The Journal of Risk and Insurance

© *The Journal of Risk and Insurance*, 2011, Vol. 78, No. 1, 185-211
DOI: 10.1111/j.1539-6975.2010.01378.x

The Characteristics of Firms That Hire Chief Risk Officers

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Abstract

We examine the characteristics of firms that adopt enterprise risk management (ERM) and find support for the hypothesis that firms adopt ERM for direct economic benefit rather than to merely comply with regulatory pressure. Using chief risk officer (CRO) hires as a proxy for ERM adoption we find that firms that are larger, more volatile, and have greater institutional ownership are more likely to adopt ERM. In addition, when the CEO has incentives to take risk, the firm is also more likely to hire a CRO. Finally, banks with lower levels of Tier 1 capital are also more likely to hire a CRO.

Introduction

In recent years, researchers have paid increasing attention to the growing prominence of enterprise risk management (ERM). In most cases this research has focused on the ERM process itself and the potential gains from adoption. For example, Nocco and Stulz (2006) argue that market imperfections render invalid the frictionless market view that a firm should not expend resources on managing idiosyncratic risk. Instead, they argue that an integrated, holistic, approach to risk management can be used to create shareholder value. Other papers discuss ERM in broad terms and mostly assume that ERM has or will be adopted. For example, Aabo, Fraser, and Simkins (2005) provide a road map for implementation, and Beasley, Clune, and Hermanson (2005) examine the factors associated with the degree of adoption. There has, however, been little work examining the characteristics of firms that actually implement ERM.

In this article, we examine factors that are hypothesized to be drivers of ERM implementation using a sample of 138 firms from 1992 to 2005. Because we are unable to directly observe whether a firm adopts ERM, we identify ERM adoption using the firm's decision to hire a chief risk officer (CRO). The goal of our study is to examine the characteristics of firms that choose to adopt ERM by using various proxies

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for the factors that are hypothesized to drive ERM adoption. Our work is related to Liebenberg and Hoyt (2003) who use a logistic model to examine the particular characteristics of firms hiring a CRO.[1] Liebenberg and Hoyt find that size and leverage are both related to the decision to implement ERM; however, many of the other factors in their regression model are insignificant. Their insignificant results are likely due to a small number of firms hiring a CRO ($n = 26$) and the use of the logistic model. In this application, a logistic model is not necessarily the appropriate method for testing the significance of a one-time event that can occur through time. We improve upon the method of Liebenberg and Hoyt in three ways. First, we use a larger sample of firms. Second, we analyze a wider range of possible determinants of CRO hiring. And third, we use a Cox proportional hazard model to measure the importance of the variables in the regression analysis. The hazard model allows us to examine a large sample of companies, of which only a proportion choose to hire a CRO, and generates more reliable standard errors than a logit model.

Our research builds on the existing risk management literature that suggests a range of factors that may influence the decision to employ traditional risk management. The factors that we examine cover a broad range of variables that measure financial, asset, market, and managerial characteristics. Financial characteristics represent indirect measures of the likelihood of financial distress. Firms that face greater risk of financial distress and the implicit and explicit costs contained therein may benefit from ERM when ERM reduces the chance of costly lower tail cash flow outcomes. Asset characteristics measure the potential costs of financial distress, such as the inability to pursue growth options. Market characteristics measure the potential costs associated with volatile security performance, such as a higher cost of capital. Finally managerial characteristics measure the degree to which the CEO's stock and option-based compensation encourages risk-taking or risk-avoiding behavior. In addition to examining industrial and financial firms in general, we look at the subset of banks in our sample and examine industry specific variables such as Tier 1 capital ratios.

Our null hypothesis is that many firms are adopting ERM purely because of regulatory pressure. Indeed, regulated industries have been at the forefront of ERM adoption. For example, ERM at financial firms has been greatly influenced by the Basel requirements. Energy firms have faced greater scrutiny following Enron, which in part led to the 2002 formation of the Committee of Chief Risk Officers (CCRO) that developed best practices for ERM in the energy sector. Furthermore, the three main rating agencies have also focused on the ERM implementation of regulated industries. Thus, if ERM is being implemented purely as a response to regulatory pressure, we should not see differences in the firms that choose to adopt ERM and those that do not, other than industry affiliation.

As an alternative to the null hypothesis, we hypothesize that firms adopt ERM for economic reasons consistent with shareholder wealth maximization, when the benefits of ERM exceed the costs. Consistent with this alternative hypothesis, we expect

[1] In a related study, Beasley, Pagach, and Warr (2008) examine the impact of ERM implementation on short-term stock returns and find that firm-specific characteristics are important determinants of the stock market reaction to ERM adoption.

firms that stand to reap the greatest benefit of a comprehensive risk management program to be more likely to adopt ERM.

As a preview of our results, we find that larger firms and firms that have greater risk of financial distress, that is, those with more volatile operating cash flows are more likely to adopt ERM, as identified by hiring a CRO. Furthermore, we find that stock volatility is also an important determinant of CRO hiring.

We also find that firms with CEOs that have incentives to take risk, based on option compensation, are also more likely to hire a CRO. This result appears counterintuitive but is consistent with boards making the CRO appointment to provide a control against the CEO's risk-taking incentives. Looking at our banking subsample, we find that banks with lower capital ratios are more likely to hire a CRO, consistent with them focusing on managing operational risk with ERM in the presence of greater leverage risk.

Our article proceeds as follows. The second section discusses related literature and develops our hypothesis. The third section provides details on the sample data and analysis methodology. The fourth section presents the univariate empirical results. The fifth section presents the multivariate determinants of CRO hiring announcements and multivariate hazard model results and the final section concludes.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The primary goal of risk management is to maximize shareholder value, and traditionally risk management has been implemented by using tradable derivative securities to hedge risk. More recently, risk management has evolved from a narrow view that focused on evaluating risk from a silo perspective to a holistic, all-risk-encompassing view, commonly termed ERM.[2] ERM is a management process that requires a firm's management to identify and assess the collective risks that affect firm value and apply an enterprise wide strategy to manage those risks in order to establish an effective risk management strategy (Meulbroek, 2002).

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) in its ERM framework defines ERM as

> (A) process, effected by an entity's board of directors, management and other personnel, applied in a 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. (COSO, 2004)

Although there is little empirical research on ERM, there are a number of case studies and surveys that examine the implementation process and explore the benefits of ERM. For example, Aabo, Fraser, and Simkins (2005) discuss ERM implementation

[2] See Tufano (1996), Liebenberg and Hoyt (2003), Beasley, Clune, and Hermanson (2005), and Slywotzky and Drzik (2005) for discussions of the development and adoption of ERM. See also Cummins and Weiss (2009) for a discussion of the impact of ERM on the reinsurance industry.

at Hydro One (a Canadian utility). The conclusions of their study provide a useful framework for understanding the ERM process. In Hydro One's case, the primary goal of ERM is not risk reduction. Instead, the firm focuses on using ERM to achieve a balance between operational risks and returns and to control the risk from lower left tail cash flow events (essentially big losses). The ERM process starts with first identifying all of the risks facing its business and then assessing the consequences of these risks along with the controls in place to respond to the risks. Management then decides whether to tolerate a risk or mitigate a risk. Although this process is consistent with traditional management of risks, such as interest rate risk, ERM differs in that it attempts to manage all risks, including operational and reputational risks that normally cannot be hedged. It is this examination of all risks facing the firm and the attempt to manage the risks in a holistic manner that separates ERM from traditional silo-based risk management.

In addition to individual firms' decisions to implement ERM practices, there has been a growing regulatory push for ERM adoption. In 2004 the New York Stock Exchange (NYSE) revised its corporate governance rules to require audit committees to "discuss guidelines and policies to govern the process by which risk assessment and management is undertaken" (NYSE, 2004). In the financial industry the Basel II regulatory requirements expand risk management requirements to include oversight of operational risks in addition to credit and market risks as part of financial institutions capital adequacy determinations (Basel, 2003). Ratings agencies have also been advocating for implementation of ERM practices. In the insurance industry A.M. Best and Standard & Poor's started evaluating companies' ERM practices on an informal basis in 2005. However, in 2008, the credit ratings agency Standard & Poor's formally decided to start a two-step process of examining how management teams, from both financial and nonfinancial companies, implement ERM. In 2009, Standard & Poor's is expected to adopt formal ratings of client firm's ERM (Cole, 2008). This increased regulatory drive toward ERM adoption generates our null hypothesis—that there are no specific characteristics of ERM adopters other than they are pressured by a regulator or rating agency. Our alternative to this hypothesis is that those firms that are adopting ERM are doing so for economic reasons consistent with the goals of ERM.

Despite increased adoption among financial and nonfinancial firms, the realized benefits of ERM are subject to debate. From the perspective of a frictionless capital market, risk management is a negative net present value (NPV) project because investors can eliminate firm risk through diversification.[3] The key to value creation by ERM thus depends on the presence of capital market frictions. This idea is consistent with the traditional corporate hedging literature that conjectures that risk management's benefit is a result of it reducing the costs associated with financial distress, underinvestment, managerial compensation, and expected corporate tax schedules.

Smith and Stulz (1985) argue that corporate hedging can increase firm value by reducing the expected costs of financial distress. These include direct costs, such as fees for violating debt covenants, as well as indirect costs, such as loss of reputation or loss of a relationship with a key stakeholder. Using survey data, Nance, Smith, and

[3] Beasley, Pagach, and Warr (2008) do not find a significant stock price reaction (positive or negative) to firms' announcements of ERM adoption.

Smithson (1993) find that firms that hedge with certain derivative contracts have less coverage of fixed claims.

Myers (1977) identifies the underinvestment problem whereby firms may reject positive NPV projects when gains from the project benefit debt holders more than equity holders. Corporate hedging helps to alleviate this problem by reducing the probability of default. Thus, firms with more growth opportunities and firms with greater leverage benefit from hedging by reducing the variability in firm value. Froot, Scharfstein, and Stein (1993) also examine the underinvestment problem as related to internal versus external funding of projects. When external funds are more costly, hedging creates value by reducing income variability, thereby increasing the probability that internal funds will be available when needed for positive NPV projects. Geczy, Minton, and Schrand (1997) find support for the underinvestment problem in an examination of currency hedging activities of nonfinancial firms. Their study finds that firms with high-growth opportunities and restricted access to internal and external financing are more likely to use currency derivatives.

Stulz (1984) examines managerial motives for hedging and suggests that managers with a high percentage of their wealth invested in their firm's equity have an incentive to engage in hedging activities in order to reduce the variability of the their firm's value and their personal wealth. DeMarzo and Duffie (1995) model a scenario in which a risk-averse manager benefits from corporate hedging activity. In their model, shareholders learn about the quality of a firm's management by observing the firm's operating performance. By engaging in hedging activities, the manager is able to reduce the noise in the firm's earnings and thus increase the reliability of the earnings as a measure of managerial quality.

Smith and Stulz (1985) find a benefit to hedging when a firm has a convex tax schedule. If a firm faces a convex tax structure it can minimize its expected taxes by reducing the variability of its earnings. Dionne and Garand (2003) use the Graham and Smith (1999) approach and find that a variable that measures tax savings for a reduction in earnings volatility is positively and significantly related to the adoption of risk management by gold mining firms.

The traditional risk management literature is important to this study because we attempt to examine the extent to which firms use ERM adoption to manage potential risk exposures. Our study complements Guay and Kothari (2003), who examine the hedging activities of nonfinancial firms. Guay and Kothari find that firm's use of derivative contracts is small in magnitude relative to the firm's total risk exposure. The author's conclude that firm's small level of derivative usage is consistent with firms: (1) using derivatives either as to "fine tune" operational hedging, (2) making decentralized decisions on the use of derivatives (such as at the divisional level), or (3) using derivatives for speculation on asset prices.

Nocco and Stulz (2006) argue that managing risks holistically provides firms a long-run competitive advantage by optimizing the trade-off between risk and return. In this framework ERM creates value by reducing the probability of large negative cash flows (or "costly lower tail outcomes"). ERM accomplishes this through the coordination of risks across the enterprise and ensuring that no single project risk has an adverse effect on the firm overall (Stulz, 1996, 2003). In this scenario, only firms that face these lower tail outcomes that will benefit from ERM, as other firms will see no benefit and could destroy value by spending corporate resources on ERM.

Lower tail outcomes have direct and indirect costs. Events such as bankruptcy and financial distress involve direct outlays to creditors, lawyers, and courts. Indirect costs include the inability to pursue profitable growth options, the loss of customer confidence, and the inability to realize the full value of intangible assets upon liquidation. A decline in debt ratings and the resulting increase in borrowing costs can also be costly for shareholders.

Lower tail outcomes will disproportionately affect managers who own stock in the company as they have an undiversified holding and bear a greater proportion of the loss than a diversified shareholder. In an efficient labor market, these managers will demand higher compensation for bearing this idiosyncratic risk. Other stakeholders, such as suppliers, may be reluctant to enter into long-term contracts with the firm if the potential for future payment is uncertain. All of these problems can result from the possibility of costly lower tail outcomes and represent value creating opportunities for a risk management program. The market imperfections that we examine are the result of lower tail outcomes that produce costs associated with financial distress, external financing, and managerial risk aversion.

In our study, we identify ERM adoption by the hiring of a CRO because corporations tend only to disclose minimal details of their risk management programs (Tufano, 1996). There are, however, good reasons to believe that CRO hiring coincides with the decision to follow an ERM program. For example, the Economist Intelligence Unit (2005) reports that many organizations appoint a member of the senior executive team, often referred to as the CRO, to oversee the enterprise's risk management process. Walker, Shenkir, and Barton (2003) note that because of its scope and impact, ERM requires strong support from senior management. Beasley, Clune, and Hermanson (2005) show that the presence of a CRO is associated with a greater stage of ERM adoption.

We examine firm-specific variables that reflect the likelihood and cost of a firm experiencing a lower tailed event either through increasing the chance of financial distress or increasing the costs associated with such distress. We also attempt to shed light on the impact of managerial incentives on ERM implementation. An overview of the variables is contained in the "Data and Method" section, which follows, whereas details of the construction of the variables are contained in the Appendix.

DATA AND METHOD

Our study starts with 138 announcements of senior risk officer appointments made from 1992 to 2005 for which we are able to obtain all the necessary data for our tests. Announcements are obtained by searching the business library of LexisNexis for announcements containing the words "announced," "named," or "appointed," in conjunction with position descriptions such as "chief risk officer" or "vice-president—enterprise risk management."[4] Only announcements for publicly traded

[4] We searched for the following titles: director, vice-president, chief, senior, executive, head, manager, and managing director.

companies were retained, and in the case of multiple announcements for the same company, we selected only the first announcement on the assumption that this represented the initiation of the risk management program.

By using the LexisNexis database we hope to capture each firm's first appointment of an executive overseeing an enterprise-level risk management program; however, it is possible that some appointments, although being the first announcements, are not actually the first appointments. These announcements will add noise to our sample and reduce the power of our tests. It is also possible that we have excluded executives from our sample that oversee an ERM program but have titles that are excluded from our search. Lam (1999) points out that some risk management executives have titles such as chief market and credit officer, but these positions may not be primarily focused on ERM. This will result in a misclassification of firms in our model and again reduce the power of our tests.

We collect data for all firms listed in Compustat from 1992 to 2005. We supplement the data with stock price data from CRSP and 13-F ownership data. In a subset of tests we include a variable to measure the sensitivity of the CEO's compensation to the volatility of the stock price. The data for this variable come from ExecuComp but are only available for the S&P 1500 firms and thus reduce the number of CRO hire firms in our subsample to 77. The full data set is an unbalanced panel in which CRO hiring events are indicated by a dummy variable that takes the value one in the year that they are made, and zero otherwise.

Table 1 presents the distribution of the announcements through time as well as the distribution across industries. Most CRO hires tend to be in the later part of the sample period, clustered around 1999 to 2002. A substantial portion of the appointments is

TABLE 1
CRO Appointments by Year

Year	All Firms	Financial Firms	Utilities
1992	7	4	0
1993	9	2	0
1994	8	3	1
1995	9	3	1
1996	11	6	3
1997	5	4	1
1998	6	4	0
1999	9	5	1
2000	13	8	1
2001	23	14	5
2002	14	6	4
2003	12	8	1
2004	9	7	0
2005	3	3	0
Total	138	77	18

Note: This table presents CRO appointments by year. The totals are broken out by financial firms ($6000 \leq$ SICC ≤ 6999) and utilities ($4900 \leq$ SICC ≤ 4999).

located in the financial and utility industries. These are defined in our sample as having SIC codes in the 6000s for financial firms and in the 4900s for utilities.

We believe that the 2003 drop-off in hiring is a function of the implementation of the Sarbanes-Oxley Act. Section 404 of the Act, which requires a certification of internal controls, became effective for fiscal years ending after June 15, 2004, and required resources to be diverted from ERM to certification of internal control. Discussions with a number of risk professionals confirmed this observation.

In our multivariate analysis, we examine variables that are either hypothesized to be determinants of the CRO hire decision or are control variables. The construction of these variables is contained the Appendix; what follows here is a summary of the variables used, classified as either financial, asset, or market characteristics.

Financial characteristic include the firm's leverage, cash ratio, operating cash flow volatility, and tax convexity. We hypothesize that firms with greater leverage, lower cash ratios, and greater cash follow volatility and more convex tax liabilities will be more likely to benefit from ERM adoption. For example, firms with greater leverage are more likely to suffer from financial distress than firms with low leverage, and the cash ratio measures the amount of liquid assets that the firm has on hand that could be used to make up a short fall in operating cash flows. Firms with more volatile operating cash flows are more likely to benefit from ERM as smoothing cash flows reduces the probability of experiencing a lower tail cash flow outcome. Smoother cash flows are also a benefit to firms with convex tax liabilities where a reduction in the volatility of taxable income can reduce the firm's tax liability.

Asset characteristics measure the potential costs of financial distress and the potential unrecoverable losses that may be incurred in financial distress. These variables include asset opacity and the presence of growth options (measured as market-to-book and sales growth). Firms that have opaque assets may have difficulty selling these assets at purchase cost to avert financial distress, as opaque assets are associated with more information asymmetry thus and thus are more likely to be undervalued. Firms with growth options have much of the firm's value tied to future, and as yet, unrealized cash flows. Because of the uncertain nature of the payoff from such expenditures, the value of these investments are unlikely to be fully realized in bankruptcy; thus, ERM may be favored by firms with higher growth options.

Market characteristics include the volatility of the firm's stock price. Firms with more volatile stock prices are more likely to benefit from ERM to the extent that stock volatility is a proxy for operational volatility.[5]

For a subset of firms we examine how executive stock and option-based compensation can affect the incentives of executives by altering their risk preferences. CEOs that have a large proportion of option-based compensation are more likely to prefer strategies that increase the volatility of the firm's stock—thus increasing the value of their option holdings. Conversely, CEOs with larger stock holdings hold undiversified portfolios that are overweighted in their company's stock. These CEOs may prefer strategies that reduce overall stock idiosyncratic risk. The distinction between option and stock

[5] In unreported tests we find that prior stock market performance has no significant impact on the CRO hire decision.

compensation is further complicated by the degree to which the option is in the money. Deep in-the-money options provide stock-like incentives compared to at the money or underwater options. Therefore, measuring option and stock-based compensation requires more than just summing the value of the CEO's holdings.

We use the approach of Rogers (2002) and Core and Guay (2002) to create measures of a CEO's incentive to increase risk versus the CEO's incentive to maximize stock price. The first measure, Vega, is the partial derivative of the dividend adjusted Black-Scholes equation with respect to the standard deviation of stock returns and measures the incentive to take risk. The second measure, Delta, is the partial derivative of the Black-Scholes equation with respect to the level of the stock price. Delta measures the incentive to increase stock price. We compute Vega and Delta for each CEO's stock and option portfolio to measure CEO risk-taking incentives.[6]

Control variables include size, number of operating segments, and institutional ownership. Firms with more operating segments are likely to be able to diversify operating and financial risks within the firm and may have less need of ERM. However, as the number of operating segments increases, the range of businesses and risks that the firm is involved in could increase the need for an overall holistic view of risk management. Firms with greater institutional ownership may have greater pressure to install controls associated with ERM.

UNIVARIATE RESULTS

As a first step in our analysis, we compare the univariate statistics of the CRO hiring firms with all the other firms for which we are able to obtain data. We present these summary statistics and comparisons of sample means and medians in two tables because of the significant differences between the capital structures of financial and nonfinancial firms. Table 2 shows the data for the nonfinancial firms, and Table 3 presents the data for the financial firms in the sample (financial firms have SICC between 6000 and 6999). Each table compares the sample means and medians of the CRO hiring firms, (estimated in the year of the hire) and the means and medians of all the other firms with data available.

Examining the nonfinancial firms first in Table 2, we find that the average CRO hiring firm is much larger than the average non-CRO hiring firm. Consistent with overall larger size, the CRO hiring firms also have on average more segments, and more institutional investors. The CRO hiring firms are, on average, more levered, and have lower cash ratios. These firms also tend to have lower market-to-book ratios and less volatile stock returns and cash flows. These results are consistent with CRO hiring firms tending to be at a more mature phase in their corporate lives than the average firm in the market. These findings run counter to our hypothesis that firms with more growth options will tend to try and protect those future revenue sources through risk management.

Table 3 presents the univariate statistics for the financial firms ($6000 \leq$ SICC ≤ 6999). First, CRO hiring firms are much larger on average than the non-CRO hiring firms (and thus have more institutional ownership and more segments). CRO hiring firms

[6] For the stock holdings, Vega = 0 and Delta = 1.

TABLE 2
Summary Statistics and Sample Comparisons—Nonfinancial Firms

	CRO Hire Firms (n = 61)			Non-CRO Hire Firms (n = 67,665)			Differences	
	Mean	Median	SD	Mean	Median	SD	T-Test of Means	Rank Sum Test of Medians
Financial characteristics								
Leverage	0.64	0.69	0.20	0.48	0.48	0.23	−6.65***	−5.69***
Cash ratio	0.06	0.02	0.11	0.19	0.09	0.23	8.88***	5.25***
SDCF %	0.87	0.66	0.08	1.94	1.00	7.70	10.62***	3.23***
Tax save	5.34	5.79	2.62	5.33	5.46	3.23	−0.04	−0.46
Asset characteristics								
Opacity	0.08	0.02	0.13	0.09	0.01	0.15	0.17	−0.03
Market-to-book	2.90	1.95	4.34	4.59	2.03	53.23	2.86***	0.87
Sales growth	0.18	0.08	0.36	0.26	0.10	1.05	1.41	0.00
Market characteristics								
SDRET %	2.76	1.97	2.22	4.33	3.70	2.90	5.50***	6.20***

(*Continued*)

TABLE 2
Continued

	CRO Hire Firms (n = 61)			Non-CRO Hire Firms (n = 67,665)			Differences	
	Mean	Median	SD	Mean	Median	SD	T-Test of Means	Rank Sum Test of Medians
Managerial characteristics								
Vega	164.76	71.36	213.75	132.06	40.40	319.35	−1.01	−1.05
Delta	332.09	201.18	559.45	1101.58	193.26	10234.52	6.70***	−1.83*
Controls								
Numseg	5.19	3.00	4.48	3.10	2.00	3.24	−3.65***	−4.11***
NINST	179.26	151.00	132.21	63.22	24.00	107.23	−6.85***	−7.85***
PINST	0.47	0.47	0.25	0.32	0.26	0.27	−4.61***	−4.39***
MVE ('000,000)	5884.93	3829.04	12353.03	1930.32	136.48	11165.53	−2.50**	−8.13***
Assets ('000,000)	10007.27	4080.49	15156.18	1856.65	130.55	11045.91	−4.20***	−9.36***

***,**,* Significant at the 1%, 5%, 10% level, respectively.

Notes: This table presents all firms from 1992 to 2005 in the sample excluding financial firms that have SICC $\geq$ 6000 and SICC $\leq$ 6999. Leverage = Total liabilities/Total Assets = $(d6 - d60)/d6$, Cash Ratio = Cash and marketable securities/Total Assets = $d1/d6$, SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow scaled by assets. This regression is run for eight quarters. Tax Save is the percentage tax savings from a 5% reduction in pre-tax earnings volatility using the method of Graham and Smith (1999). Opacity = Intangibles/ Total Assets = $d33/d6$, MB = Market Value of Equity/ Book Value of Equity = $(d199 * d25)/d60$, Sales Growth is the average growth in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. Vega is the partial derivative of the CEOs option and stock portfolio to stock volatility and Delta is the partial derivative with respect to the stock price as in Rogers (2002). Numseg is the number of operating segments of the firm. PINST is institutional ownership as the percentage of the firm's stock. The number of institutional investors is designated as NINST. MVE is market value of equity. Assets are Total Assets ($d6$). The means test is a two-sided t-test. The medians test is a Wilcoxon Sign Rank test with the Z-statistic reported. ***,**,* Significant at the 1%, 5%, and 10% level, respectively.

TABLE 3
Summary Statistics and Sample Comparisons—Financial Firms

	CRO Hire Firms (n = 77)			Non-CRO Hire Firms (n = 17,215)			Differences	
	Mean	Median	SD	Mean	Median	SD	T-Test of Means	Rank Sum Test of Medians
Financial characteristics								
Leverage	0.83	0.92	0.20	0.75	0.88	0.25	−3.48***	−3.94***
Cash ratio	0.11	0.07	0.11	0.10	0.05	0.14	−0.66	−2.49**
SDCF %	0.20	0.07	0.32	0.82	0.08	7.38	9.08***	1.399
Tax save	5.38	5.19	3.04	5.27	5.15	3.45	−0.32	−0.55
Asset characteristics								
Opacity	0.03	0.01	0.07	0.02	0.00	0.09	−0.60	−4.57***
Market-to-book	2.10	1.79	1.34	5.86	1.43	141.53	3.45***	−3.21***
Sales growth	0.19	0.16	0.27	0.18	0.11	0.65	−0.33	−2.37***
Market characteristics								
SDRET %	2.37	2.12	1.11	2.78	2.20	2.13	3.22***	0.96

(*Continued*)

TABLE 3
Continued

	CRO Hire Firms (n = 77)			Non-CRO Hire Firms (n = 17,215)			Differences	
	Mean	Median	SD	Mean	Median	SD	*T*-Test of Means	Rank Sum Test of Medians
Managerial characteristics								
Vega	419.78	212.48	556.84	196.26	61.34	392.30	−2.71***	−4.48***
Delta	2137.21	617.74	6263.55	2673.97	332.94	21609.92	0.53	−2.26***
Controls								
Numseg	3.42	1.00	4.33	2.34	1.00	3.22	−2.18**	−2.04**
NINST	212.33	148.00	203.91	53.43	19.00	95.10	−6.79***	−8.32***
PINST	0.44	0.48	0.25	0.26	0.18	0.24	−6.29***	−6.03***
MVE ('000,000)	9664.60	1886.17	14319.67	1646.14	136.75	8622.10	−4.88***	−8.85***
Assets ('000,000)	62822.92	13003.96	109898.90	9935.86	603.36	59210.75	−4.19***	−8.87**

Notes: This table presents only financial firms from 1992 to 2005 with SICC > = 6000 and SICC < = 6999. Leverage = Total liabilities/Total Assets = $(d6 - d60)/d6$, Cash Ratio = Cash and marketable securities/Total Assets = $d1/d6$, SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow scaled by assets. This regression is run for eight quarters. Tax Save is the percentage tax savings from a 5% reduction in pretax earnings volatility using the method of Graham and Smith (1999). Opacity = Intangibles/Total Assets = $d33/d6$, MB = Market Value of Equity/Book Value of Equity = $(d199 * d25)/d60$, Sales Growth is the average growth in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. Vega is the partial derivative of the CEO's option and stock portfolio to stock volatility and Delta is the partial derivative with respect to the stock price as in Rogers (2002). Numseg is the number of operating segments of the firm. PINST is institutional ownership as the percentage of the firm's stock. The number of institutional investors is designated as NINST. MVE is market value of equity. Assets is Total Assets ($d6$). The means test is a two-sided t-test. The medians test is a Wilcoxon sign rank test with the Z-statistic reported. ***,**,* Significant at the 1%, 5%, 10% level, respectively.

are more levered than the non-CRO firms have less volatile cash flows, and stock returns. These firms also have lower market-to-book ratios.

For both tables we observe conflicting findings for Vega and Delta. For nonfinancial firms, Delta is higher for the CRO hiring firms, implying that compensation to CEOs is more in the form of pure equity. Conversely for financial firms, we find that Vega is higher for the CRO hiring firms implying option-based compensation.

The univariate results in Tables 2 and 3 should be considered with some caution, however, because in most cases the results are consistent with the simple hypothesis that large firms are more likely to hire CROs. Larger firms tend to be more levered and less volatile. The multivariate analysis that follows in the "Multivariate Determinants of CRO Hiring Announcements" section will attempt to disentangle the size effect.

MULTIVARIATE DETERMINANTS OF CRO HIRING ANNOUNCEMENTS

In this section, we focus on the multivariate determinants of the CRO hire decision. An important contribution of this article is the econometric approach that we use to model the relation between the CRO appointment decision and firm characteristics. Typically, binary decisions of this type are modeled using a "static model," so called by Shumway (2001), in which a logit regression is run on a data set that is composed of the dates on which CROs are hired. For each firm with a hiring event, a nonhiring match firm is identified. A "hire" dummy variable is created and coded one for the firms that have hires, whereas the other nonhire matching firms are coded zero. The major disadvantage of this approach is that it ignores information contained in the time periods in which there are no CRO hires, specifically, the evolution of a firm toward a hiring decision.

An alternative approach is to use the full time series of data, including those periods during which no hiring event occurs. For the periods with no hirings, the dependent binary variable is zero for every firm in the data set. The data set is not a traditional panel data set but more correctly termed an event history data set, which reduces in observations each time a firm hires a CRO and thus exits from the data set. This approach has been used by other authors, including Pagano, Panetta, and Zingales (1998) to model the IPO decision and Denis, Denis, and Sarin (1997) to model executive turnover.

Using a logit model to estimate the parameters of an event history data set will produce incorrect test statistics because of the assumption that all the observations for a firm are independent. To see this lack of independence, consider that an event on day $t = 1$ can only be preceded by a nonevent on day $t = -1$. A hazard model overcomes this problem and can incorporate the impact of time on the hiring decision. Hazard models, commonly used in medical research, model an event (in this case a CRO hire) as a function of the determinants of the event.[7] The hazard model approach takes account of the evolution of a firm's characteristics and computes a hazard ratio of the firm hiring a CRO, whether or not the firm actually hires. The parameter estimates of the hazard model should be similar to those of the logit model (using a full event

[7] In addition to those cited, several other authors use hazard models in finance research, for example, Johnson (2004), Onega and Smith (2001), McQueen and Thorley (1994), Deshmukh (2003), and Danielsen, Van Ness, and Warr (2007).

history data set), but the hazard model produces superior test statistics. We estimate the following hazard model:

$$\text{CROHIRE}_{it} = f(\text{Financial Characteristics, Asset Characteristics, Market Characteristics, Managerial Characteristics, Controls})_{it-1} + e_{it}. \quad (1)$$

We use a Cox proportional hazard function to estimate Equation (1). The Cox model is a semiparametric model in which the likelihood of the event is not related to elapsed time. The subscript i represents each firm in the data set that could have a CRO hiring announcement but has not yet had one. The subscript t represents every year from 1992 to 2005. The dependent variable, CROHIRE is a binary variable that takes the value of one, if the firm announces the appointment of a CRO, and zero otherwise. For the years prior to a CRO hiring, CROHIRE = 0. Once a CRO is hired, the observation drops out of the data set. Therefore, a firm can have a maximum of one observation with CROHIRE = 1. The independent variables are estimated as of the beginning of the fiscal year in which the CRO is hired, that is, $t - 1$.

Hazard Model Results

Table 4 presents the results of our basic hazard model estimation. Because we have a mix of industries represented in the data set, we industry adjust each of the right-hand-side variables by deducting the two-digit SICC mean of the variable from the firm's observation. We report both hazard ratios and coefficients. A hazard ratio indicates the likelihood of a change in the dependent variable given a change in the independent variable. The coefficient is equal to the log of the hazard ratio. A common practice in tests such as these is to compute standardized hazard ratios by calculating the effect of a one standard deviation shift for each independent variable. However, several of the variables in our study are right-tail skewed and consequently have large standard deviations, which may make cross-sectional comparisons misleading. Furthermore, as the variables are mean adjusted, the interpretation of a standard deviation of a mean adjusted variable is not straightforward. Therefore we opt to leave the hazard ratios as raw ratios. A hazard ratio of less than unity indicates a negative relation, whereas a hazard ratio of greater than unity indicates a positive relation.

Two major results stand out from the regression. Large firms and firms with more risk, as measured by SDCF (cash flow volatility) and SDRET (return volatility) are more likely to hire a CRO. This result supports our hypothesis that firms facing greater risk will reap greater benefit from ERM. Size is unsurprising given that larger firms are likely to benefit from economies of scale in a risk management program, although we note that we have quite a few firms with assets below a billion dollars who have hired a CRO. The SDCF variable is interesting, as in the earlier univariate tests this variable appeared to be lower for the CRO firms. However, now, after controlling for size, the true effect of this variable is revealed.

We find no relation between Tax Save (which measures exposure to a convex tax code) and the likelihood ERM adoption. In unreported robustness checks we replaced this variable with the ratio of deferred taxes to assets as in Dionne and Garand (2003).

TABLE 4
Industry Adjusted Cox Proportional Hazard Model on the Determinants of CRO Hires

	Hazard Ratio	Coefficient
Leverage	0.792	−0.233
	(*−0.431*)	
Cash Ratio	1.548	0.437
	(*0.675*)	
Ln(SDCF)	1.139**	0.130
	(*2.110*)	
Ln(Assets)	1.888***	0.635
	(*9.484*)	
Tax Save	1.021	0.021
	(*0.739*)	
Opacity	0.413	−0.884
	(*−1.219*)	
Ln(MB)	0.723	−0.325
	(*−1.542*)	
Sales Growth	1.061	0.060
	(*0.712*)	
Ln(SDRET)	1.842**	0.611
	(*2.559*)	
Numsegs	0.964	−0.036
	(*−1.489*)	
PINST	2.106**	0.745
	(*2.041*)	
NINST	1.000	0.000
	(*0.747*)	
Observations = 74,717	CRO hires = 134	

Notes: The dependent variable is binary: 1 for a firm-year in which a CRO is hired, 0 otherwise. Data are annual from 1992 to 2005. The independent variables are industry adjusted by deducting the two-digit SICC mean value from the observation. Hazard ratios and coefficients that are ln(Hazard Ratio) are presented. Leverage = Total liabilities/Total assets = $(d6 - d60)/d6$, Cash Ratio = Cash and marketable securities/Total assets = $d1/d6$, and SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow scaled by assets. This regression is run for eight quarters. ln(Assets) is the log of assets. Tax Save is the percentage tax savings from a 5% reduction in pretax earnings volatility using the method of Graham and Smith (1999). Opacity = Intangibles/Total assets = $d33/d6$. MB is market-to-book and is computed as Market value of assets/Book value of assets = $(d199 * d25 + (d6 - d60))/d6$. Sales Growth is the average percentage change in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. Numsegs is the number of operating segments of the firm. PINST is institutional ownership as the percentage of the firm's stock. Z-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

This variable is also insignificant. Of the asset characteristic variables, Sales Growth is insignificant and market-to-book is negative but below normal significance levels. The weak negative sign on market-to-book runs counter to the hypothesis that growth firms may adopt ERM to protect growth options. This result coupled with the lack of significance on the sales growth variable points to the conjecture that growth options are not important in the decision to hire a CRO.

Finally we find that PINST (the percentage of shares held by institutions) is positive and significant, consistent with an institutional desire for greater risk management.

As a robustness check to Table 4 hazard model, we also estimate the probit regressions using firm-level averages for all the firms in the sample.[8] While this approach does not capture the evolution of the firm's characteristics through time (it is a "static model" as discussed earlier), it does examine the overall characteristics of the firm's hiring CROs versus the firms that do not. To conserve space, these results are not reported. We find confirmation that the probability of hiring a CRO is positively correlated with cash flow and return volatility, size, and institutional ownership. In this model, the probability of a CRO hire is also negatively correlated with market-to-book. This finding, as we discussed before, could be due to lower growth firms or higher risk firms adopting ERM. Given the controls that we have in place for risk (SDRET and SDCF) we are inclined to believe that the explanation is not risk based but may be that lower growth firms are in a more mature stage.

A criticism of our method is that it does not specifically tackle the issue of endogeneity. For example, firms with more advanced risk management may tolerate more volatile operating cash flows. Thus, adoption of ERM may actually result in higher cash flow volatility. This is an interpretation that we cannot rule out, although we consider that it is unlikely to account for our findings as our tests control for endogeneity by regressing the dependent variable (CRO hire dummy) on lagged independent variables. We suggest that future, more specialized studies of ERM may benefit from more focused analyses including dealing with the endogeneity issue.

Financial Firms

Table 5 presents the analysis of our subsample of financial firms (SICC: 6000-6999).[9] In these tests we do not industry adjust the observations as they are all in the same industry group. Instead, we add dummy variables for the major financial subindustries in which the firm's segments operate.

The results show that the coefficients on operating cash flow volatility, size, market-to-book, number of institutions, and number of segments are significant. These results are largely consistent with the main results from Table 4. The number of segments results is consistent with firms that have less operational diversification (which would be a natural risk reduction method) employing ERM. We also find that segments with SICC 6000 (depository institutions), 6200 (brokers), and 6300–6400 (insurance firms) are significantly positive. Thus, the adoption of ERM is not uniform throughout the financial industry, consistent with certain areas of the industry facing regulatory pressure from public and private entities.

In Table 6, we investigate banking institutions (SICC 6000-6099) in more detail. We add three new variables to the model; Tier 1 capital ratio (Compustat item 337), provision

[8] Specifically, we take firm averages for all the non-CRO hiring firms and use the values of the CRO hiring firms in the year that they actually hire a CRO. We ignore the years for the CRO hire firms in which they did not hire the CRO.

[9] In unreported tests we repeat the analysis for utility stocks and find that size and cash flow volatility remain important determinants of CRO hiring for these firms.

for loan losses (item 342) as a percentage of assets, and a measure of the duration gap. Duration gap requires computation of the duration of the bank's assets and liabilities. Given data restrictions, we adopt a more simple approach and compare the annual change in the bank's assets to the change in the bank's liabilities as in Choi (2007):

TABLE 5
Cox Proportional Hazard Model on the Determinants of CRO Hires for Financial Firms

	Hazard Ratio	Coefficient
Leverage	0.377	−0.975
	(*−1.005*)	
Cash Ratio	0.623	−0.474
	(*−0.409*)	
Ln(SDCF)	1.149**	0.139
	(*2.081*)	
Ln(Assets)	1.616***	0.480
	(*5.563*)	
Tax Save	0.982	−0.018
	(*−0.496*)	
Opacity	0.412	−0.886
	(*−0.528*)	
Ln(MB)	0.293**	−1.226
	(*−2.242*)	
Sales Growth	1.058	0.057
	(*0.244*)	
Ln(SDRET)	0.951	−0.050
	(*−0.138*)	
Numsegs	0.906**	−0.099
	(*−2.366*)	
PINST	1.446	0.369
	(*0.660*)	
NINST	1.003***	0.003
	(*3.116*)	
Seg6000—Depository inst.	15.99***	2.772
	(*3.272*)	
Seg6100—Nondepository credit inst.	1.648	0.500
	(*0.892*)	
Seg6200—Security brokers	4.676***	1.542
	(*3.323*)	
Seg6300—Insurance carriers	1.800	0.588
	(*1.341*)	
Seg6400—Insurance agents	12.910***	2.558
	(*3.988*)	
Seg6700—Investment managers	0.738	−0.304
	(*−0.437*)	
Observations = 14,549	CRO hires = 74	

(*Continued*)

TABLE 5
Continued

Notes: The dependent variable is binary: 1 for a firm-year in which a CRO is hired, 0 otherwise. Hazard ratios and coefficients that are ln(Hazard Ratio) are presented. Financials are ($6000 \leq$ SICC ≤ 6999). Leverage = Total liabilities/Total assets = $(d6 - d60)/d60$, Cash Ratio = Cash and marketable securities/Total assets = $d1/d6$, and SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow scaled by assets. This regression is run for eight quarters. ln(Assets) is the log of assets. Tax Save is the percentage tax savings from a 5% reduction in pretax earnings volatility using the method of Graham and Smith (1999). Opacity = Intangibles/Total assets = $d33/d6$. MB is market-to-book and is computed as Market value of assets/Book value of assets = $(d199 * d25 + (d6 - d60))/d6$. Sales Growth is the average percentage change in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. Numsegs is the number of operating segments of the firm. PINST is institutional ownership as the percentage of the firm's stock. The number of institutional investors is designated as NINST. The SICC of the firm's segments enter as dummy variables. Note that SIC 6500 is excluded due to colinearity. Z-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

$$\text{DUR RATIO} = \frac{\Delta\text{Assets}}{\text{Assets}} \bigg/ \frac{\Delta\text{Liabilities}}{\text{Liabilities}}. \qquad (2)$$

Operating cash flow volatility is no longer a significant determinant of the CRO hire in either model.[10] However, size (Assets) remains significant and positively related to the probability of a CRO hire. We also find that Tier 1 capital is negatively related to the CRO hire decision. Thus firms with lower Tier 1 capital are more likely to employ a CRO and manage risk. This result is consistent with our hypothesis that the firms with high costs of financial distress, or operate in a highly leveraged state are the greatest beneficiaries of ERM.

CEO Incentives

In Table 7, we explore the effect of CEO compensation on the CRO hire decision. As in Table 4, we industry adjust the right-hand-side variables. As we stated earlier, data on CEO compensation are only available for a subset of our firms, and hence we have a reduced sample size. We measure CEO incentives as in Rogers (2002), using Vega to measure the sensitivity of the manager's compensation to stock volatility and Delta to measure the sensitivity to the stock value.[11] The coefficient on Vega is positive and significant, indicating that as CEOs compensation packages become more sensitive

[10] Our sample is significantly reduced in these tests, and as a result the power of the tests to reject the null is also reduced.

[11] This variable does not include cash based bonus compensation. In unreported results we included the bonus as a percentage of total compensation but found it to be insignificant. One problem with using bonus as part of this variable is that it is very difficult to estimate the Delta for bonus, i.e., the sensitivity of the bonus to stock price performance.

TABLE 6
Cox Proportional Hazard Model on the Determinants of CRO Hires for Banks Only

	Hazard Ratio	Coefficient
Ln(SDCF)	0.952	−0.049
	(*−0.243*)	
Ln(Assets)	1.651***	0.501
	(*4.051*)	
Tax Save	1.037	0.036
	(*0.595*)	
Opacity	0.081	−2.511
	(*−0.198*)	
Ln(MB)	0.015	−4.196
	(*−1.211*)	
Sales Growth	0.945	−0.056
	(*−0.049*)	
Ln(SDRET)	0.771	−0.261
	(*−0.345*)	
PINST	2.298	0.832
	(*0.818*)	
NINST	1.004**	0.004
	(*2.399*)	
Tier 1	0.852*	−0.161
	(*−1.757*)	
Loan Loss	1.156	0.145
	(*1.040*)	
Duration Gap	0.901	−0.105
	(*−0.607*)	
Observations = 6,180	CRO hires = 33	

Notes: The dependent variable is binary: 1 for a firm-year in which a CRO is hired, 0 otherwise. Hazard ratios and coefficients that are ln(Hazard Ratio) are presented. Banks are ($6000 \leq$ SICC $\leq$ 6199). SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow, scaled by assets. This regression is run for eight quarters. ln(Assets) is the log of assets. Tax Save is the percentage tax savings from a 5% reduction in pretax earnings volatility using the method of Graham and Smith (1999). Opacity = Intangibles/Total assets = $d33/d6$. MB is market-to-book and is computed as Market value of assets/Book value of assets = $(d199 * d25 + (d6 - d60))/d6$. Sales Growth is the average percentage change in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. PINST is institutional ownership as the percentage of the firm's stock. The number of institutional investors is designated as NINST. Tier 1 capital is $d337$, Loan loss provision is d342/d6, duration ratio is $\frac{\Delta Assets}{Assets} / \frac{\Delta Liabilities}{Liabilities}$. Z-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

to stock volatility, the likelihood of hiring a CRO increases. This result appears to be at odds with the incentives of a CEO to maximize his/her own personal wealth, as one would expect a rational CEO who has much of his/her compensation in the form of at-the-money options to prefer that the firm be more risky. If, however, ERM reduces downside risk without impacting upside risk, the CEO should rationally

TABLE 7
Industry Adjusted Cox Proportional Hazard Model on the Determinants of CRO Hires Including CEO Incentives

	Hazard Ratio	Coefficient
Leverage	1.563	0.447
	(*0.510*)	
Cash Ratio	0.913	−0.091
	(*−0.092*)	
Ln(SDCF)	1.046	0.045
	(*0.617*)	
Assets	1.762***	0.567
	(*4.140*)	
Tax Save	1.069*	0.067
	(*1.668*)	
Opacity	0.215	−1.536
	(*−1.514*)	
Ln(MB)	0.927	−0.075
	(*−0.368*)	
Sales Growth	1.388*	0.328
	(*1.825*)	
Ln(SDRET)	3.382***	1.218
	(*3.114*)	
Ln(VEGA)	1.285*	0.251
	(*1.913*)	
Ln(DELTA)	0.888	−0.118
	(*−0.976*)	
Numsegs	0.946*	−0.056
	(*−1.728*)	
PINST	1.290	0.254
	(*0.413*)	
NINST	1.000	0.000
	(*−0.072*)	
Observations = 16,259	CRO hires = 76	

Notes: The dependent variable is binary: 1 for a firm-year in which a CRO is hired, 0 otherwise. The independent variables are industry adjusted by deducting the two-digit SICC mean value from the observation. Hazard ratios and coefficients that are ln(Hazard Ratio) are presented. Leverage = Total liabilities/Total assets = $(d6 - d60)/d6$, Cash Ratio = Cash and marketable securities/Total assets = $d1/d6$, and SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow. This regression is run for eight quarters. ln(MVE) is the log of market value of equity. ln(Assets) is the log of assets. Tax Save is the percentage tax savings from a 5% reduction in pretax earnings volatility using the method of Graham and Smith (1999). Size is market value of equity. Opacity = Intangibles/Total assets = $d33/d6$. MB is market-to-book and is computed as Market value of equity/Book value of equity = $(d199 * d25)/d60$ or Market value of assets/Book value of assets = $(d199 * d25 + (d6 - d60))/d6$. Sales Growth is the average percentage change in sales over the prior 3 years. SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO. Vega is the partial derivative of the CEOs option and stock portfolio to stock volatility and Delta is the partial derivative with respect to the stock price as in Rogers (2002). Numsegs is the number of operating segments of the firm. PINST is institutional ownership as the percentage of the firm's stock. *Z*-statistics are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

embrace ERM even if the CEO has an incentive to take risks and gets rewarded in the upside.[12]

It is generally not the CEO who makes the decision to implement ERM; instead, it is the board of directors that usually leads this initiative (Lam, 2001), although during this time period, quite a few CEOs also held the board chairman position. Thus, a possible explanation for this result is that the board recognizes that the CEO has an incentive to increase risk and therefore by implementing a risk management program controls the risk that is expected to be taken on by the CEO. From the board's point of view this is a rational strategy—to effectively encourage risk taking by the CEO and at the same time implement a program to actively manage, coordinate, and understand these risks.

Two other results in this table also allow lend support to this explanation. We find that Tax Save is positive and significant and Sales Growth is positive and significant. Thus, in this table, there is evidence for the risky growth options explanation for ERM adoption. That is, these firms adopt ERM to protect future, as yet unrealized, cash flows that are derived from risky growth options. These are results are consistent with the findings of Coles, Daniel, and Naveen (2006), who find that firms with more risky investment policies tend to use compensation structures with higher Vega and lower Delta.

CONCLUSION

We use a hazard model to examine the determinants of the firm's decision to adopt ERM, which we identify by the hiring of a CRO. The hazard model generates reliable test statistics when a time-series panel data set is used. ERM allows managers to evaluate the firm's total risk exposure and engage in a holistic and unified risk management strategy. A holistic and unified risk management strategy can create value by taking interactions between individual risks into account (Meulbroek, 2002).

We find that firms hiring CROs are doing so for some reasons that are consistent with the hypothesized benefits of ERM. For example we find that firms appear to implement ERM when they are larger, and have more volatile cash flows and riskier stock returns. When we consider financial firms alone we find that ERM adoption is more prevalent among depository institutions, brokers, and insurance companies. Furthermore, we find that banks with lower Tier 1 capital are more likely to hire a CRO, consistent with these highly levered banks needing to have greater awareness of the portfolio of risks facing them.

Other authors find a direct relation between CEO risk taking incentives (option vs. stock compensation) and hedging activity. This relation is normally negative in that the more risk-taking incentives that the CEO has, the less likely the firm is to hedge. In our tests, the correlation is positive as we find that the likelihood of ERM adoption is increasing in the risk taking incentives of the CEO. This evidence is consistent with firms that have risky growth options also using high Vega compensation schemes to provide managerial incentives, while at the same time using ERM to manage the risks being undertaken.

[12] We thank the referee for suggesting this explanation.

Although our study provides detail into the decision of firms to implement ERM there are limitations. Due to the lack of disclosure by firms about their risk management programs, we identify the decision to adopt ERM with the hiring of a CRO. Further study of the implementation process is needed to understand the evolution of firms' ERM programs. Additionally, further research is needed to understand the CRO's role within the firm; ideally, this research should focus on the hiring process, the reporting relationship, and the inner details of firms' ERM programs.

APPENDIX

Variable Construction

Variable Name (Description)	Notes
Leverage (debt ratio)	Total liabilities/Total assets = $(d6 - d60)/d6$
Cash Ratio (liquid assets)	Cash and marketable securities/Total assets = $d1/d6$
SDCF (operating cash flow volatility)	SDCF is the standard deviation of the error term from a regression of the firm's quarterly operating cash flow on the prior quarter's operating cash flow, scaled by total assets. This regression is run for eight quarters. Our results are quantitatively unchanged if we use the standard deviation of EPS as the volatility measure.
Tax Save (convexity of the firm's tax structure)	Tax Save is computed using Equation (1) of Graham and Smith (1999). The variable is based on the fitted values of the regression run by Graham and Smith and is computed as follows: Tax Save = 4.88 + 7.15TI(Neg) + 1.60TI(Pos) +0.019Vol − 5.50RHO − 1.28ITC + NOL(3.29 − 4.77TI(Neg) − 10.93TI(Pos)). Where TI(Neg) is a dummy variable for pretax income between −\$500,000 and 0 and TI(Pos) is a dummy variable for pretax income between 0 and \$500,000. NOL is a dummy variable that takes the value of 1 if the firm reports an unused net operating loss carry forward (data52). Vol is the absolute coefficient of variation of taxable income computed as the absolute value of the ratio of the mean of taxable income (data170) to the standard deviation of taxable income. Rho is the first-order serial correlation of taxable income. Vol and Rho are computed using up to the past 10 years of data for the firm. ITC is a dummy for the presence of investment tax credits.
Size (assets)	Size is the log of the firm's assets measured at the fiscal year-end prior to the CRO hire announcement.
Opacity (tangibility of assets)	Intangibles/Total assets = $d33/d6$
MB (market-to-book)	(Market value of equity + book debt)/Book assets = $((d199 * d25) + (d6 - d60))/ d6$
Sales Growth (past sales growth)	Sales Growth is the average percentage change in sales over the prior 3 years. When 3 years of data are unavailable, we use 2 years, and when 2 years are unavailable we just use the 1 year growth rate.

(*Continued*)

APPENDIX
Continued

Variable Name (Description)	Notes
SDRET (standard deviation of returns)	SDRET is the standard deviation of the firm's daily returns over the year prior to the hiring of the CRO.
Numsegs (number of operating segments)	Number of operating segments reported in Compustat.
PINST and NINST (institutional ownership)	Institutional ownership is the percentage of the firm's stock held by institutional investors as recorded in 13-F filings. This variable is designated as PINST. The number of institutional investors is designated as NINST.
Vega and Delta (managerial risk-taking incentives)	We follow Rogers (2002), who in turn follows Core and Guay (2002) in computing the option sensitivities to volatility and price. Delta measures the option value's sensitivity with respect to a 1% change in stock price and Vega measures the option value's sensitivity to a 0.01 change in standard deviation. These values are computed as: Delta: $\frac{\partial Value}{\partial S}\frac{S}{100} = e^{-dT}N(d_1)\frac{S}{100}$, Vega: $\frac{\partial Value}{\partial \sigma} \times 0.01 = 0.01[e^{-dT}N'(d_1)S\sqrt{T}]$, where $d_1 = \frac{\ln(S/X)+T(r-d+\sigma^2/2)}{\sigma\sqrt{T}}$. Note that d_1 is from the Black-Scholes option pricing model. $N(\cdot)$ is the cumulative probability function for the normal distribution, $N'(\cdot)$ is the normal probability density function, S is the share price of the stock at the fiscal year-end, d is the dividend yield as of fiscal year-end, X is the exercise price of the option, r is the risk-free rate. We use the risk-free rate provided in ExecuComp. σ is the annualized standard derivation of daily stock returns measured over 120 days prior to fiscal year-end and T is remaining years to maturity of option.
	The data for estimation are from ExecuComp (and originally from the proxy statements); however, the exercise price and maturity are only available for current years' option grants. Therefore, to estimate prior years' exercise prices and maturities we follow the Core and Guay (2002, p. 617) algorithm. The proxy statement provides realizable values of options grants (i.e., the excess of the stock price over the exercise price). Because X and T are computed separately for new options, the number and fiscal year-end realizable value of new options must be deducted from the number and realizable value of unexercisable options. Dividing unexercisable (excluding new grants) and exercisable realized values by the number of unexercisable and exercisable options held by the executive, respectively, yields estimates of, on average, how far each of the groups of options is in the money. Subtracting this number from the stock price yields the average exercise price. The exercise price is computed for exercisable and unexercisable options. The time to maturity for the

(*Continued*)

APPENDIX
Continued

Variable Name (Description)	Notes
	exercisable options is the maturity of the new grants less 1 year (or 9 years if no new grant is made). For the unexercisable options, the time to maturity is the maturity of the new grants less 3 years (or 6 years if no grant is made). We treat the stock holdings of the CEO as having a Vega of zero and a Delta of one and include them in the computation of Vega to Delta.

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