The Value of Investing in Enterprise Risk Management[*]

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ABSTRACT

Using a survey of risk management practices in the insurance industry we examine the impact of enterprise risk management on firm performance. We find enterprise risk management improves firm operating performance. Firms with Chief Risk Officers, dedicated risk committees, and risk management entities that report to Chief Financial Officers experience higher cost efficiency and return on assets. Confidence that risk is reflected in their business decisions is also positively related to firm performance. We also find life insurers benefit from the development and use of economic capital models to a greater extent than property-casualty insurers. Even simple economic capital models improve the performance of life insurers.

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1. Introduction

Modigliani and Miller (1958) establish that in perfect capital markets capital structure does not affect the market value of the firm. In this setting, risk management also does not create value. The intuition is that the firm is risk neutral and risk is priced at fair value, so the firm is indifferent between bearing risk or purchasing fair risk management services. In imperfect capital markets, however, researchers have posited that risk management may create value by reducing and/or exploiting market imperfections – taxes (Modigliani and Miller, 1963), bankruptcy costs (Kraus and Litzenberger, 1973), the cost of external capital (Froot, Scharfstein, and Stein, 1993), and agency costs (Jensen and Meckling, 1976). Without relaxing the assumptions of Modigliani and Miller, MacKay and Moeller (2007) show risk management can create value if revenues are concave in output prices or costs are convex in input prices. For a sample of oil refiners, they find revenue functions are concave, while cost functions are generally not convex.

Traditionally the approach of risk management has been a silo approach in which one risk is managed at a time. In this approach, risk management is purchased without acknowledging the interrelationship of risks. The new approach to risk management, known as Enterprise Risk Management (ERM), is a holistic approach to risk management in which many risks are examined jointly (Froot, Scharfstein and Stein, 1998). It is an enterprise level assessment, quantification, financing, and managing of risk. With ERM a firm assesses the interaction of a risk with the firm's portfolio of other important risks.[1]

[1] ERM is also commonly referred to as an integrated or portfolio approach to risk management.

ERM also emphasizes that the organizational benefits of risk management can create value for firms (Nocco and Stulz, 2006). Beyond improving internal decision-making (Nocco and Stulz, 2006), ERM can also lead to more efficient capital allocation (Myers and Reed, 2001), better capital structure decisions (Graham and Rogers, 2002), and better risk management decisions (Mayers and Smith, 1982; Cummins, Phillips and Smith, 2001).

Even though researchers have pointed to the strategic and operational value of using an enterprise risk approach (Doherty, 2000), the vast majority of empirical studies examine whether the behavior of firms that use financial derivatives is consistent with extant theories about market imperfections (Allayannis and Weston, 2001; Nain, 2005; Kim, Mathur, and Nam, 2006). In contrast, we use an approach that is philosophically similar to MacKay and Moeller (2007) to examine the impact of ERM on firm value by investigating its effect on firm cost and revenue efficiency.

We identify ERM and the sophistication of its development using a unique survey conducted by Towers Perrin-Tilinghast on their worldwide insurance clients. We then link this survey information to insurance company annual statutory financial data. The insurance industry is particularly useful to study the value of ERM. First, the insurance industry is in the business of risk management and they are on the forefront of implementing ERM. Second, testing for the contribution of ERM on firm value depends on the actions of the firm as well as on random factors thus firm performance will rise or fall with industry fortunes (Bertrand and Mullainathan, 2001). Since large movements in industry profits are likely to be beyond the control of a single firm, it will be difficult to isolate the performance of individual firms from the concurrent performance of the industry in which they operate. Focusing on a single industry mitigates these concerns. Third, focusing on a single industry allows us to better measure firm growth

opportunities and acknowledge differences in access to external capital markets as well as agency costs associated with various organizational forms, distribution channels, and products. Finally, there are established measures of firm cost and revenue efficiency in the insurance literature (Cummins and Weiss, 2001).

Our paper makes an important contribution to the literature. It is the first study to gauge the overall sophistication of the firm's ERM program and investigate its impact on firm performance. Prior studies empirically examine the value of ERM (e.g., Liebenberg and Hoyt, 2003 and 2009; Beasley, Clune and Hermanson, 2005; Beasley, Pagach and Warr, 2010) using the appointment of a Chief Risk Officer (CROs) to identify ERM. The appointment of a CRO as an identification strategy is potentially problematic: the CRO may not be using ERM; the CRO could be replacing another CRO; the appointment could merely indicate a title change, rather than reflect the firm's use of ERM; and/or the insurer can appoint a CRO but not report it. In contrast, we have detailed information on a number of ERM initiatives. This allows us to identify the specific aspects of enterprise risk management that create value.

We find life insurers benefit from the use of economic capital models. Even simple economic capital models improve a firm's returns on assets. In addition, insurers with a dedicated entity responsible for firm-wide risk management experience a higher level of cost efficiency and returns on assets. Moreover, the use of a dedicated risk committee and a primary reporting relationship to the officials in the C-Suite of the insurer (either the CEO or the CFO) increases efficiency and return on assets. Finally, a firm's confidence that risk is reflected in their business decisions is also related to greater efficiency and returns on assets.

The rest of the paper is organized as follows. Section 2 discusses our measures of insurer performance. Section 3 describes the data. Section 4 presents the results and Section 5 concludes.

2. Cost and Revenue Efficiency

Our definition of efficiency is based on the firm's ability to marshal its resources. Ideally two firms with similar characteristics and opportunity sets should have the same level of production, Y^*. However, in reality some firms will not be as successful as others. As a result a firm may be at a production level Y, which is less than Y^*. In the production efficiency and productivity literature, first introduced by Debreu (1951), Farrell (1957), and Koopmans (1951), the difference between Y^* and Y is firm inefficiency.

Measuring efficiency as the deviation from Y^* requires us to estimate a credible benchmark of Y^*. Ideally this benchmark needs to hold constant the firm's opportunity set and characteristics. Traditional measures of efficiency (for example, return on assets) are constrained to a single input and output and therefore are unable to control for differences among firms in input and output mix. Frontier efficiency methods, in contrast, provide a mechanism to benchmark Y^* and control for differences in input usage and output production in multi-input, multi-output firms using a rigorous approach derived from micro-economic theory (Aigner, Lovell, and Schmidt, 1977; Charnes, Cooper, and Rhodes, 1978). Frontier efficiency methods form a "best practice" frontier function for each firm that provides maximum output for any given combination of inputs. This frontier function serves as the benchmark hypothetical value Y^* that a firm could obtain if it were to match the production performance of its best-performing peer(s). A firm's shortfall from the best-practice frontier is a measure of inefficiency.

Frontier efficiency measures have become the state-of-the-art in measuring firm performance relative to more traditional financial ratio measures of performance. The measures are derived directly from microeconomic theory and provide "meaningful and reliable measures of performance in a single statistic that controls for differences in input usage and output production

in multi-input, multi-output firms," (Leverty and Grace, 2009). Berger and Humphrey (1997) identified more than 130 efficiency articles written or published in the 1992-97 period on the banking and insurance industries alone. Eling and Luhen (2009) survey over 90 studies in the insurance industry alone over the period to 2008.

We focus on cost and revenue efficiency. Cost efficiency is the ratio of the minimum required costs to the actual costs utilized to produce a given level of output. A firm is considered fully efficient if its actual input usage equals optimal input usage for given output quantities and input prices. A firm is inefficient if actual input usage exceeds optimal input usage. Revenue efficiency is the ratio of the revenues of a given firm to the revenues of a fully efficient firm with the same input vector and output prices. It is important to estimate both cost and revenue efficiency, since the objective of the firm is profit maximization. Thus to be completely efficient the firm must be both cost efficient and revenue efficient.

We use a standard linear programming technique, data envelopment analysis (DEA), to construct the "best practice" frontier for each firm and measure the firm's performance relative to this frontier.[2] Given a certain level of inputs and outputs, DEA compares each firm to its 'best practice' peers and provides an efficiency score from zero to one.[3] A firm is classified as fully

[2] There are two methods for estimating frontier functions – a regression approach and a mathematical programming approach. The regression approach assumes a production function and measures efficiency based on both random and firm-specific (in)efficiency components. The aproach requires assumptions to be made for the production function (e.g., Cobb-Douglas or translog), the distribution of the random error component, as well as the distribution of the firm-specific inefficiency component. The regression model is subject to specification error unless the components required for the analysis are precisely known. Data Envelopment Analysis, in contrast, does not require any assumptions regarding the production function or error term distribution and is thus less susceptible to specification errors. Banker and Natarajan (2008) show that DEA-based procedures generally outperform regression methods since it is often the case that no a priori knowledge exists about the form of the production function or the distributions of the error and efficiency components. Cummins and Zi (1998) find DEA estimates of U.S. life insurer efficiency are more highly correlated with traditional performance measures (e.g., premium ratios and return on assets) than efficiency estimates derived from the regression approach.

[3] For parsimony, DEA is not discussed in detail. For additional details refer to Cooper, Seiford, and Tone (2000).

efficient (efficiency of 1.0) if it lies on the frontier and inefficient (0 < efficiency < 1) if its outputs can be produced more efficiently by another set of firms. Although DEA was traditionally viewed as a strictly non-parametric methodology, research has shown that it can be interpreted as a maximum likelihood procedure (Banker, 1993). In addition, the DEA estimator is consistent and converges faster than other estimators (Grosskopf, 1996). Nevertheless, DEA efficiency estimates are biased upward in finite samples (Simar and Wilson, 1998). To correct the upward bias, we implement the bootstrapping procedure of Simar and Wilson (2000) with 2000 bootstrap replications. To estimate and bootstrap efficiency we use FEAR, a package for frontier efficiency analysis in R (Wilson, 2007).

In accordance with a majority of the recent literature on financial institutions, we adopt a modified version of the value-added approach to identify the important outputs of life and property-liability insurers (Berger and Humphrey1992; Cummins and Weiss 2001). Leverty and Grace (2009) examine other approaches to measuring insurance output and find that the value-added approach is the most consistent with the economic realities of the insurance market. The value-added approach employs as important outputs all categories that have substantial value-added, as judged by operating cost allocations (Berger and Humphrey, 1992). Following Cummins and Weiss (2001), we identify three principal services that insurers provide: *(i)* risk-pooling and risk-bearing, *(ii)* "real" financial services relating to insured losses, and *(iii)* financial intermediation. In defining measures for insurance output, we are searching for proxies for the quantity of insurance services provided.

Property-Liability Insurers:

The proxy for the quantity of risk-pooling and real insurance services for property-liability insurers is the present value of the losses that are expected to be paid as a result of providing

insurance coverage in the current time period – (i.e., known in the insurance literature as losses incurred). Since the risks and types of services provided differ between the main types of insurance, we separate lines of insurance with similar characteristics into categories: personal lines property losses, personal lines liability losses, commercial lines property losses, and commercial lines liability losses.[4] Output prices are defined as the difference of premiums earned and the present value of losses incurred divided by the present value of losses incurred. This is the markup of prices over expected losses. The value-added approach captures the quantity of intermediation output using the real invested assets of a firm averaged over the course of the year (Cummins and Weiss, 2001). The price of the intermediation output is measured by the expected rate of return on the insurer's assets.

The inputs of the firm are classified into five categories: administrative labor, agent labor, business services and materials (including physical capital), financial equity capital and policyholder-supplied debt capital.[5] The quantity of an input is defined as the current dollar expenditure associated with the particular input from the regulatory annual statement divided by its current price, which we obtain from the U.S. Department of Labor and the Bureau of Labor Statistics.[6] The construction of the inputs and outputs is the standard in the literature. All monetary values are deflated to real dollars using the Consumer Price Index.

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[4] The line of business definitions are described in Phillips, Cummins, and Allen (1998).
[5] See Cummins and Weiss (2001) for a comprehensive explanation of the inputs used in the value-added approach.
[6]The price of administrative labor is calculated with U.S. Department of Labor data on the average weekly wage rate for Standard Industrial Classification (SIC 6331), property-liability insurer. The price of agent labor is the average weekly wage rate for insurance agents (SIC 6411) and the price of business service and materials is the average weekly wage rate for business services (SIC 7300). The price of financial equity capital is based on the insurers A.M. Best Company financial rating. Similar to Cummins, Tennyson, and Weiss (1999), the cost of capital is equal to 12 percent for firms rated in the "A" range, 15 percent for firms in the "B" range, and 18 percent for insurers below the "B" range. The cost of policyholder supplied debt capital is the average corporate credit spread of similarly rated firms.

Life Insurers:

Recent life insurer research uses incurred benefits plus additions to reserves as the proxy for the quantity of risk pooling for life insurers (Yuengert, 1993; Cummins, Tennyson, and Weiss, 1999; and Berger et al., 2000). Incurred benefits are payments received by policyholders in the current year while increases in reserves represent present value of funds set aside for future loss payments. Incurred benefits plus increases in reserves are useful proxies for the risk-pooling and risk-bearing functions since they account for the amount of funds pooled by insurers and redistributed to policyholders as compensation for insured events and therefore should be highly correlated with the intermediation output.

Both incurred benefits and additions to reserves are also correlated with the real services provided by insurers including benefit administration and financial planning. Because products differ in the types of contingent events that are covered and in the relative importance of the risk-pooling, intermediation, and real service components of output, we define five output variables, equal to the sum of incurred benefits and additions to reserves for the five major lines of life insurance business—individual life insurance, individual annuities, group life insurance, group annuities, and accident and health insurance.

For life insurance inputs, we also utilize the inputs that are widely used in the literature: labor, business services, financial capital, and policyholder supplied debt capital. All input quantities and prices are constructed in accordance to the description in Cummins and Weiss (2001). All monetary values are deflated to real dollars using the Consumer Price Index.

3. Data

To construct our efficiency measures we use the National Association of Insurance Commissioner's (NAIC's) annual regulatory statement database. We supplement this information with data from the Bureau of Labor Statistics, the Federal Reserve Board, and A.M. Best. Since the universe of firms determines the cost and revenue frontiers, efficiency is calculated for all of the individual units in the U.S. property-liability and life insurance industries. We estimate efficiency separately for each industry and for each year of the sample (2004 and 2006). Because the NAIC database is compiled for regulatory purposes, it contains firms that are not viable operating entities because they are under regulatory supervision or experiencing other financial difficulties. Consequently, we drop firms not actively participating in the insurance market by eliminating firms with zero or negative equity capital, total premiums, assets, or total insurance output as well as firms with negative or zero labor input. Our sample of property-liability insurers represents approximately 97 percent of the total net premiums written in the industry in 2006 and the sample of life insurers 98 percent. Table 1 provides the summary statistics of the inputs and outputs used in the efficiency analysis.

To evaluate insurer ERM practices we use the Tillinghast Towers Perrin ERM survey for 2004 and 2006.[7] The survey participants are Chief Financial Officers (CFOs), Chief Actuaries, and CROs of life and non-life insurers.[8] Table 2 shows that in terms of net premiums written the survey respondents represent 30 to 36 percent of the U.S. property-liability insurance industry and 43 to 55 percent of the U.S. life insurance industry. Table 3 provides a detailed breakdown of how the survey respondents compare to the industry as a whole. Surveyed firms tend to be

[7] The survey was undertaken every two years since 2000; however, the questions before 2004 and after 2006 do not match the 2004 and 2006 questions.
[8] We attribute the responses of a single survey participant to all subsidiaries of the insurer group.

larger (in terms of premiums, surplus, and total assets) and have lower capital-to-asset ratios (i.e., they carry higher leverage). Surveyed insurers are also more cost efficient and less revenue efficient. However, the difference in revenue efficiency is not statistically significant in the life insurance industry.

We next examine the set of survey results that pertain to an insurer's use of ERM. Due to how the survey is constructed (not every question is asked in a consistent way in each survey period), we focus the construction of our variables on the set of questions that are identical in 2004 and 2006. The first set of variables deals with a firm's Economic Capital Model (ECM). In markets with inefficiencies profit maximization requires efficient allocation of the costs of capital and an economic capital model is one way of understanding a firm's economic capital needs (see e.g. Myers and Reed, 2001; Cummins, Lin and Phillips, 2009). For that reason, the first variable we use to evaluate an insurer's ERM program is an indicator variable for whether a firm has an economic capital model (ECM). We also capture the maturity of the economic capital model. Specifically, we use three variables that indicate whether the firm uses: (1) a simple factor-based ECM (e.g., Risk Based Capital); (2) an advanced model (e.g., scenario based or one with stress tests); or (3) a sophisticated model (e.g., stochastic simulation).

The insurance industry employs statutory accounting and as a result much of its regulatory valuation is based upon book value. Nevertheless, decisions to maximize firm value should be made on a forward, financial valuation, basis.[9] Accordingly, we develop a variable that is set equal to one if at one of firm's three principal risk metrics is market based, i.e., it is based on equity or earnings rather than GAAP, regulatory, or IAS measures.

[9] For example, Ryan and Trahan (2006) show that firms that adopt value-based management (VBM) systems outperform a matched sample firms after adopting VBM.

Past research has stressed that organizational structure impacts the success of information sharing between business segments and the top management (e.g., Stein, 2002). Thus, how the risk management function is organized within the firm is likely to be important in determining how effectively information on risk is shared between the top management and the individual business segments. A risk management team or a CRO can improve the collection and analysis of firm risks reducing information asymmetries among firm managers regarding the firm's current and future risks (Nocco and Stulz, 2006). As a result, we capture whether the firm has whether the firm has a CRO or significant risk management entity (e.g., a risk management committee).

Reporting relationships are also important. Firms with a strong dialogue between their senior management team and business segments regarding organization-wide risk preferences are going to have a better understanding of their risks. Moreover, a risk manager that has access to the Board may have more credibility than one that does not. Further, requiring the CRO to report to the C-suite signals the philosophical importance of risk management to the overall operation of the firm. A risk committee (which could be a combination of senior managers and various C-suite level personnel) also potentially signals the firm's commitment to an enterprise approach to risk management. Accordingly, we create indicators of whether the entity responsible for risk management reports to the board, the CFO, the CEO, or a committee.

Executive compensation plays an important part in the firm's ability to monitor and to incentivize managers (Jensen and Meckling, 1976). The recent financial crises made salient the importance of a strong link between executive compensation and risk management. Consequently, we construct an indicator for whether the firm uses the output from risk management to influence executive compensation.

The last survey question queries respondents on how confident they are that risk is reflected in the firm's decision making. All the risk management in the world would have little or no influence on the firm if the information is not used. Accordingly, we create an indicator for whether the respondent believes that risk is a reflected in the firm's decision making process.

4. Methodology and Results

We examine survey responses in three ways: by company type (life or property-liability insurer); by year (2004 or 2006), and by country of domicile (whether the parent firm is headquartered in the U.S. or outside the U.S.). Table 4 shows the results by company type. Roughly 17% of life insurers and 13% of property-liability insurers use simple economic capital models. Life insurers are more likely to have more mature models. Approximately 40% of life and non-life insurers use a market value based financial metric. 40-50% of firms have a dedicated risk management team or risk manager. Few insurers have risk management reporting to the board, but most firms have a reporting relationship between the risk manager and someone in the C-suite (like a CFO, General Counsel, or Chief Auditor). A small fraction of insurers have the risk manager report to a special risk committee or another unit, such as the chief actuary or the general counsel. A small percentage of firms (24-35%) incorporate risk management into their incentive compensation. Over half of the firms report they are confident risk is reflected into their decisions.

Turning to the efficiency variables, life insurers are on average less revenue efficient than property-liability insurers, but more cost efficient. Revenue efficiency is 0.114 for the mean life insurer and 0.224 for the mean property-liability insurer. Thus, the average life (property-liability) insurer operates at 11.4% (22.4%) of its maximum possible revenue. The average life insurer is 50% cost efficient and the average property-liability insurer is 33% cost efficient.

Table 5 shows the results by year. More firms use a market measure of firm value in 2006 than in 2004 and fewer insurers report using a simple economic capital model or a dedicated risk manager. However, more firms use a dedicated risk committee. In addition, more firms have an established reporting relationship between the risk management entity and the Board of Directors, while fewer firms have the risk manager reporting to a member of the C-suite. In 2006 survey respondents are less confident ERM is reflected in their decisions compared to 2004. ERM's link to executive compensation is also lower.

Table 6 displays the results based upon where the firm is headquartered. U.S. headquartered (HQ) firms are more revenue efficient, but less cost efficient. The difference in cost efficiency is not statistically significant. Non-U.S. HQ firms are more likely to have a financial value metric and an economic capital model. The economic capital model is also more sophisticated. Non-U.S. HQ insurers are also more likely to have a dedicated risk manager and the risk manager is more likely to report to the Board of Directors. U.S. HQ insurers are more likely to have the risk manger report to someone in the C-suite and more likely to use a risk committee. Non-U.S. HQ insurers are more likely to have the output from ERM used as part of executive compensation, while U.S. HQ firms are more confident risk is reflected in their decisions.

To investigate the effects of ERM on firm performance while controlling for firm specific factors, we estimate regressions of the following general form:

$$\mathrm{Eff}_{i,t} = \alpha + \beta' \mathrm{X}_{i,t} + \gamma \mathrm{Z}_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $EFF_{i,t}$ is efficiency, X is a vector of firm characteristic variables, and Z is a vector of variables of ERM activities.[10] The firm characteristic variables include size (natural logarithm of total assets), the capital to asset ratio, product line mix (for property-casualty insurers the percent of net premiums written in commercial property, commercial liability, and personal property insurance, and for life insurers the percent of net premiums written in annuities and life insurance), A.M. Best rating (an indicator set equal to one if the firm has an A.M. Best rating of B+ or better), and indicators of whether the company is part of a group of insurers, a licensed property-liability insurer, a publicly traded firm, and/or a privately held stock company. In addition, we also control for whether the respondent self reports that it is primarily a life or property-liability insurer. The vector of risk management activities is the set of variables described above in Section 3.

We estimate the regression using cost efficiency and revenue efficiency as the dependent variables. We also examine cost and revenue efficiency separately for the U.S. HQ companies. We use weighted least squares to control for heteroskedasticity related to the size of the organization. The weight is the square root of total assets.

Table 7 shows the results of these multivariate regressions. We focus our discussion on the risk management variables. We start with the cost efficiency regression results. The sophistication of a firm's economic capital model (ECM), which ranges from simple to advanced, is significantly related to life insurer cost efficiency, but not property-liability insurer efficiency. Firms that use at least one risk metric that is based upon market-value principles are more cost efficient. In addition, firms with a CRO are correlated with higher levels of cost

[10] Banker and Natarajan (2008) determine that OLS is an appropriate and robust technique to evaluate the impact of external variables on efficiency.

efficiency. The increase is even larger if the firm uses a risk committee. Finally, if the insurer is confident that risk is reflected in its business decisions, its cost efficiency is higher. Most of these findings are robust when we focus our analysis on the sample of US headquartered firms.

Turning to the revenue efficiency results, we see ERM influences revenue efficiency but does so differently than cost efficiency. For example, relative to the omitted category of not having a model, a simple ERM model is associated with higher life insurer revenue efficiency. However, we do not find evidence more sophisticated models are associated with greater productivity. For U.S. HQ firms, we even find evidence that an advanced ECM reduces revenue efficiency. A CRO or a dedicated risk committee also has a negative impact on revenue efficiency. These latter two results may be due to the fact that CROs or the presence of more advanced ECM models may limit firms from selling high-risk products. Finally a C-suite primary reporting requirement (either CFO or CEO) is associated with higher levels of revenue efficiency relative to the omitted category of reporting to some other official in the organization. Thus, the information made available through the ERM process may lead to better functioning of internal capital markets.

To assess the economic implications of our results, we calculate the cost savings or revenue enhancement associated with the implementation of each ERM initiative. For example, the estimated coefficient in Table 7 suggests that a simple ECM model yields an 8.4 percent increase in the cost efficiency of life insurers, which translates into $63 million in cost savings for the average life insurer (the average life insurer in the survey sample has $751 million in total costs). To provide a scale invariant measure, we also show the impact of each initiative on the average firm's return on assets (ROA). The implementation of a simple ECM yields a 0.54 percent increase in ROA. We complete a similar analysis for each statistically significant (at the 5 % level) ERM initiative. The results are shown in Table 8.

The cost savings associated with ERM range from $19.8 to $73.6 million. These cost savings translate into an increase in ROA that ranges between 0.34 and 0.89 percent. For U.S. HQ firms the range is 0.32 to 0.96 percent. For revenue efficiency, the positive impact on ROA ranges from 0.20 to 0.36 percent. The overall net impact on revenue and cost efficiency is positive for most combinations of ERM variables. The sole exception is for property-liability insurers that use simple ECM models, which has has a negative effect for U.S. HQ companies.

5. Conclusion

We examine the effect of ERM initiatives on firm performance. We gauge the sophistication of a firms ERM program using a unique worldwide survey of ERM practices conducted by a leading insurance consulting firm. We link the survey results to firms operating in the United States in both the life and property-liability insurance industries. Most previous studies analyzing the effect of risk management on firms have focused on how the use of ERM has influenced market-based measures for publicly traded firms such as Tobin's Q. The efficiency approach we adopt allows us to focus our analysis directly on the cash flow implications of adopting ERM and also allows us to include both private and public organizations.

Our results suggest ERM practices across insurers result in economically and statistically significant increases in both cost and revenue efficiency. Specifically, we find that life insurers benefit from the use of economic capital models and even relatively simple models produce significant increases in returns on assets. An insurer with a dedicated entity responsible for firm-wide risk management (such as a CRO) also experiences a higher level of cost efficiency and returns on assets. Further, the use of a dedicated risk committee and a primary reporting relationship to the officials in the C-Suite of the insurer (either the CEO or the CFO) is significantly related to increases in efficiency and return on assets. Finally, we find the insurer’s

confidence that risk is reflected in their business decisions is also significantly related to increases in efficiency and returns on assets.

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Table 1
Inputs and Outputs for Life and Property-Liability Insurers

This table provides summary statistics for the inputs and outputs used in the efficiency analysis for affiliated and unaffiliated singles. Frontier efficiency analysis is performed separately for each year. All input and output quantities and prices are constructed in accordance to the description in Cummins and Weiss (2001).

Panel A: Life Insurers (n=)

	Quantities		Prices	
	Mean	Std. Dev.	Mean	Std. Dev.
Input Quantities				
Agent Labor	32.27	158.38	52379.03	9544.48
Administrative Labor	704.40	2008.91	62753.35	11930.30
Materials & Business Services	815.95	2370.73	56468.10	2542.27
Debt Capital (millions)	4159.03	12894.11	0.06	0.01
Equity Capital (millions)	490.72	1307.20	0.04	0.02
Output Quantities				
Individual Life	97.95	401.02	4.20	84.18
Individual Annuities	172.94	582.70	0.84	2.66
Group Life	17.97	142.93	6.38	54.93
Group Annuities	108.29	497.43	0.84	3.65
Group Accident & Health	54.29	256.56	1.59	7.50
Intermediation Output	4024.14	12016.82	0.04	0.02

Panel B: Property-Liability Insurers (n=)

	Quantities		Prices	
	Mean	Std. Dev.	Mean	Std. Dev.
Input Quantities				
Agent Labor	2507.09	7064.54	45047.41	364.27
Administrative Labor	380.12	1113.80	51406.34	657.59
Materials & Business Services	3375.77	8802.31	7.99	0.17
Debt Capital (millions)	280.78	846.36	0.03	0.02
Equity Capital (millions)	181.17	554.78	0.12	0.02
Output Quantities				
Personal Short-Tail	12.99	48.17	0.39	0.62
Personal Long-Tail	32.64	102.45	0.36	0.54
Commercial Short-Tail	16.53	57.12	0.99	1.23
Commercial Long-Tail	37.38	110.61	0.73	1.05
Intermediation Output	425.87	1318.29	0.05	0.02

Table 2
Comparison Between Industry and Survey Respondents

This table compares the insurers that responded to the survey to the industry as a whole in terms of assets and net premiums written (NPW). Assets and NPW are expressed in millions of real dollars.

Panel A: Life Insurers

	Assets			NPW		
Year	Industry	Survey Respondents	Percent	Industry	Survey Respondents	Percent
2004	2755.88	1507.13	54.7	550.98	288.76	52.4
2006	2846.67	1301.93	45.7	571.72	247.5	43.3

Panel B: Property-Liability Insurers

	Assets			NPW		
Year	Industry	Survey Respondents	Percent	Industry	Survey Respondents	Percent
2004	1152.99	345.34	30	385.53	122.85	31.9
2006	1427.88	508.26	35.6	432.38	144.84	33.5

Table 3
Summary Statistics: Comparing Survey Respondents to All Companies

This table compares the insurers that responded to the survey to the industry as a whole. Total Assets is real total assets. Policyholders Surplus is a statutory accounting recognition of firm's total assets minus total liabilities and capital. NPW is Net Premiums Written. Total Assets, Surplus, and NPW are expressed in millions of real dollars. Capital-to-Assets is the ratio of Policyholders Surplus to Total Assets. Return on Equity is the ratio of net income to total equity. Return on Assets is net income over total assets. Stock is an indicator variable set equal to one if the firm has a stock organizational structure, and zero otherwise. Mutual is an indicator variable set equal to one if the firm has a mutual organizational structure, and zero otherwise. Cost Efficiency is the ratio of the costs of a fully efficient firm to the given firm's actual costs. Revenue Efficiency is the ratio of observed revenue to the maximum revenue of a fully efficient firm with the same input quantities and output prices. % Annuities, % Life, and % Accident and Health are the percent of total net premiums written in the life insurance lines of business of annuities, life insurance, and accident and health insurance, respectively. % Commercial Property, % Commercial Liability, % Personal Property, and % Personal Liability are the percent of total net premiums written in the property-liability insurance lines of business of commercial property, commercial liability, personal property, and personal liability insurance. A t-test is used to test the difference in means between all the companies in the industry and the survey companies. ***, **, * denotes statistical significance at the 1, 5 and 10 percent levels, respectively.

Panel A: Life Insurers

	All Companies			Survey Companies			Test Results
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	H_0: $\mu_{IND} = \mu_{SURV}$
Total Assets	1099	4483.720	15161.590	250	10548.890	23725.400	3.87 ***
Policyholder Surplus	1099	442.210	1242.860	250	964.730	1748.700	4.47 ***
NPW	1099	850.330	2531.000	250	2051.240	4089.720	4.45 ***
Capital-to-Assets	1099	0.224	0.185	250	0.167	0.144	5.32 ***
Return on Equity	1099	0.086	0.340	250	0.096	0.320	0.46
Return on Assets	1099	0.023	0.089	250	0.019	0.050	0.87
% Annuities	1099	0.199	0.300	250	0.253	0.321	2.41 ***
% Life	1099	0.420	0.365	250	0.438	0.359	0.71
% Accident & Health	1099	0.365	0.394	250	0.298	0.338	2.75 ***
Stock	1087	0.923	0.267	249	0.936	0.246	0.74
Mutual	1087	0.076	0.266	249	0.064	0.246	0.69
Cost Efficiency	1099	0.281	0.241	250	0.325	0.245	2.55 ***
Revenue Efficiency	1066	0.129	0.179	239	0.118	0.167	0.90

(Continued on Next Page)

Table 3 - *Continued*

Panel B: Property-Liability Insurers

	All Companies			Survey Companies			Test Results
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	H_0: $\mu_{IND} = \mu_{SURV}$
Total Assets	2890	775.380	3855.570	366	2023.830	6241.470	3.74 ***
Policyholder Surplus	2890	294.420	1814.350	366	752.620	2689.820	3.17 ***
NPW	2890	262.420	1325.750	366	675.150	2247.840	3.44 ***
Capital-to-Assets	2890	0.426	0.187	366	0.388	0.154	4.38 ***
Return on Equity	2890	0.078	0.295	366	0.084	0.188	0.56
Return on Assets	2890	0.030	0.071	366	0.030	0.072	0.15
% Commercial Property	2890	0.222	0.285	366	0.233	0.226	0.83
% Commercial Liability	2890	0.402	0.389	366	0.418	0.295	0.90
% Personal Property	2890	0.096	0.144	366	0.096	0.107	0.10
% Personal Liability	2890	0.282	0.301	366	0.260	0.250	1.54 *
Stock	2890	0.694	0.461	366	0.883	0.322	9.98 ***
Mutual	2890	0.219	0.414	366	0.060	0.238	10.86 ***
Cost Efficiency	2890	0.308	0.164	366	0.325	0.138	2.16 **
Revenue Efficiency	2623	0.238	0.198	317	0.224	0.162	1.41 *

Table 4
Summary Statistics: Life Insurers v. Property-Liability Insurers

This table compares life insurers to property-liability insurers. All the firms in this table responded to the survey. *Group* is an indicator variable set equal to one if the individual insurer is a member of a group of affiliated insurers, and zero otherwise. *P/L Insurer* is an indicator variable set equal to one if the insurer is licensed as a property-liability insurer, and zero otherwise. *Size* is the natural logarithm of total assets. *A.M. Best >= B+* is an indicator variable set equal to one if the insurers is rated B+ or better by A.M. Best. *Publicly Traded* is an indicator variable of whether the firm is part of a publicly traded group of insurers. *Privately Held Stock Company* is an indicator of whether the firm a privately held stock company. *Market Value Financial Metric* is an indicator of whether the firm's principal financial metric is market value based. *Economic Capital Model* (ECM) is an indicator for whether the insurer has an economic capital model. *Maturity of ECM* equals one if the insurer's ECM is simple, two if it is advanced, and three if it is sophisticated. *Dedicated Risk Manager (RM)* is an indicator for whether the insurer has a dedicated risk management team/person. *RM Reports to Board* is an indicator set equal to one if the firm's dedicated risk manager reports to the Board of Directors, and zero otherwise. *RM Reports to C-Suite* is an indicator set equal to one if the firm's dedicated risk manager reports to the CEO or CFO, and zero otherwise. *RM Reports to a Committee* is an indicator set equal to one if the firm's dedicated risk manager reports to a committee. *ERM in Incentive Compensation* is an indicator for whether the firm's ERM output is used in incentive compensation. *Risk Reflected in Decisions* is an indicator set equal to one if the insurer is confident risk is reflected in its decisions, and zero otherwise. All remaining variables are defined in the header of Table 3. A t-test is used to test the difference in means between life and property-liability insurers. ***, **, * denotes statistical significance at the 1, 5 and 10 percent levels, respectively.

	All Companies (n=532)		Life Insurers (n=215)		P/L Insurers (n=317)		Test Results H_0: $\mu_{LIFE} = \mu_{P/L}$
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Cost Efficiency	0.395	0.209	0.494	0.256	0.328	0.135	8.71 ***
Revenue Efficiency	0.180	0.167	0.114	0.151	0.224	0.162	8.02 ***
Firm Characteristic Variables:							
Group	0.023	0.149	0.019	0.135	0.025	0.157	0.52
Size	20.508	2.059	21.710	1.935	19.693	1.715	12.34 ***
Capital-to-Assets	0.287	0.182	0.143	0.110	0.385	0.153	21.10 ***
A.M. Best >= B+	0.868	0.338	0.777	0.417	0.931	0.255	4.83 ***
Publicly Traded	0.536	0.499	0.535	0.500	0.536	0.499	0.03
Privately Held Stock Company	0.177	0.382	0.167	0.374	0.183	0.387	0.46
% Commercial Property	0.135	0.201	0.000	0.000	0.227	0.217	18.59 ***
% Commercial Liability	0.242	0.296	0.000	0.000	0.406	0.284	25.45 ***
% Personal Property	0.059	0.093	0.000	0.000	0.099	0.103	17.16 ***
% Annuities	0.105	0.239	0.260	0.317	0.000	0.000	12.04 ***
% Life	0.180	0.314	0.447	0.355	0.000	0.000	18.46 ***
Risk Management Variables:							
Market Value Financial Metric	0.430	0.496	0.465	0.500	0.407	0.492	1.33 *
Economic Capital Model (ECM)	0.536	0.499	0.572	0.496	0.511	0.501	1.39 *
Maturity of ECM	1.099	1.175	1.144	1.157	1.068	1.188	0.74
Dedicated Risk Manager (RM)	0.694	0.461	0.670	0.471	0.710	0.455	0.97
RM Reports to Board	0.122	0.328	0.042	0.201	0.177	0.382	5.30 ***
RM Reports to C-Suite	0.829	0.377	0.926	0.263	0.763	0.426	5.43 ***
RM Reports to a Committee	0.024	0.155	0.014	0.118	0.032	0.175	1.39 *
ERM in Incentive Compensation	0.282	0.450	0.349	0.478	0.237	0.426	2.78 ***
Risk Reflected in Decisions	0.586	0.493	0.544	0.499	0.615	0.487	1.62 *

Table 5
Summary Statistics: 2004 v. 2006

This table compares 2004 to 2006. All the firms in this table responded to the survey. *P/L Insurer* is an indicator variable set equal to one if the insurer is licensed as a property-liability insurer, and zero otherwise. *Life Insurer* is an indicator variable set equal to one if the insurer is licensed as a life insurer, and zero otherwise. All remaining variables are defined in the headers of Tables 3 and 4. A t-test is used to test the difference in means between life and property-liability insurers. ***, **, * denotes statistical significance at the 1, 5 and 10 percent levels, respectively.

	All Years (n=523)		2004 (n=255)		2006 (n=277)		Test Results H_0: $\mu_{2004} = \mu_{2006}$
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Cost Efficiency	0.395	0.209	0.447	0.222	0.347	0.184	5.63 ***
Revenue Efficiency	0.180	0.167	0.172	0.188	0.187	0.144	1.00
Firm Characteristic Variables:							
Group	0.023	0.149	0.016	0.125	0.029	0.168	1.04
P/L Insurer	0.596	0.491	0.549	0.499	0.639	0.481	2.11 **
Size	20.508	2.059	20.618	2.046	20.406	2.070	1.19
Capital-to-Assets	0.287	0.182	0.262	0.174	0.311	0.185	3.12 ***
A.M. Best >= B+	0.868	0.338	0.855	0.353	0.881	0.325	0.88
Publicly Traded	0.536	0.499	0.659	0.475	0.422	0.495	5.62 ***
Privately Held Stock Company	0.177	0.382	0.055	0.228	0.289	0.454	7.60 ***
% Commercial Property	0.135	0.201	0.132	0.215	0.138	0.188	0.31
% Commercial Liability	0.242	0.296	0.212	0.286	0.269	0.303	2.22 **
% Personal Property	0.059	0.093	0.060	0.098	0.059	0.089	0.07
% Annuities	0.105	0.239	0.114	0.245	0.097	0.232	0.85
% Life	0.180	0.314	0.194	0.317	0.168	0.312	0.97
Risk Management Variables:							
Market Value Financial Metric	0.430	0.496	0.271	0.445	0.578	0.495	7.53 ***
Economic Capital Model (ECM)	0.536	0.499	0.573	0.496	0.502	0.501	1.64 *
Maturity of ECM	1.099	1.175	1.149	1.188	1.052	1.163	0.95
Maturity of ECM x Life Insurer	0.462	0.925	0.463	0.917	0.462	0.934	0.01
Dedicated Risk Manager (RM)	0.694	0.461	0.678	0.468	0.708	0.456	0.73
RM Reports to Board	0.122	0.328	0.075	0.263	0.166	0.373	3.29 ***
RM Reports to C-Suite	0.829	0.377	0.906	0.293	0.758	0.429	4.67 ***
RM Reports to a Committee	0.024	0.155	0.012	0.108	0.036	0.187	1.86 **
ERM in Incentive Compensation	0.282	0.450	0.329	0.471	0.238	0.427	2.33 ***
Risk Reflected in Decisions	0.586	0.493	0.753	0.432	0.433	0.496	7.94 ***

Table 6
Summary Statistics: Non-U.S. Headquartered Insurers v. U.S. Headquartered Insurers

This table compares non-U.S. headquartered insurers to U.S. headquartered insurers. All the firms in this table responded to the survey. *Non-U.S. HQ* is an indicator variable set equal to one if the insurer is not headquartered in the United States, and zero otherwise. *Non-U.S. HQ* is an indicator variable set equal to one if the insurer is headquartered in the United States, and zero otherwise. All remaining variables are defined in the headers of Tables 3, 4, and 5. A t-test is used to test the difference in means between life and property-liability insurers. ***, **, * denotes statistical significance at the 1, 5 and 10 percent levels, respectively.

	All Years (n=523)		Non-U.S. HQ (n=226)		U.S. HQ (n=306)		Test Results H_0: $\mu_{non\text{-}U.S.} = \mu_{U.S.}$
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Cost Efficiency	0.395	0.209	0.407	0.228	0.386	0.194	1.09
Revenue Efficiency	0.180	0.167	0.163	0.156	0.192	0.173	2.00 **
Firm Characteristic Variables:							
Group	0.023	0.149	0.027	0.161	0.020	0.139	0.52
P/L Insurer	0.596	0.491	0.606	0.490	0.588	0.493	0.42
Size	20.508	2.059	20.636	2.057	20.414	2.060	1.23
Capital-to-Assets	0.287	0.182	0.294	0.195	0.282	0.171	0.72
A.M. Best >= B+	0.868	0.338	0.863	0.345	0.873	0.334	0.33
Publicly Traded	0.536	0.499	0.593	0.492	0.493	0.501	2.29 **
Privately Held Stock Company	0.177	0.382	0.336	0.473	0.059	0.236	8.10 ***
% Commercial Property	0.135	0.201	0.148	0.204	0.126	0.199	1.28 *
% Commercial Liability	0.242	0.296	0.249	0.303	0.237	0.292	0.47
% Personal Property	0.059	0.093	0.055	0.091	0.062	0.095	0.85
% Annuities	0.105	0.239	0.114	0.250	0.099	0.230	0.68
% Life	0.180	0.314	0.156	0.289	0.198	0.331	1.56 *
Risk Management Variables:							
Market Value Financial Metric	0.430	0.496	0.593	0.492	0.310	0.463	6.71 ***
Economic Capital Model (ECM)	0.536	0.499	0.664	0.473	0.441	0.497	5.24 ***
Maturity of ECM	1.099	1.175	1.414	1.148	0.866	1.142	5.45 ***
Maturity of ECM x Life Insurer	0.462	0.925	0.544	0.980	0.402	0.879	1.73 **
Dedicated Risk Manager (RM)	0.694	0.461	0.761	0.427	0.644	0.480	2.97 ***
RM Reports to Board	0.122	0.328	0.252	0.435	0.026	0.160	7.45 ***
RM Reports to C-Suite	0.829	0.377	0.730	0.445	0.902	0.298	5.03 ***
RM Reports to a Committee	0.024	0.155	0.009	0.094	0.036	0.186	2.19 **
ERM in Incentive Compensation	0.282	0.450	0.341	0.475	0.239	0.427	2.56 ***
Risk Reflected in Decisions	0.586	0.493	0.482	0.501	0.663	0.473	4.22 ***

Table 7
Impact of Enterprise Risk Management on Firm Cost and Revenue Efficiency

This table reports the results of multivariate weighted least squares regressions. The weights are based on total assets. There are two dependent variables: Cost Efficiency and Revenue Efficiency. We perform the regression for all the insurance companies in our sample (All) and for the subsample of United States headquarted insurers (U.S. Only). *Year 2006* is an indicator variable if the year is 2006. *Primarily Life Insurer* and *Primarily P/L Insurer* are indicator variables for whether the insurer self-reports that it is primarily a life insurer or a property-liability insurer. *Dedicated Risk Manager (RM) is CRO* is an indicator for whether the insurer has a dedicated Chief Risk Officer. *Dedicated Risk Manager (RM* is Committee is an indicator for whether the insurer has a dedicated risk management team. *RM Reports to CEO* is an indicator set equal to one if the firm's dedicated risk manager reports to the CEO, and zero otherwise. *RM Reports to CFO* is an indicator set equal to one if the firm's dedicated risk manager reports to the CFO, and zero otherwise. All remaining variables are defined in the headers of Tables 3, 4, and 5. ***, **, * denotes statistical significance at the 1, 5 and 10 percent levels, respectively.

	Cost Efficiency		Revenue Efficiency	
	All	U.S. Only	All	U.S. Only
Constant	0.280 **	0.160	0.224 ***	0.121
Year 2006	-0.088 ***	-0.101 ***	0.059 ***	0.049 **
Firm Characteristic Variables:				
Group	0.008	0.052	-0.096 **	-0.097 *
P/L Insurer	0.118	0.051	0.287 ***	0.236 **
Size	0.005	0.005	-0.013 ***	-0.008 **
Capital-to-Assets	-0.229 **	-0.217 **	-0.172 ***	-0.145 **
A.M. Best >= B+	-0.016	-0.009	0.028 *	-0.008
Publicly Traded	0.079 ***	0.044	-0.011	-0.032
Privately Held Stock Company	0.098 ***	0.091	-0.001	0.010
Primarily Life Insurer	0.015	-0.018	0.033 **	0.071 **
Primarily P/L Insurer	0.052 **	0.128 ***	0.047 ***	0.081 ***
% Commercial Property	-0.281 **	-0.076	-0.012	0.065
% Commercial Liability	-0.295 **	-0.258 *	-0.170 **	-0.084
% Personal Property	0.081	0.514	0.079	0.362
% Annuities	0.124 ***	0.282 ***	0.066 ***	0.115 ***
% Life	-0.107 ***	0.012	0.048 **	0.072 **
Risk Management Variables:				
Simple ECM x Life Insurer	0.084 ***	0.076 **	0.061 ***	0.051 **
Advanced ECM x Life Insurer	0.098 ***	0.112 ***	0.020	-0.019
Sophisticated ECM x Life Insurer	0.098 ***	-0.043	0.025	-0.048 *
Simple ECM x P/L Insurer	-0.056	-0.090 *	-0.020	-0.074 **
Advanced ECM x P/L Insurer	-0.039	-0.034	-0.004	-0.029
Sophisticated ECM x P/L Insurer	-0.074 *	-0.070	-0.027	-0.031
Market Value Financial Metric	0.043 **	0.061 **	-0.010	-0.012
Dedicated Risk Manager (RM) is CRO	0.072 ***	0.083 ***	-0.033 **	-0.034 *
Dedicated RM is a Committee	0.115 ***	0.127 ***	-0.043 **	-0.029
RM Reports to Board	-0.016	0.042	0.041	0.077
RM Reports to CEO	-0.022	-0.004	0.045 *	0.045
RM Reports to CFO	-0.045	0.009	0.068 **	0.074 **
RM Reports to a Committee	-0.022	-0.025	-0.019	-0.039
ERM in Incentive Compensation	0.002	0.070 ***	0.007	0.020
Risk Reflected in Decisions	0.048 **	0.042 *	0.008	-0.008
Observations	523	306	523	306
R-squared	0.398	0.591	0.400	0.453

Table 8
Economic Value of Enterprise Risk Management Initiatives

This table reports the economic value of various Enterprise Risk Management initiatives in terms of cost savings and revenue enhancement. The economic value is calculated using the estimated coefficients reported in Table 7 multipled by the total cost (or total revenue) of the average insurer in the survey sample. To provide a scale invariate measure of the economic value, we also show the impact of each initiative on the average firm's return on assets (ROA). The effects of the ERM initiatives are shown if the underlying statistical significance was at least at the 5 percent level. The sample is broken down into two categories: (1) all companies in our sample and (2) the subsample of companies headquartered in the United States. All variables are defined in the headers of Tables 3, 4, 5, and 7.

	Cost Savings				**Revenue Enhancement**			
	All		US Only		All		US Only	
Variable	Cost Savings	ROA	Cost Savings	ROA	Revenue Enhancement	ROA	Revenue Enhancement	ROA
Life Insurer with Simple Capital Model	$ 62,962,236	0.54%	$ 56,930,421	0.49%	$ 23,975,626	0.20%	$ 20,147,058	0.17%
Life Insurer with Advanced Capital Model	$ 73,591,151	0.63%	$ 83,821,951	0.71%				
Life Insurer with Sophisticated Capital Model	$ 73,508,523	0.63%						
P/L Insurer with Simple Capital Model							$ (17,190,583)	-0.87%
P/L Insurer with Advanced Capital Model								
P/L Insurer Sophisticated Capital Model								
Market Value Financial Metric	$ 19,832,459	0.34%	$ 27,087,841	0.46%				
Dedicated Risk Manager (RM) is CRO	$ 33,149,262	0.56%	$ 37,202,892	0.63%	$ (10,359,598)	-0.18%		
Dedicated RM is a Committee	$ 52,829,766	0.89%	$ 56,693,305	0.96%	$ (13,370,133)	-0.23%		
RM Reports to Board								
RM Reports to CEO								
RM Reports to CFO					$ 21,023,982	0.36%	$ 23,126,380	0.39%
RM Reports to a Committee								
ERM in Incentive Compensation			$ 31,026,918	0.52%				
Risk Reflected in Decisions	$ 22,295,975	0.38%	$ 18,697,250	0.32%				