KEYSPAN CORP	SIGMATRON INTERNATIONAL INC
CATAPULT COMMUNICATIONS	KINDER MORGAN INC	SMUCKER (JM) CO
CHESAPEAKE UTILITIES CORP	KINDRED HEALTHCARE INC	SOUTH JERSEY INDUSTRIES INC
CLECO CORP	LEGG MASON INC	TESORO CORP
CMS ENERGY CORP	LEHMAN BROTHERS HOLDINGS	TEXTRON INC
CONSTELLATION ENERGY GRP	LENNAR CORP	TXU CORP
CRAWFORD & CO	LIONBRIDGE TECHNOLOGIES INC	UGI CORP
CROSSTEX ENERGY LP	MARRIOTT INTL INC	UNISOURCE ENERGY CORP
CUMMINS INC	MBIA INC	VECTREN CORP

(*continued on next page*)

Appendix B (*continued*)

Company name	Company name	Company name
DUKE ENERGY CORP	MCF CORP	WEBMETHODS INC
EDISON INTERNATIONAL	MENTOR CORP	XCEL ENERGY INC
EL PASO CORP	MERRILL LYNCH & CO INC	XTO ENERGY INC
ENBRIDGE ENERGY PRTNRS	MGIC INVESTMENT CORP/WI	ZOLL MEDICAL CORP
ENERGY WEST INC	MGP INGREDIENTS INC	
ENTERCOM COMMUNICATIONS	MORGAN STANLEY	
EQUITABLE RESOURCES INC	NESTOR INC	
EXELON CORP	NEW JERSEY RESOURCES CORP	
FERRELLGAS PARTNERS – LP	NEWTEK BUSINESS SERVICES INC	
FIRSTENERGY CORP	NICOR INC	
FLUOR CORP	NORTHEAST UTILITIES	
FORD MOTOR CO	OGE ENERGY CORP	

Appendix C. Probit model for determinants of ERM adoption

Variables	Dependent variable ERM Coefficients ($\Pr > \chi^2$)
$Prob(AERM_i = 1) = \beta_0 + \beta_1 Big4_i + \beta_2 FS_i + \beta_3 ZScore_i + \beta_4 DE\ Ratio_i + \beta_5 Investment\ Opportunity_i + \beta_6 Foreign\ Transaction_i + \varepsilon_i$	
β_0 (Intercept)	3.380 (<0.001)
β_1 (*Big4*)	−0.071 (0.441)
β_2 (*Size*)	−0.239 (<0.001)
β_3 (*ZScore*)	0.003 (0.037)
β_4 (*DE Ratio*)	−0.006 (0.241)
β_5 (*Investment Opportunity*)	1.545 (0.012)
β_6 (*Foreign Transactions*)	0.582 (<0.001)
Number of ERM firms	244
Number of non-ERM firms	7232
Likelihood ratio score ($\Pr > \chi^2$)	511.265 (<0.001)

$AERM_i$ is an indicator variable defining whether firm *i* adopted ERM ($AERM_i = 1$) or did not engage in ERM ($AERM_i = 0$) at any point during 2005. $Big4_i$ is a dummy variable and is set to one if firm *i*'s auditor is from big four CPA firms, or set to zero otherwise. FS_i stands for firm size and is measured as the logarithm of firm *i*'s total assets (Compustat #6). $ZScore_i$ is the Z-score developed following Altman (1968). $DE\ Ratio_i$ divides total debt (Compustat #9 + Compustat #34) by stockholder's equity (Compustat #216). $InvestmentOpportunity_i$ is the sum of capital expenditure (Compustat #128) and R&D expenditures (Compustat #46) scaled by firm's total assets. $ForeignTransaction_i$ is a dummy variable, and takes on a value of one if firm *i* has zero foreign currency adjustment (Compustat #150) in 2005, and zero otherwise.

Appendix D. ERM Index (*ERMI*)

Indicator	Definition
ERMI (ERM Index) = $\sum_{k=1}^{2} Strategy_k + \sum_{k=1}^{2} Operation_k + \sum_{k=1}^{2} Reporting_k + \sum_{k=1}^{2} Compliance_k$	
$Strategy_1$	$Strategy_1 = (Sales_i - \mu_{Sales})/\sigma_{Sales}$, where $Sales_i$ = Sales of firm *i* in 2005, μ_{Sales} = average industry sales in 2005, and σ_{Sales} = standard deviation of sales of all firms in the same industry.

Appendix D (*continued*)

Indicator	Definition
$Strategy_2$	$Strategy_2 = (\Delta\beta_i - \mu_{\Delta\beta})/\sigma_{\Delta\beta}$, where $\Delta\beta_i = -$ (β_i in 2005 $-$ β_i in 2004), β_i = firm *i*'s beta (data from Compustat), $\mu_{\Delta\beta}$ = average industry $\Delta\beta$ in 2005, and $\sigma_{\Delta\beta}$ = standard deviation of $\Delta\beta$'s of all firms in the same industry.
$Operation_1$	$Operation_1$ = (*Sales* Compustat #6)/(*Total Assets* Compustat #12).
$Operation_2$	$Operation_2$ = *Sales*/(*Number of Employees* Compustat #29).
$Reporting_1$	$Reporting_1$ = (*Material Weakness*) + (*Auditor Opinion*) + (*Restatement*), where *Material Weakness* is set to -1 if a firm discloses any material weakness in its 10K, otherwise is set to 0; *Auditor Opinion* is set equal to 0 if a firm has unqualified opinions in its 10K, otherwise it is set to -1; and *Restatement* is set to -1 if a firm announced a restatement in 2005, otherwise it is set to 0 (data is from GAO, 2006).
$Reporting_2$	$Reporting_2 = \lvert NormalAccruals\rvert/(\lvert NormalAccruals\rvert + \lvert AbnormalAccruals\rvert)$, where *AbnormalAccruals* is the error term from the regression model $TA_{ijt}/A_{ijt-1} = \alpha_{jt}[1/A_{ijt-1}] + \beta_{1jt}[\Delta REV_{ijt}/A_{ijt-1}] + \beta_{2jt}[PPE_{ijt}/A_{ijt-1}] + e_{ijt}$, TA_{ijt} = total accruals and is defined as income before extraordinary items (Compustat #18) minus operating cash flows (Compustat #308)), A_{ijt-1} = total assets (Compustat #6), ΔREV_{ijt} = change in net revenues (Compustat #12), PPE_{ijt} = gross property plant and equipment (Compustat #8), e_{ijt} = error term, *NormalAccruals* is defined as TA_{ijt} minus *AbnormalAccruals*.
$Compliance_1$	$Compliance_1$ = *Auditor Fees*/*Total Assets*, where data for *Audit Fees* is hand-collected from firm's proxy statements and data for Total Assets is from Compustat #6.
$Compliance_2$	$Compliance_2$ = *Settlement Net Gain*/*Total Assets*, where data for *Settlement Net Gain* and *Total Assets* are from Compustat #372 and #6, respectively.

Notes: (1) Each of the eight indicators is standardized among all ERM firms before being combined. Thus the mean of *ERMI* for the total sample is zero (see Table 2). (2) Whenever the industry is mentioned, the industry is measured as all active firms with the same two digits SIC code in Compustat.

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