Enterprise Risk Management: Strategic Antecedents, Risk Integration and Performance

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ABSTRACT

The current literature on the adoption of enterprise risk management (ERM) abstracts from the issue of its strategic context. Accounting for the interplay between ERM and various individual risk management (IRM) practices, this paper presents a theoretical basis to study the strategic determinants, risk integration, and value creation of ERM. We tested hypotheses with data from the US property and casualty (PC) insurance industry. Our results show that insurers with more reinsurance purchase, higher derivative usage, and greater geographic diversification are more likely to adopt ERM. After ERM initiation, the magnitude of certain IRM adjustments is substantial. Interestingly, the market responds negatively to ERM adoption. ERM displays a strong negative correlation with firm value with a discount of 11% (5%) in terms of Tobin's Q (ROA).

JEL classification: G22; G32; D81

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1. Introduction

Enterprise risk management (ERM) represents a fundamental shift in the way that firms deal with risk. Through a holistic approach, ERM identifies and measures diverse risk factors and coordinates risk management activities across all operating units of an organization, as opposed to the traditional practice whereby each business unit separately assesses its particular risks and decides how to mitigate them on its own.

Recent surveys show that the concept of ERM has been rapidly embraced by the business community (e.g., Kleffner et al., 2003; Fraser et al., 2008), and accordingly, the phenomenon has received a growing scholarly attention. So far, studies in this stream of research have mainly focused on the link of ERM to firm characteristics. For example, Beasley et al. (2005) observe that the extent to which a firm commits to ERM is determined by its size and executive support. Through an empirical analysis of senior risk officer appointments during 1992-2005, Pagach and Warr (2007) find that financial leverage plays an important role in ERM adoption, with high leverage firms being more likely to apply ERM than firms with low leverage ratios. Researchers have also looked at how ERM is related to the structure of board of directors. In analyzing firms in the segment of pharmaceutical preparations, Desender (2009) detects that firms with a higher percentage of outside directors do not necessarily favor ERM adoption. Board independence affects ERM only when there is a separation of CEO and board chairman positions.

Yet, surprisingly little attention has been paid to the strategic context within which ERM is motivated and carried out. By definition, a better understanding of ERM requires a perspective that emphasizes the importance of integration among a firm's broad range of risks as well its specialized individual risk management (IRM) strategies – namely, strategies that are designed for separate silos of firm risks (e.g., insurance, diversification, or hedging through financial derivatives). Indeed, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) stresses ERM as "a process … applied in strategy setting and across the enterprise" (2004, p. 2). However, despite the presumed role of ERM in "commingling" various IRMs, there is no research of which we are aware on how IRMs act as catalysts for ERM formation. In addition, no research has empirically explored whether ERM elicits modification of IRM conducts. Considering that ERM integrates IRMs, the adoption of ERM should intuitively have an impact on the firm's existing IRM operations.

Understanding the connection between ERM and IRMs is not only important in its own right, but may also provide insights into how ERM contributes to firm performance. Given their common function in handling risks, the effect of one practice (ERM) will tend to be contingent on the status of the other (IRMs). Unfortunately, studies on the value relevance of ERM programs have often neglected IRMs with an implicit assumption of mutual exclusivity of the two risk management approaches. Focusing on ERM alone is problematic because, as will be clear, IRMs may provoke ERM adoption. As such, without controlling for IRMs, the observed ERM effect might be simply a reflection of the impact of its underlying IRM drivers, leading to spurious results.

The purpose of this study is threefold: (1) to investigate whether the heterogeneity in IRMs across firms accounts for their different propensities toward ERM, (2) to analyze the patterns of IRM adjustments subsequent to ERM adoption, and (3) to examine the influence of ERM on firm performance in the context of IRMs. We focus on ERM activities in the insurance industry because insurers, which are relatively homogeneous in terms of their investment, financing activities and regulatory environments, are active in espousing ERM concepts, making them ideal candidates for such studies. Specifically, we test our hypotheses using a longitudinal data set of 85 U.S. publicly traded property and casualty (PC) insurers. Our results broadly support the view that ERM and IRMs are closely related and have mutual impacts on each other. Thus, this paper extends the literature on ERM by being the first study to show the dynamics between ERM and other related organizational risk management strategies.

Our article also contributes to the debate regarding the value creation of ERM behaviors. Our results show that, after screening out the impact of IRMs, the stock market responds negatively to insurers' ERM adoptions. One explanation for this finding is that ERM is still at its infancy stage (see Figure 1 described in Section 3.1.), and its benefit, procedure and mechanisms remain vague and ambiguous. As such, firms adopting ERM have to rely on experiential learning, conduct experiments and accumulate knowledge through trials and errors, the process of which can be demanding and time-consuming. Given its unclear utility, the market apparently views ERM, at the current state, as too costly to justify its implementation.

The remaining paper proceeds as follows. The next section briefly reviews the risk management literature, followed by hypotheses development. We then describe our data, variables and methods. This is followed by the discussion of the empirical results. The article concludes with a summary.

2. Theory and hypotheses development

In this section, we first review the literature on the rational for risk management. We then discuss motivations for adopting ERM and formulate hypotheses on how the levels of various IRMs inspire ERM endeavors. Next, we develop hypotheses about the impact of ERM on IRM reconfiguration. Finally, we build hypotheses on the value effects of ERM.

2.1. Rational for risk management

The literature on corporate risk management is vast and growing. A general consensus of this body of research is that though hedging is not necessary in an "ideal" world depicted by Modigliani and Miller, it is meaningful and conducive to firms in a real business context where market imperfections exist. Specifically, hedging can assist firms to (i) reduce financial distress costs (Smith and Stulz, 1985; Lin et al., 2008; Lookman, 2009), (ii) alleviate underinvestment problems (Myers, 1977), (iii) increase tax savings (Adams et al., 2008), and (iv) avoid costly external financing (Froot and O'Connell, 2008).

Like industrial firms, insurance firms can reap benefits from engaging in risk management. Cummins et al. (1997) point out that insurers play two major roles in the market: risk warehousing and financial intermediation, each of which exposes the firms to substantial risks. First, by selling insurance policies, insurers pool risks from individuals and businesses and promise to pay claims upon the occurrence of specific loss events. This function, though a fundamental reason for their existence, can be a source of problems to insurers because the rationale of risk pooling is based on the independence of claim losses across policies. Other things equal, a high positive loss correlation would undermine the companies' underwriting capacity. Second, given the fact that insurers issue debt contracts on the one hand, and invest their surplus on the other, they also serve the role of financial intermediaries. Cummins et al. (1997, 2001) provide detailed description of this function, so we do not repeat it here. One conclusion the authors draw is that, as a consequence of their positions in the market, insurers are subject to considerable financial risks.

The literature has documented various approaches that firms apply to deal with risks. In the insurance industry where underwriting and financial risks are the dominant risks, probably the most commonly used IRMs are geographic diversification, business diversification, reinsurance and financial derivatives. Each of the strategies tackles some distinct risk dimension, for which we will provide intuition below.

Portfolio theory suggests that diversification helps to decrease risk because of the imperfect correlation among different regions or markets (Carson et al., 2008; Song and Cummins 2008). In support to this argument, Baele et al. (2007) and Carson et al. (2008) have shown that diversification decreases earnings volatility so that it makes well-diversified firms safer by lowering their probability of default. This insight has implications to insurers because, as has been noted above, the underwriting ability of these firms depends on the loss correlation of their policies. By managing a diversified portfolio, insurers are able to spread risks and prevent excessive exposure from a single source.

Notwithstanding the benefit of diversification, it has only limited efficacy against extreme events. To illustrate, a large-scale catastrophe like Hurricane Katrina can affect diverse business lines[1] as well as multiple states, leading to correlated losses across large numbers of contracts and policies. As a result, reinsurance has been widely adopted in the insurance sectors. In 2003 alone, an amount of $146 billion premium, or over 13 percent of total PC direct premium written, was ceded to reinsurers globally. By using reinsurance, insurers can transfer part of the risks to reinsurers and, thus, reduce the effect of unexpected high-end losses (or underwriting tail risks).

Financial risks pose a major threat to insurers as well. In fact, "the loss of value of investments (alone) was the cause of about 10 per cent of insurance insolvencies in the U.S. in the past 20 years" (Fitzpatrick, 2001, p. 24). Unlike underwriting risks, financial risks are systematic risks which are hardly diversifiable. Fortunately, the variety of financial instruments and over-the-counter products (such as options, futures, forwards and swaps) available in the

[1] Hurricane Katrina had an impact on many insurance lines, including, among others, property damage insurance and business interruption insurance.

financial market presents a solution to hedge against these risks, which include, among others, interest rate risk and exchange rate risk, two of the primary ones that insurers face (see Cummins et al., 1997, 2001 for more details).

Whereas the aforementioned IRMs provide useful means for risk management, each of the strategies rests on a silo-based approach, with a concentration on only one of the various aspects of organizational risks. Recently, researchers introduce ERM as an alternative approach. Rather than treating them as statistically independent, ERM considers inherent connections among individual risks and manages them in a holistic fashion. Conceptually, the consolidated approach of ERM may add value to firms in a couple of ways. First, by assessing all risks, firms can develop a complete picture of their own risk portfolios. This allows the firms to explore natural hedging among different classes of risks, which is ignored by IRMs. Indeed, Rosenberg and Schuermann (2006) find that the total risk of an organization is not equal to the sum of individual risks. Based on data from banking holding companies, their simulation shows that an integration of separate risks can reduce the overall level of organizational risk up to about 40%. Second, not all risks are of equal importance, not even to the same firm. Through ERM, firms can prioritize risk factors according to their own risk appetites. This process and the corresponding knowledge generated can guide organizational behaviors, improve operational efficiency, and allow firms to better allocate their resources to optimize their effort in risk management.

2.2. How IRMs act as catalysts for ERM formation

Insurance companies purchase reinsurance to limit large losses and/or to meet regulatory solvency requirements. However, reinsurance is expensive, generally offered with a premium over and above the expected risk transferred (Cummins et al., 2008a). The high price of reinsurance relative to the expected loss could be explained by the information asymmetry between insurers and reinsurers (Jean-Baptiste and Santomero, 2000). In addition, due to a series of massive catastrophes that occurred in the last two decades[2], quantities of reinsurance supply fall and prices rise in the aftermath of large losses. Examining the catastrophe reinsurance market, Froot (2001) finds that insurers pay several times the actuarial price of their ceded risk.

As a consequence, despite its widespread use, the high reinsurance cost is a concern to insurers. ERM consolidates various risks across the entire organization and, thus, reduces the amount of risk to be ceded. This function of ERM is important in the sense that it offers potential for cost savings by lowering the need for reinsurance usage (Shamieh, 2007). Therefore, insurers that buy more reinsurance protection are more inclined to initiate ERM because they tend to benefit more from ERM adoption. Consequently, we hypothesize that:

> *H1a:* Insurers with a larger amount of reinsurance purchase are more likely to adopt ERM.

In the presence of market imperfections, companies are motivated to hedge risk with financial derivatives (Smith and Stulz, 1985). A 1998 survey of major non-financial firms revealed that over 50% of the firms rely on some form of financial derivatives to manage price and market-related risks (Bodnar, et al., 1998). However, using 1994 data, Cummins et al. (1997) report that only 7% of PC insurers and 12% of life insurers engage in derivatives transactions. Based on more updated data from 2000 to 2006, a recent study by Song and Cummins (2008) shows that the average derivatives usage rate is merely 2.5% of total firms in the PC insurance industry.

The above observations indicate that although financial derivatives have been widely

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[2] Among the long list of major catastrophes during the period are Hurricane Andrew in 1992, the Northridge Earthquake in 1994, September 11 terrorist attacks in 2001, and Hurricane Katrina in 2005, to mention just a few.

utilized by industrial firms, it has not been fully exploited by insurance companies. Compared to those with no or limited use of derivatives, insurers that are active in the derivatives market tend to be more conscious about financial risks in that the requirement of selection of appropriate financial instruments and the corresponding actions for execution necessitate a deep understanding of movements of financial market forces. Along this line of reasoning, firms that hedge more with derivatives tend to extract more benefits from ERM programs because, given their level of awareness and knowledge, they are more likely to find subtle connections between financial risks and other risks in organizational systems. This makes these firms more likely to adopt ERM. Thus,

> *H1b:* Insurers with a higher degree of financial derivative usages for hedging are more likely to adopt ERM.

Diversification diminishes the impact of losses that are either location- or business-specific (Cummins and Nini, 2002); yet, as a cost, this strategy augments the level of risk complexity that the company faces (Wagner, 2010). By expanding its business (or geographic) frontiers, an insurer encounters new risk factors that can be inherently different from what have been incorporated in its existing risk portfolio. Diversification also imposes a need for a more sophisticated organizational structure to facilitate interdepartmental knowledge exchange, task coordination and effective resource allocation (Lang and Stulz, 1994). The increased complexity of organizational structure makes firm behaviors more opaque to investors and more difficult to monitor, leaving room for opportunistic behaviors (Laeven and Levine, 2007). In this sense, there is a tradeoff between underwriting risks and operational risks to diversifying insurers. ERM aims at streamlining risk coordination. The increased risk complexity of diversifiers suggests that these firms have a higher propensity to adopt ERM because they are more likely to gain from managing all risks comprehensively. Therefore, we propose the following two hypotheses:

H1c: Insurers with a larger degree of geographic diversification are more likely to adopt ERM.

H1d: Insurers with a larger degree of business diversification are more likely to adopt ERM.

2.3. Post-ERM adjustment of IRMs

ERM is not a substitute of IRMs, but rather creates synergies for the latter by incorporating them within one integrated framework (COSO, 2004; Beasley et al., 2008). In this sense, ERM acts as a central planner to coordinate and reformulate all IRMs.

As noted earlier, cost savings play an essential role in motivating ERM programs. A successful ERM strategy can streamline operation, reduce redundancy, and consolidate risk management, thereby minimizing costly risk transfer. Indeed, some insurance managers have explicitly stated in public that, through a sound ERM program, they have successfully reduced costs by greater risk retention and less reinsurance purchase (e.g., Safeco Corporation and American International Group, Inc.). The coverage period of a reinsurance contract is typically one year (Froot, 2001); thus, insurers can promptly bring their reinsurance level closer to the optimal enterprise-wide level after initiating ERM.

As financial intermediaries, PC insurers are subject to significant interest rate risk due to their heavy investment in illiquid assets and real estates. In addition, they are also exposed to exchange rate risk due to increasing globalization of insurance and financial risks (Cummins et al, 1997, 2001). As stated above, in the U.S. insurance industry, financial derivatives play a trivial role in hedging asset risk. ERM helps identify and quantify all types of risks underestimated or ignored by insurers. Therefore, we predict ERM programs will foster the derivative usage for hedging purpose.

In contrast to reinsurance and financial derivatives, it is much more difficult and unmanageable for a firm to change business lines and underwriting regions in the initial phase of an ERM program. On the one hand, insurers may be required by regulators to underwrite specific lines of insurance in particular regions. On the other hand, the insurers may face substantial transaction costs if they expand to or exit from a market or a business line too quickly. Issues such as costly external financing at expansion, fire sale of assets when exiting from a market or a business line in haste, and difficulty of accessing needed information and expertise are barriers for ERM insurers to rapidly move away from the prior level of diversification at the time of ERM adoption. Accordingly, we conjecture that geographic diversification and product diversification are persistent in the short run and it is less likely for ERM adopters to change either type of diversification right after embarking on an ERM program. Hence, we enunciate our hypothesis on the post-ERM adjustments of IRMs as follows:

> *H2:* In the short run, ERM decreases the degrees of reinsurance purchase, increases the level of financial derivative usage, but retains the levels of diversification—product-wise and geographically.

2.4. Effects of ERM on firm value

Two alternative views have been proposed on the value-creation of ERM: (i) ERM has a positive effect on firm value; and (ii) ERM has an adverse effect on firm value. Whereas some practitioners (e.g., Goldman Sachs and Allstate Inc.) assert that ERM is economically justified, a survey conducted by Fraser et al. (2008) finds that only 8% of the sample firms implement ERM to "enhance shareholder or firm value".

Proponents of ERM argue that ERM is conducive because it balances risk and resources in a seamless manner (Nocco and Stulz, 2006). In the context of the insurance industry, ERM may enhance asset-liability management, achieve better pricing for policyholders with a stable loss profile, temper the severity of hard markets, and reduce the possibility of extreme soft market price-cutting (Zaccanti, 2009). Furthermore, insurers may benefit from ERM through improved ratings (Samantha et al., 2004), more cost savings (Shamieh, 2007), and better compliance with solvency regulation (Basel, 2003). In particular, during financial turbulences, strong ERM practices may ensure insurers to act and recover quickly. For example, well-designed ERM programs of ANZ, Goldman Sachs and Barclays help steer the firms through the recent financial crisis and make them relatively more successful than most of their peers (Samanta, 2009).

In contrast, critics of ERM claim that ERM is still at its early stage, whose true value and utility is yet to be understood through repeated trials-and-errors, experiments, and knowledge accumulation and consolidation (Samanta, 2009). This argument is strengthened by the recent collapse and bailout of American International Group (AIG), one of the first ERM adopters in the U.S. insurance industry. ERM can be costly, or even detrimental, if motivated by managerial hubris (Roll, 1986). When blindly following the wave of ERM adoption, managers are likely to underestimate the difficulty and cost of initiating and maintaining ERM programs or overestimate their own abilities to coordinate and aggregate various IRMs and risks. As such, an ERM program that is conceived as beneficial to the firm could simply be a poor decision with misjudged benefits and costs. In addition, if applied inappropriately (e.g., lack of integration), ERM programs may lead to an additional layer of bureaucracy. Thus the implied opportunity cost and the explicit set-up and operation costs incurred amid the long-process of ERM implementation can in fact destroy firm value. Consequently, the above arguments suggest two competing hypotheses.

H3a: ERM has a positive effect on firm value.

H3b: ERM has a negative effect on firm value.

3. Empirical evidence

3.1. Data and variable construction

The initial sample for our empirical analysis consists of all 105 publicly-traded PC insurers in the US market during the period 2000-2007.[3] Accounting related data are obtained from the National Association of Insurance Commissioners (NAIC) annual statements, and market-based measures are constructed by using data from Compustat.[4] Credit information is from A. M. Best's *Key Rating Guide*. The final sample includes 509 observations for 85 unique PC insurance firms for which the required data are available in this eight-year period.

We follow procedures suggested by Beasley et al. (2008), Hoyt and Liebenberg (2009) and Pagach and Warr (2007) to perform a detailed search of financial reports, newswires, and other media for evidence of insurers' ERM activities.[5] Figure 1 demonstrates the cumulative number of insurers adopting ERM, and it shows that, among the 85 unique PC insurers, 31 companies adopted ERM programs during our study period. Notably, the number of ERM insurers presents a slow, but steady increase before 2006 and then grows substantially afterwards. The total number of ERM insurers increases from 12 in year 2005 to 23 in 2006 and then to 31 in 2007.

< Insert Figure 1 about here >

3.1.1. Risk Management Variables – ERM and IRMs

We define *ERM* as a dummy variable with value 1 if an insurer engaged in ERM in a particular year during the period 2000-2007 and zero otherwise. We also consider four IRM

[3] There is only limited number of ERM adoptions before 2000. Thus, we focus on the period from 2000 to 2007.
[4] We draw the sample with the SIC code 6331, which represents the PC insurers.
[5] More specifically, we use SEC filings, LexisNexis, company websites and Google to perform keyword searches for each insurer. Our search strings include the following phrases and their acronyms: "enterprise risk management", "chief risk officer", "risk committee", "strategic risk management", "consolidated risk management", "holistic risk management", and "integrated risk management".

activities commonly used by insurance companies: reinsurance, geographic diversification, product diversification, and derivatives. In particular, reinsurance, product diversification and geographic diversification are mechanisms to manage underwriting risks, and the usage of derivatives is for hedging financial risks.

The first IRM variable, *Reinsurance*, is defined as the ratio of reinsurance ceded to the sum of direct business written and reinsurance assumed (Cole and McCullough, 2006). The second IRM measure, G_DIV_i, captures an insurer's geographic diversification. It equals one minus geographical Herfindal index:

$$G\_DIV_i = 1 - \sum_j \left(\frac{DPW_{i,j}}{DPW_i} \right)^2 ,$$

where $DPW_{i,j}$ is the premium written for insurer i in state j and DPW_i is the total premium written for insurer i. A higher value of *G_DIV* suggests that the insurer underwrites business in more regions. The third IRM variable, product diversification (P_DIV_i), is similarly defined as follows:

$$P\_DIV_i = 1 - \sum_l \left(\frac{DPW_{i,l}}{DPW_i} \right)^2 ,$$

where $DPW_{i,l}$ is the premium written for insurer i in line of business l.

The last IRM variable, level of derivative usage (denoted as *Derivative*), equals an insurer's notional amount of all derivative positions for hedging purpose held at year end, normalized by its total assets. Although the notional amounts for equity options and bond options are not available, following Song and Cummins (2008), we use number of traded contracts and strike price to generate approximate notional values for those contracts.[6]

3.1.2. Firm value measurement

[6] Notional amount for equity options are approximated as number of contracts × strike price× 100. Notional amount for bond options are approximated as number of contracts × par value per contract.

Tobin's Q is a prospective market-based value measure, which reflects future expectations of investors. It is a useful performance variable for our study because the benefits of ERM may not be apparent in the short run. In this paper, we define *Tobin's Q* as the market value of equity plus the book value of liabilities divided by the book value of assets (Yermack, 1996; Cummins et al. 2006). Cummins et al. (2006) argue that this definition of *Tobin's Q* is appropriate for insurance companies because the book value of their assets is a close approximation of replacement costs. In addition to *Tobin's Q*, to provide further evidence, we also examine the valuation effects of ERM via return on asset (*ROA*)[7], an accounting-based performance measure.

3.1.3. Other firm-specific variables

The significance of information asymmetry on risk management decision has received great attention in the literature (Géczy et al., 1997). The problem of information asymmetry in reinsurance transaction can be mitigated by a long-term contracting relationship between insurers and reinsurers because repeated interactions promote trust and allow for better communication, which can translate to a lower price (Jean-Baptiste and Santomero, 2000; Doherty and Smetters, 2005; Lin et al., 2009). We measure the level of information asymmetry by calculating *Reinsurance Sustainability Index*, which is defined as the proportion of premiums ceded over a three-year period to reinsurance providers which are present in all the three years.[8] In particular, a high value of this index signals low levels of information asymmetry problem and reinsurance cost, which could diminish the need for ERM. Thus, one would expect a negative relationship

[7] We also tested the effect of ERM on some other accounting-based performance measures, such as return on equity (ROE) and underwriting ROA (calculated as underwriting income divided by total assets), and the pattern of results was essentially the same. To conserve space, we do not report these results. Details of the estimation results are available upon request.

[8] Specifically, the value of the index for each primary insurer in year t is based upon the $[t - 3, t]$ window and this value shows whether and to what extent primary insurers keep long-term relationships with the same reinsurers (Garven and Grace, 2007; Lin et al., 2009).

between ERM adoption and this index.

The insurance industry is one of the most heavily regulated industries in the economy. Price regulation can cause insufficient capital level, thereby affecting insurers' risk management decisions. Hence, we include in our analysis a price regulation variable, *% Premium in Price Regulated Lines*, which is defined as the ratio of premiums in price regulated lines (primarily personal auto and workers' compensation) to total premium (Cummins et al., 2008b).

Claims of property lines of business tend to occur in a relatively short period following policy issuance. To control for the possibility that insurers with a higher percentage of premiums in short-tail business transfer more risk to alleviate potential liquidity problems, we include a control variable, *Percentage of Premiums in Property Lines of Business*, which is measured as the percentage of premium written in property lines of business.[9]

Catastrophic losses can create shocks large enough to impact the entire PC industry and thereby exhaust internal funds of many insurers, resulting in costly external finance and financial distress. Thus, it is intuitive to believe that catastrophe-prone insurers are more likely to adopt ERM, because ERM might be a cost-effective means to handle extreme risk by reducing the need for external funding. *Exposures to Catastrophe Risk* is defined as premiums from all catastrophe-prone insurance lines of business in states boarding the Gulf coast and the Atlantic ocean plus earthquake insurance premiums from all states divided by total premiums (Cummins et al., 2008b).[10,11]

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[9] Specifically, the property lines of business include automobile physical damage, special property, fidelity and surety, and a miscellaneous line consisting of accident and health, credit, and financial and mortgage guarantee.

[10] Catastrophe-prone insurance includes the following lines of business from the NAIC annual statement: earthquake, fire, allied lines, farmowners, homeowners, commercial multiple peril, inland marine, and auto physical damage.

[11] The variable is defined as the ratio of total premium written in specific lines and in specific states to the total premium collected in a firm. The lines and states are earthquake from all states and the fire, allied lines, multiple peril crop, inland marine, private passenger auto physical damage, commercial auto physical damage, homeowners and farmowners in states of Texas, Louisiana, Missisippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New

Firms with good financial ratings have high franchise value so they may suffer significant reputation cost if an adverse event takes place (Song and Cummins, 2008). ERM and various IRMs aim at mitigating (if not eliminating) negative risk outcomes. Thus, highly-rated insurers would be motivated to manage risk to maintain their credit standing. We transform each letter credit rating into a cardinal scale to define our credit rating variable, *Best's Rating*. The highest credit rating 'A++' or 'A+' is assigned a value of 1, then 'A' or 'A-' a value of 2, and etc.[12] Therefore, a lower value of this variable represents a better financial status.

Furthermore, prior studies suggest that cash flow volatility is of relevance to risk management decision because higher cash flow volatility entails (i) higher tax payment owing to progressive tax rates (Lin et al., 2009), and (ii) higher probability of financial distress (Smith and Stulz, 1985). Thus, the more volatile a firm's income, the more likely it is to manage risk (Nance, et al., 1993). To capture the effect of cash flow volatility on insurers' risk management decision, we estimate *Firm's overall volatility* with the equation

$$\sigma_{CF} = (\sigma_L^2 + \sigma_V^2 - 2\sigma_{LV})^{1/2},$$

where σ_L is the volatility of losses estimated from a time series of loss ratios of six property lines of business and seven liability lines of business,[13] σ_V is the volatility of assets based on six asset return series,[14] and σ_{LV} is the covariance of losses and assets. See Cummins et al. (2008b) for the

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Hampshire and Maine. Premiums written in different lines and states are needed to create this variable. The information is collected from three different Exhibits of NAIC annual reports.

[12] We convert rating 'B++' or 'B+' to the value of 3, rating 'B' or 'B-' to 4, rating 'C++' or 'C+' to 5, rating 'C' or 'C-' to 6, rating 'D' to 7, and rating 'E' or 'F' or 'S' to 8.

[13] Specifically, the property lines of business include automobile physical damage, special property, fidelity and surety, accident and health, credit, and financial and mortgage guarantee. Liability lines include automobile liability, other (commercial) liability, medical malpractice, workers compensation, special liability, commercial multiple peril, and homeowners/farmowners. Classification of lines as property and liability is based on Schedule P of the NAIC regulatory annual statement.

[14] The rate of return series are as follows: (1) Equities - the total return on the Standard & Poor's 500 Stock Index; (2) government bonds - the Lehman Brothers intermediate term total return; (3) corporate bonds - Moody's corporate bond total return; (4) real estate - the National Association of Real Estate Investment Trusts (NAREIT)

detailed estimation procedure.

We also control other firm characteristics with the following variables: 3-year premium growth rate, financial leverage and firm size of the sample PC insurers. The variable, *3-year premium growth rate*, signals a firm's growth potential and is measured by annual total premium growth rate in a three-year period. Firms that face more growth opportunities might be distracted from ERM attempts (Pagach and Warr, 2007). Leverage is approximated by the ratio of book value of liabilities to book value of assets, and firm size is estimated by the natural logarithm of the book value of total assets.

3.2. Descriptive statistics

Table 1 reports the descriptive statistics of principal variables included in our analysis over the period from years 2000 to 2007. On average, 17.3% of the sample insurers initiated and implemented ERM programs. For the whole sample of insurers, reinsurance ratios and derivative usage are at average values of 23% and 0.3%, respectively. The mean level of geographic (product) diversification is 77.1% (68.1%).

Table 1 also compares medians and means of various IRMs, firm value, and other firm characteristics variables between ERM and non-ERM insurers. Results show that on average ERM insurers purchase less reinsurance (19.3%) than non-ERM insurers (23.8%), but the difference is insignificant. The average derivative usage of ERM insurers is 1.7%, significantly higher than that of non-ERM insurers, 0.1%. In addition, ERM insurers are more diversified in terms of lines of business and underwriting regions than non-ERM insurers at the significance level of 1%.

As for firm performance, ERM insurers have higher *Tobin's Q* and *ROA* than non-ERM

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total return; (5) mortgages - the Merrill Lynch mortgage backed securities total return; and (6) cash and invested assets - the 30-day U.S. Treasury bill rate.

insurers. On average, *Tobin's Q* (*ROA*) of ERM insurers is 1.143 (0.039) compared to 1.082 (0.021) for non-ERM insurers. The median size of all sample insurers is $2,059 million. At median size, ERM insurers ($11,649 million) tend to be much larger than non-ERM insurers ($1,594 million). The average credit rating score for the entire sample is 1.873, equivalent to a rating between A and A+. In general, ERM insurers have better credit rating than non-ERM insurers. Moreover, ERM insurers have lower premium growth rates over the past three years and have less volatile cash flows.

< Insert Table 1 about here >

The bivariate correlation matrix for the variables employed in the regressions is shown in Table 2. As reported, ERM is positively correlated with the use of financial derivatives and with the degrees of product and geographic diversification, whereas negatively correlated with the reinsurance ratio. Results suggest a potential substitute relation between the adoption of ERM and reinsurance, while a possible complement relation between ERM and the other IRMs. On the other hand, the correlations among the firm-characteristics variables are mostly quite low, indicating that these variables provide largely orthogonal information about firm risk.

< Insert Table 2 about here >

To provide a complete illustration of the determinants of ERM adoption, risk integration effects of ERM, and firm value creation from ERM we further conduct the analyses on a multivariate basis by controlling firm-specific characteristics. Collinearity was checked using variance inflation factors (VIFs). Most of the VIF values were below 2 with the maximum at 2.80. Hence, collinearity is not a problem in our regressions.

3.3. Empirical models and results

We apply a probit regression model to examine the incentives of ERM adoption accounting for the effects of existing IRMs. We also test how insurance companies systematically adjust IRMs after ERM adoption by implementing a simultaneous equations model. Finally, to investigate whether ERM adoption enhances firm value, we utilize a two-stage treatment-effect model.

3.3.1. Probit model: The determinants of ERM adoption

Probit model (1) identifies the factors that motivate insurers to adopt ERM:

$$Pr(ERM_{i,t}) = \alpha_0 + \alpha_1 \times Reinsurance_{i,t-1} + \alpha_2 \times Derivative_{i,t-1} + \alpha_3 \times G\_DIV_{i,t-1} + \alpha_4 \times P\_DIV_{i,t-1} + \beta_i' Z_{i,t} + \eta_t + \varepsilon_{i,t}. \quad (1)$$

As noted before, $ERM_{i,t}$ is an indicator variable equal to 1 for ERM firm i in year t and 0 otherwise. The dependent variable $Pr(ERM_{i,t})$ indicates the likelihood of adopting ERM, which is a function of four IRMs, namely, reinsurance, derivatives, geographic diversification, and product diversification. To ensure that our results are not simply driven by reverse causality, that is, adopting ERM changes the states of IRMs, we construct these IRM measures one year before the initiation of ERM. The signs of α_j, the coefficients of IRMs, are of interest (j = 1, 2, 3, or 4). $Z_{i,t}$ is a vector of variables controlling insurer-specific characteristics and η_t is the fixed effect for year t.

Models (1), (2), (3), and (4) in Table 3 present the results of analyses in which each IRM is examined separately, while model (5) is the full model with all of the four IRMs included. Having controlling firm characteristics and year effects, the results provide evidence that insurers holding greater reinsurance are more likely to adopt ERM, consistent with Hypothesis 1a on the positive effect of reinsurance usage on ERM adoption. Reinsurance is costly so insurers with a high level of reinsurance usage are motivated to implement ERM because ERM can realize integration benefit via risk pooling and reduce costly reinsurance. Specifically, a 1 percentage point increase in the measure *Reinsurance* is associated with 0.993 percentage point increase in the likelihood of ERM adoption, all else equal.

The estimated coefficient for *Derivative* is positive and significant. Given the mean of *Derivative* is only 0.3%, a 0.1 percentage point increase in *Derivative* is associated with around 2.6 percentage points increase in the likelihood of ERM implementation according to model (5) in Table 3. The positive coefficient for *Derivative* is consistent with Hypothesis 1b that insurers with more derivative usage have better understandings on various financial risks as well as potential benefits of ERM from integrating financial and underwriting risks. So they are more likely to establish ERM programs.

In addition, the positive relationship between ERM and geographic diversification shown in models (3) and (5) of Table 3 is in line with Hypothesis 1c. As noted earlier, diversification increases firms' risk complexity (Lang and Stulz, 1994; Laeven and Levine, 2007). The presence of ERM facilitates risk coordination and thus motivates geographically-diversified insurers to embrace this new risk management concept. Specifically, a 1 percentage point rise in geographic diversification is associated with around 2.3 percentage points increase in the likelihood of ERM initiation. However, we find no evidence of significant relationship between product diversification and ERM adoption. This suggests that insurers view ERM as an efficient way to integrate geographic- but not for product-related risks.

The coefficients for the firm characteristics variables in all models of Table 3 are generally consistent with the existing literature. We observe a negative impact of the reinsurance sustainability variable, *Reinsurance Sustainability Index*, in various regression specifications of Table 3. This supports the argument that a long-term contracting relation between insurers and reinsurers decreases information asymmetry problem, reduces reinsurance loadings and thus offsets potential cost benefits generated by ERM (Jean-Baptiste and Santomero, 2000; Lin et al., 2009). Accordingly, insurers with high reinsurance sustainability index are discouraged from pursuing ERM.

We find larger firms are more likely to engage in ERM because they have the institutional size to support the administrative cost of an ERM program, thus achieving the economy of scale. Furthermore, better credit rating is positively associated with ERM adoption. This finding is consistent with the argument that highly-rated firms may lose substantial franchise values if an adverse event occurs (Song and Cummins, 2008). ERM makes potential threats more transparent, risk integration more efficient and possible reputation loss less severe.

Leverage is commonly used to measure financial distress (Smith and Stultz, 1985). Nevertheless, to insurers, besides leverage, exposure to catastrophe risks also increases insolvency risk (Lin et al., 2009). Our result suggests that to PC insurers, the financial stress from the exposures to catastrophe risks is more important than the leverage in determining their ERM initiation.

< Insert Table 3 about here >

3.3.2. Simultaneous equations model: Effects of ERM on risk integration

The simultaneous equations model consists of four equations that represent financial risk management from derivative utilization (*Derivative*) and underwriting risk management from reinsurance usage (*Reinsurance)*, geographic diversification (*G_DIV*), and product diversification (*P_DIV*):

$$Reinsurance_{i,t} = \alpha_{1,0} + \alpha_{1,1} \times Derivative_{i,t} + \alpha_{1,2} \times G\_DIV_{i,t} + \alpha_{1,3} \times P\_DIV_{i,t} + \beta_1 \times ERM_{i,t-1} + \gamma_{1,i}' Z_{i,t-1} + \upsilon_i + \eta_t + \varepsilon_{i,t} \quad (2)$$

$$Derivative_{i,t} = \alpha_{2,0} + \alpha_{2,1} \times Reinsurance_{i,t} + \alpha_{2,2} \times G\_DIV_{i,t} + \alpha_{2,3} \times P\_DIV_{i,t} + \beta_2 \times ERM_{i,t-1} + \gamma_{2,i}' Z_{i,t-1} + \upsilon_i + \eta_t + \varepsilon_{i,t} \quad (3)$$

$$G\_DIV_{i,t} = \alpha_{3,0} + \alpha_{3,1} \times Reinsurance_{i,t} + \alpha_{3,2} \times Derivative_{i,t} + \alpha_{3,3} \times P\_DIV_{i,t} + \beta_3 \times ERM_{i,t-1} + \gamma_{3,i}' Z_{i,t-1} + \upsilon_i + \eta_t + \varepsilon_{i,t} \quad (4)$$

$$P\_DIV_{i,t} = \alpha_{4,0} + \alpha_{4,1} \times Reinsurance_{i,t} + \alpha_{4,2} \times Derivative_{i,t} + \alpha_{4,3} \times G\_DIV_{i,t} + \beta_4 \times ERM_{i,t-1} + \gamma_{4,i}' Z_{i,t-1} + \upsilon_i + \eta_t + \varepsilon_{i,t}\ , \quad (5)$$

where υ_i is the fixed effect for insurer i and η_t is the fixed effect for year t. ERM fine-tunes coordination among IRMs. The specification of our simultaneous equations model takes into account these ERM effects while capturing the relations among four IRM programs. To ensure that our results are not simply driven by reverse causality, we construct the variable *ERM* one year before each IRM decision is made. Following Graham and Rogers (2002), we use a two-stage estimation procedure in our simultaneous equations model and the results are presented in Table 4.[15]

As shown in Table 4, the lagged *ERM* indicator is negatively and significantly related to reinsurance purchase. The results provide evidence supporting that after integrating various risks, ERM reduces the reinsurance level because of risk-integration effect. Specifically, the reinsurance ratio decreases by 7.4 percentage points post-ERM adoption. This is a significant reduction given the average reinsurance ratio of non-ERM insurers is only 0.238.

The regression results also provide support for the argument that insurers hedge more with derivatives after implementing ERM. The coefficient of the lagged ERM variable is positive and significant in the derivative regression. On average, the insurers double their derivative

[15] We apply the two-stage estimation procedure because one of the dependent variables, *Derivative*, is censored at zero. For the first-stage *Derivative* specification, we estimate a Tobit regression. The first-stage *Reinsurance*, *G_DIV*, and *P_DIV* equations are estimated with ordinary least squares (OLS) respectively. In the second stage, structural equations are estimated using the predicted *Reinsurance*, *Derivative*, *G_DIV*, and *P_DIV* from the first stage as the independent variables. Specifically, our endogenous variables in the simultaneous equations are four predicted IRMs and the exogenous variables include the year dummies, the firm dummies, and the firm characteristics variables in Table 4. Other instruments include the lagged terms of the aforementioned exogenous variables except the year and firm dummies. To conserve space, we focus on the second stage of the simultaneous equations system. One concern with the 2SLS framework is its sensitivity to the choice of instrumental variables. As an alternative to the simultaneous equations, we run the Tobit regression for *Derivatives* and the ordinary least squares (OLS) regressions separately for the other three IRMs using the actual values instead of their predicted values. These specifications also suggest ERM decreases reinsurance ratio but increases derivatives usage.

positions after ERM adoption. This suggests that ERM illuminates neglected but important financial risks and propel insurers to hedge them with derivatives, provided the existing level of derivative usage in the insurance industry is unsatisfactorily low (Cummins et al, 1997; Song and Cummins, 2008).

However, we find no significant effects of ERM on either geographic or product diversification in Table 4. This can be explained by the relatively short period of ERM implementation as of 2007 (Figure 1). The managerial decisions on diversification in lines of business or in geographic regions depend on a firm's blueprint, a change of which entails a large amount of time, energy, negotiation, and resources. Therefore, in the short run, ERM does not lead to observable adjustments in both dimensions of diversification. Different from geographic and product diversifications, reinsurance policies and financial derivatives can be adjusted promptly due to their short-term contracting features so we observe ERM insurers have a notable change in these two IRMs.

In terms of the interdependency of the four IRMs, we observe no significant relationship between reinsurance ratio and derivative level or geographic diversification whereas reinsurance is negatively related to product diversification. In addition, more geographically- (product-) diversified insurers tend to underwrite more diversified lines of business (in more diversified regions). Finally, derivative usage increases with geographic diversification. These results provide some supports for either the complementary hypothesis or the substitution hypothesis on the possible relationships between various IRMs (Cummins et al., 2001).

Among various firm characteristics variables, insurers with a higher percentage of premium underwritten in property lines operate with more reinsurance, higher product diversification but less derivative. This implies that the insurers use reinsurance and diversification to mitigate potential liquidity problems created by the short-tail lines.

< Insert Table 4 about here >

3.3.3. Treatment-effect model: Effects of ERM on firm value

To test the effects of ERM on firm value, we need to address the endogeneity of ERM adoption. We do so by employing equations (6) and (7) simultaneously:

$$ERM_{i,t-1}^{*} = \alpha_0 + \alpha_1 \times Reinsurance_{i,t-2} + \alpha_2 \times Derivative_{i,t-2} + \alpha_3 \times G\_DIV_{i,t-2} + \alpha_4 \times P\_DIV_{i,t-2} + \beta_i' Z_{i,t-1} + \eta_{t-1} + \varepsilon_{i,t-1} \quad (6)$$

$$ERM_{i,t-1} = 1 \text{ if } ERM_{i,t-1}^{*} > 0 \text{ and } ERM_{i,t-1} = 0 \text{ if } ERM_{i,t-1}^{*} \leq 0$$

$$Firm\ Value_{i,t} = \delta_0 + \delta_1 \times ERM_{i,t-1} + \delta_2 \times Reinsurance_{i,t-1} + \delta_3 \times Derivative_{i,t-1} + \delta_4 \times G\_DIV_{i,t-1} + \delta_5 \times P\_DIV_{i,t-1} + \lambda_i' Z_{i,t} + v_6 \times self\text{-}selection_{i,t-1} + \upsilon_i + \eta_t + u_{i,t} \quad (7)$$

The self-selection equation (6) reflects firms' decision to become ERM firms. While the latent variable *ERM**, the expected net benefit from undertaking ERM, is unobservable, we can detect the existence of an insurer's ERM program. The insurer adopts ERM only when the net benefit is positive but chooses not to do so if the net benefit is zero or negative. Therefore, the binary choice variable *ERM* equals to 1 when an ERM program exists and 0 otherwise. The error terms (ε, u) are assumed to follow a multivariate normal distribution.

In the firm value equation (7), the performance measure, *Firm Value*, is modeled as a function of the lagged binary choice *ERM*, a vector of the observed firm characteristics variables *Z*, and a self-selection parameter, *self-selection*, calculated from the self-selection regression (6). We estimate the net benefits of being an ERM insurer on *Firm Value* in a *treatment-effect model* using a two-step consistent estimation procedure. In our specifications, the performance variable, *Firm Value*, is either *Tobin's Q* or *ROA*.

a. Effects of ERM on firm value creation— Tobin's Q

Studies by Nocco and Stultz (2006) and Pagach and Warr (2007, 2008) have examined the sole effects of ERM on firm value. We extend this line of research by controlling the effects of various IRMs. Incorporating these IRMs in the firm value regression (7) is important because it addresses the potential endogeneity problem that the IRMs may also determine *Tobin's Q*, while they are correlated with the firm's ERM adoption in the same year. In addition, to account for the overall shift of ERM adoption across time, we estimate the self-selection equation with year fixed effects. For the firm value equation, we control both year and firm fixed effects. Results are summarized in Table 5.[16]

Model (1) in Table 5 examines *Tobin's Q* of ERM and non-ERM insurers. The result provides evidence supporting the firm value destroying hypothesis (Hypothesis 3b). To PC insurers, the adoption of ERM decreases *Tobin's Q* by 0.111, which is consistent with Pagach and Warr (2007, 2008). Models (2), (3), (4), and (5) augment Model (1) by incorporating different IRMs: reinsurance, derivatives, geographic diversification, and product diversification, respectively. Model (6) considers the effects of ERM along with all the four IRMs. Results from all the models indicate that ERM consistently has a significant and negative effect on firm value. In addition, managing underwriting risks through geographic diversification and product diversification could significantly reduce insurers' *Tobin's Q*. The results support strategic focus hypothesis as shown in Elango et al. (2008). On the other hand, similar to Scordis and Barrese (2007) we observe no significant effects of reinsurance on firm value. The usage of derivatives also does not create value for PC insurers, consistent with the findings of Jin and Jorin (2006) while they examine the oil and gas industry. It is worth pointing out that, in Table 4, ERM

[16] Estimates from the ERM choice model (6) are based on the data from 1999 to 2006 since the variable ERM_{t-1} is one-year before the value variable *Tobin's* Q_t in equation (7) is constructed. The results of the self-selection equation (6) are very close to those in Table 3. To conserve space, we do not report these results.

appears to adjust the levels of reinsurance and derivatives but these two IRMs have no significant effects on *Tobin's Q* as presented in Table 5. This finding helps explain why ERM does not create value from the investors' perspective.

In addition, we conduct the analysis by controlling for other value determinants. Higher premium growth over the past three years enhances insurers' market value, whereas more business written in regulated lines significantly reduces insurers' value. We also find a negative relation between size and firm value as suggested by Lang and Stulz (1994) and Allayannis and Weston (2001).

Diagnostic tests indicate that the treatment-effect model is appropriate, with evidence that the self-selection parameter is significant. The Hausman test for exogeneity of *ERM* with respect to *Tobin's Q* is rejected.[17]

< Insert Table 5 about here >

b. Effects of ERM on firm performance— ROA

To further understand whether ERM provides benefits, we conduct an analysis based on *ROA*, an accounting-based performance measure. Results in Table 6 draw a consistent conclusion that ERM adoption has a significant and negative impact on *ROA*, which echoes the findings on *Tobin's Q* in Table 5 and thus confirms the firm-value reduction hypothesis described in Hypothesis 3b. Specifically, on average the *ROA* of ERM insurers is about 0.05 lower than non-ERM insurers, all else equal. As suggested by Beasley et al. (2008) and Pagach and Warr (2008), large start-up and administrative costs associated with the ERM program constrain insurers from pursuing their optimal investment policy, thereby reducing firm value.

< Insert Table 6 about here >

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[17] The treatment-effect model is also appropriate for the firm value equation (7) with ROA as the dependent variable discussed below.

In terms of the effects of IRMs on firm performance, reinsurance usage has a positive and significant effect on the accounting-based firm value (*ROA*). As expected, better credit rating has a positive effect on *ROA*, consistent with Song and Cummins (2008). Moreover, higher overall volatility and higher percentage of premium in catastrophe states and lines are negatively associated with *ROA*. It suggests that the uncertainty of an insurer, either from the entire firm's operation or from the underwriting business, reduces the accounting-based firm performance.

4. Conclusions

This paper focuses on several important but previously neglected areas of ERM, namely, the impacts of IRMs on ERM initiation and IRM reconfiguration after ERM adoption. We also correct the potential bias caused by the ignorance of IRMs when investigating firm value effect of ERM. We argue that IRMs can be catalysts or deterrents for a firm to engage in ERM, contingent on its existing level and cost of IRM utilization. Furthermore, upon launching an ERM program, the firm will coordinate and fine-tune IRMs to reflect the core spirit of ERM. Specifically, by indentifying and integrating various risks, ERM decreases costly IRMs but increases those that are under-implemented. To the best of our knowledge, this is the first study to examine the interplay and dynamics between ERM and IRMs, two correlated risk management concepts.

We test our predictions based on the US publicly traded PC insurers from 2000 to 2007. The findings of the paper support our hypotheses that insurers with higher reinsurance ratio, more derivatives usage, and greater geographic diversification are more likely to implement ERM. These insurers may realize more benefits from ERM so that they are more motivated to embrace this new mechanism.

Our results also shed new light on the role of ERM in IRM adjustments. ERM insurers appear to decrease reinsurance purchase but increase derivatives positions. They, however, do not make significant change in geographic or product diversification, at least in the short run. In sum, our findings indicate that after ERM adoption, two of the four IRMs, i.e. reinsurance and derivatives, move toward the desirable directions. This is good news for investors of firms that currently undertake ERM.

Yet, the bad news is that the stock market reacts negatively to this new phenomenon despite its conceptual benefits. We observe ERM lowers both insurers' *Tobin's Q* and *ROA*. This may be because it is difficult for investors to decipher the value of ERM since ERM complicates risk management processes (Fraser et al., 2008). Furthermore, the market may view ERM as a costly program whose potential benefits hardly justify its costs (Beasley et al., 2008; Pagach and Warr, 2008).

The above findings of this study highlight regulatory implications for reporting and solvency requirements. Overseeing ERM requires a comprehensive and longitudinal assessment of all dimensions of firm risks and corresponding risk management practices. Given this complexity, plus the potential downside of ERM effort, the public's interest is best served by establishing regulations that require transparency of information and adequate consumer protection. More transparent and tractable risk reporting is likely to be beneficial in facilitating market understanding and monitoring of ERM activities. Enhanced risk information will also provide new information on the firm's performance and financial stability, which facilitates regulatory oversight of company operation and safeguards the interests of customers.

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Figure 1

Cumulative number of sample publicly traded property and casualty insurers engaged in ERM (2000-2007)

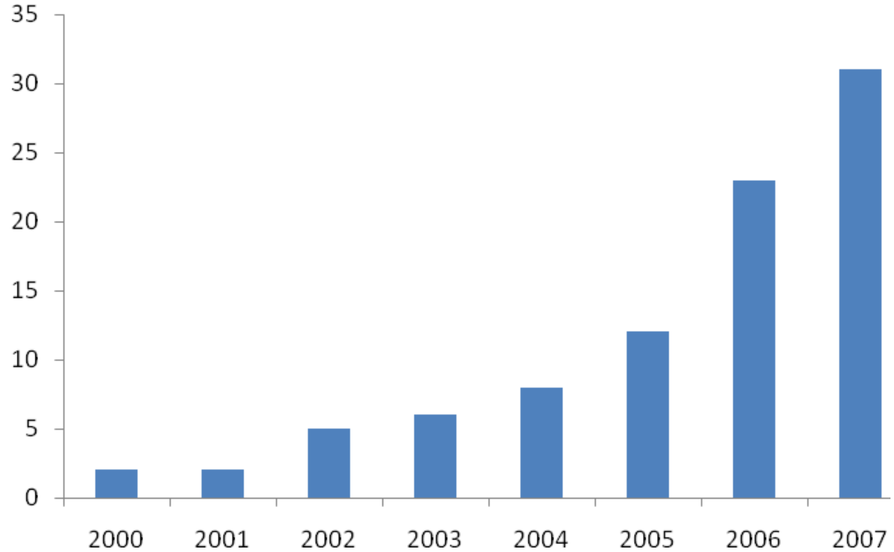

Table 1

Descriptive statistics and univariate differences (2000-2007)

	All Insurers			ERM = 1			ERM = 0			Difference	
	No.	**Mean**	**Median**	**No.**	**Mean**	**Median**	**No.**	**Mean**	**Median**	**Mean**	**Median**
Risk management variables											
ERM firm indicator	509	0.173	0								
Reinsurance	509	0.230	0.122	88	0.193	0.102	421	0.238	0.124	-0.045	-0.023 **
Derivative	509	0.003	0.000	88	0.017	0.000	421	0.001	0.000	0.016 ***	0.000 ***
Geographical diversification	509	0.771	0.904	88	0.898	0.935	421	0.744	0.876	0.154 ***	0.059 ***
Product diversification	509	0.681	0.761	88	0.747	0.817	421	0.667	0.753	0.080 ***	0.064 ***
Firm value and characteristics											
Tobin's Q	509	1.093	1.063	88	1.143	1.089	421	1.082	1.051	0.061 ***	0.038 ***
Return on assets	509	0.024	0.027	88	0.039	0.040	421	0.021	0.024	0.018 ***	0.017 ***
Reinsurance sustainability index	509	0.724	0.843	88	0.806	0.883	421	0.707	0.837	0.099 ***	0.046 ***
Total assets ($m)	509	8,617	2,059	88	22,881	11,649	421	5,607	1,594	17,274 ***	10,055 ***
BV of liabilities/BV of assets	509	0.645	0.663	88	0.644	0.659	421	0.646	0.663	-0.001	-0.004
3-year premium growth rate	509	0.152	0.085	88	0.095	0.052	421	0.164	0.101	-0.069 **	-0.050 ***
Best's rating	509	1.873	2.000	88	1.409	1.029	421	1.970	2.000	-0.561 ***	-0.971 ***
Firm's overall volatility	509	0.148	0.146	88	0.138	0.140	421	0.150	0.147	-0.013 **	-0.007 **
% premium in price regulated lines	509	0.284	0.261	88	0.271	0.265	421	0.287	0.260	-0.017	0.005
% premium in property lines of business	509	0.107	0.093	88	0.100	0.096	421	0.109	0.091	-0.008	0.005
% premium in catastrophe states and lines	509	0.196	0.163	88	0.197	0.160	421	0.196	0.165	0.002	-0.006

Note: Statistical significance of difference in means and in medians is based on a *t*-test and non-parametric Wilcoxon rank sum test, respectively.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 2

Correlation matrix (2000-2007)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
ERM firm indicator	**(1)**	100%															
Reinsurance	**(2)**	-6%	100%														
Derivative	**(3)**	18%	0%	100%													
Geographical diversification	**(4)**	22%	11%	6%	100%												
Product diversification	**(5)**	13%	-7%	4%	39%	100%											
Reinsurance sustainability index	**(6)**	13%	-2%	4%	14%	20%	100%										
Tobin's Q	**(7)**	15%	-13%	2%	-10%	-13%	9%	100%									
Total assets ($m)	**(8)**	35%	-10%	19%	24%	21%	19%	14%	100%								
Return on assets	**(9)**	15%	-16%	5%	6%	4%	16%	23%	14%	100%							
BV of liabilities/BV of assets	**(10)**	0%	9%	0%	11%	-12%	2%	-10%	-5%	-33%	100%						
3-year premium growth rate	**(11)**	-9%	9%	-4%	8%	-1%	-25%	15%	-2%	-6%	1%	100%					
Best's rating	**(12)**	-23%	18%	-7%	-26%	-23%	-22%	-25%	-28%	-42%	22%	-4%	100%				
Firm's overall volatility	**(13)**	-11%	17%	-3%	18%	-21%	0%	-20%	-3%	-8%	4%	3%	9%	100%			
% premium in price regulated lines	**(14)**	-3%	-26%	1%	-31%	-37%	-3%	13%	0%	-2%	4%	-9%	17%	-41%	100%		
% premium in property lines of business	**(15)**	-4%	-13%	0%	9%	14%	-1%	6%	-2%	8%	-25%	-1%	-9%	0%	-18%	100%	
% premium in catastrophe states and lines	**(16)**	0%	-3%	0%	-19%	27%	-7%	3%	-3%	4%	-18%	-3%	7%	-10%	-17%	14%	100%

Table 3

Determinants of ERM adoption: Probit model (2000-2007)

	(1)	(2)	(3)	(4)	(5)
Intercept	-12.616 ***	-9.997 ***	-10.612 ***	-11.285 ***	-10.996 ***
	(1.99)	(2.11)	(1.90)	(1.86)	(2.11)
IRM variables					
Lagged reinsurance	0.993 **				0.940 **
	(0.44)				(0.46)
Lagged derivative		33.980 **			26.109 *
		(14.07)			(14.22)
Lagged geographical diversification			2.258 ***		2.294 ***
			(0.71)		(0.74)
Lagged product diversification				-0.454	-0.072
				(0.62)	(0.66)
Firm characteristics variables					
Reinsurance sustainability index	-0.784 *				-0.819 *
	(0.42)				(0.45)
Log(BV of assets)	0.570 ***	0.442 ***	0.412 ***	0.525 ***	0.436 ***
	(0.08)	(0.07)	(0.07)	(0.08)	(0.09)
Return on assets	-5.035 *	-5.704 **	-5.743 **	-6.203 **	-4.624
	(2.66)	(2.63)	(2.76)	(2.67)	(2.91)
BV of liabilities/BV of assets	0.795	0.569	-0.240	0.615	-0.193
	(1.01)	(0.99)	(1.06)	(0.99)	(1.07)
3-year premium growth rate	-0.219	0.104	0.016	0.002	-0.169
	(0.37)	(0.35)	(0.35)	(0.36)	(0.36)
Firm's overall volatility	-8.174 ***	-8.060 ***	-10.150 ***	-9.122 ***	-8.949 ***
	(2.79)	(2.75)	(2.91)	(2.84)	(3.04)
% premium in price regulated lines	0.014	-0.556	0.018	-0.743	0.435
	(0.48)	(0.46)	(0.49)	(0.55)	(0.59)
% premium in property lines of business	-2.112	-2.563	-2.870 *	-2.446	-2.576
	(1.61)	(1.58)	(1.55)	(1.58)	(1.60)
% premium in catastrophe states and lines	0.391	0.244	1.317 *	0.431	1.331 *
	(0.39)	(0.64)	(0.76)	(0.64)	(0.78)
Best's rating	-0.539 ***	-0.491 ***	-0.521 ***	-0.406 **	-0.690 ***
	(0.17)	(0.17)	(0.18)	(0.17)	(0.19)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Diagnostics					
Model fit statistics: -2 Log L	269.2	269.6	263.9	276.2	251.1
Test - H_0: $\beta = 0$ (Likelihood Ratio)	198.0 ***	197.6 ***	203.3 ***	191.0 ***	216.1 ***
No. of observations	509	509	509	509	509

Notes: Standard errors are reported in parentheses. All firm characteristics variables are in lagged terms.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 4

Risk integration effects of ERM: Simultaneous equations model (2000-2007)

	Reinsurance	Derivative	Geograph Diversification	Product Diversification
Intercept	-3.981	0.224 ***	-0.892 *	0.167
	(2.84)	(0.01)	(0.51)	(1.72)
ERM variable				
Lagged ERM firm indicator	-0.074 ***	0.001 ***	-0.005	-0.005
	(0.02)	(0.00)	(0.00)	(0.01)
IRM variables				
Reinsurance'		0.004	-0.024	-0.164
		(0.00)	(0.05)	(0.13)
Derivative'	10.499		3.261	-1.704
	(12.86)		(2.37)	(7.52)
Geographical diversification'	-1.319	0.060 **		1.546 *
	(1.76)	(0.03)		(0.88)
Product diversification'	-1.009 *	-0.004	0.172 *	
	(0.54)	(0.01)	(0.10)	
Firm characteristics variables				
Reinsurance sustainability index	0.010	-0.001 ***	0.002	-0.003
	(0.02)	(0.00)	(0.00)	(0.01)
Log(BV of assets)	0.293	-0.013 ***	0.084 ***	-0.042
	(0.18)	(0.00)	(0.03)	(0.11)
Return on assets	-0.940	0.057 ***	-0.342 ***	0.311
	(0.78)	(0.01)	(0.11)	(0.46)
BV of liabilities/BV of assets	0.409	-0.022 ***	0.135 ***	-0.201
	(0.31)	(0.00)	(0.04)	(0.18)
3-year premium growth rate	-0.056 ***	0.000	0.002	-0.012
	(0.02)	(0.00)	(0.00)	(0.01)
Best's rating	-0.015	0.001	-0.020 ***	0.023
	(0.04)	(0.00)	(0.00)	(0.02)
Firm's overall volatility	-4.203 *	0.150 ***	-1.129 ***	0.749
	(2.20)	(0.02)	(0.27)	(1.37)
% premium in price regulated lines	-0.518 ***	0.002	-0.056	-0.135
	(0.16)	(0.00)	(0.03)	(0.10)
% premium in property lines of business	1.222 ***	-0.015 **	0.110	0.385 *
	(0.35)	(0.01)	(0.08)	(0.23)
% premium in catastrophe states and lines	0.440	0.011 **	-0.143 ***	0.312 **
	(0.29)	(0.00)	(0.04)	(0.15)
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Diagnostics				
Adjusted R-squre	0.948	0.996	0.998	0.974
No. of observations	509	509	509	509

Notes: This table shows the results of second-stage OLS or Tobit estimations of four IRMs on explanatory variables including the predicted value of reinsurance ratio (Reinsurance'), the predicted value of derivatives usage (Derivatives'), the predicted value of geographic diversification (Geographic diversification'), and the predicted value of product diversification (Product diversification'). Standard errors are reported in parentheses. All firm characteristics variables are in lagged terms.

* Significant at 10%.

** Significant at 5%.

*** Significant at 1%.

Table 5

Effects of ERM on Tobin's Q: Treatment-effect model (2000-2007)

	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.389 **	0.384 **	0.390 **	0.201	0.472 ***	0.558 ***
	(0.16)	(0.16)	(0.16)	(0.14)	(0.16)	(0.16)
ERM variable						
Lagged ERM firm indicator	-0.111 ***	-0.111 ***	-0.111 ***	-0.104 ***	-0.112 ***	-0.106 ***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
IRM variables						
Lagged reinsurance		-0.010				0.014
		(0.03)				(0.03)
Lagged derivative			-0.020			-0.016
			(0.09)			(0.09)
Lagged geographical diversification				-0.287 ***		-0.260 ***
				(0.06)		(0.06)
Lagged product diversification					-0.144 ***	-0.081 *
					(0.05)	(0.05)
Firm characteristics variables						
Reinsurance sustainability index	-0.023	-0.023	-0.023	-0.019	-0.026	-0.022
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log(BV of assets)	-0.034 **	-0.033 **	-0.034 **	-0.018	-0.030 **	-0.019
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Return on assets	0.143	0.146	0.143	0.078	0.153	0.084
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
BV of liabilities/BV of assets	0.000	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
3-year premium growth rate	0.045 ***	0.045 ***	0.045 ***	0.046 ***	0.048 ***	0.048 ***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Best's rating	-0.004	-0.004	-0.004	-0.008	-0.004	-0.008
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm's overall volatility	-0.217	-0.211	-0.219	-0.199	-0.227	-0.217
	(0.26)	(0.26)	(0.26)	(0.25)	(0.26)	(0.25)
% premium in price regulated lines	-0.032	-0.034	-0.032	-0.082 **	-0.064	-0.093 **
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
% premium in property lines of business	-0.037	-0.036	-0.037	-0.051	0.023	-0.018
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
% premium in catastrophe states and lines	0.018	0.019	0.019	-0.025	0.034	-0.012
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Self-selection parameter	0.066 ***	0.066 ***	0.067 ***	0.063 ***	0.068 ***	0.065 ***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Diagnostics						
rho	0.948	0.944	0.9519	0.932	0.975	0.958
Wald Chi-square	1562.0	1563.7	1561.1	1669.0	1595.6	1675.1
No. of observations	509	509	509	509	509	509

Notes: Standard errors are reported in parentheses. All firm characteristics variables are in lagged terms.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 6

Effects of ERM on return on assets: Treatment-effect model (2000-2007)

	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.082	0.099	0.085	-0.096	0.095	-0.093
	(0.12)	(0.12)	(0.12)	(0.13)	(0.12)	(0.13)
ERM variable						
Lagged ERM firm indicator	-0.053 ***	-0.054 ***	-0.054 ***	-0.051 ***	-0.053 ***	-0.051 ***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
IRM variables						
Lagged reinsurance		0.018				0.022 *
		(0.01)				(0.01)
Lagged derivative			-0.032			-0.029
			(0.05)			(0.05)
Lagged geographical diversification				-0.053 **		-0.071 ***
				(0.03)		(0.03)
Lagged product diversification					0.017	0.031
					(0.02)	(0.02)
Firm characteristics variables						
Reinsurance sustainability index	0.000	-0.001	0.000	0.001	0.000	0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log(BV of assets)	0.014 **	0.013 **	0.013 **	0.016 **	0.013 **	0.014 **
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
BV of liabilities/BV of assets	-0.230 ***	-0.229 ***	-0.230 ***	-0.221 ***	-0.231 ***	-0.218 ***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
3-year premium growth rate	-0.007	-0.005	-0.007	-0.007	-0.007	-0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Best's rating	-0.007 *	-0.008 **	-0.007 *	-0.008 **	-0.007 *	-0.009 **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm's overall volatility	-0.443 ***	-0.451 ***	-0.446 ***	-0.432 ***	-0.441 ***	-0.439 ***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
% premium in price regulated lines	0.006	0.010	0.006	-0.004	0.010	0.005
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
% premium in property lines of business	-0.030	-0.032	-0.030	-0.034	-0.037	-0.050
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
% premium in catastrophe states and lines	-0.055 *	-0.055 *	-0.055 *	-0.065 **	-0.056 *	-0.070 **
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Self-selection parameter	0.022 ***	0.022 ***	0.022 ***	0.021 ***	0.022 ***	0.021 ***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Diagnostics						
rho	0.727	0.746	0.741	0.699	0.723	0.717
Wald Chi-square	826.5	828.5	824.5	843.2	829.4	855.8
No. of observations	509	509	509	509	509	509

Notes: Standard errors are reported in parentheses. All firm characteristics variables are in lagged terms.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.