The Effects of Executive Compensation on Corporate Risk Management

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Abstract

We provide the first evidence on the effects of executive compensation on corporate risk management for financial institutions. Our unique dataset that allows construction of a new, cleaner measure of corporate risk management behavior. Specifically, we include hedging-driven usage of both derivatives and insurance. To address potential endogeneity, we utilize a difference-in-differences approach, based on the implementation of FAS 123R, that required firms to expense stock-based compensation at fair value. We find that the decline in convexity of executive compensation following FAS 123R led firms to increase their risk management, primarily through increased insurance demand.

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1. Introduction

In a world of perfect capital markets, firm value is independent of risk management, including corporate hedging. Prior literature explains the existence of corporate hedging demand in practice by considering imperfections in capital markets whereby expected bankruptcy costs, tax incentives, and the underinvestment problem (among other explanations) provide important motivations to alter corporate behavior to maximize firm value (Mayers and Smith, 1982; Mayers and Smith, 1990).

We investigate compensation systems that may induce managers to alter firms' hedging behaviors. Smith and Stulz (1985) argue that managers whose wealth is closely tied to their firm's performance are limited in their ability to diversify their portfolio effectively. As managers are risk averse, they try to reduce risk in their portfolio through hedging even in the face of deadweight costs to the firm. However, through the design of compensation contracts, firms can provide incentives for managers that help to re-align managerial and shareholder interests. More specifically, convexity in executive compensation can offset the concavity of a manager's utility function.

Prior research studying the effect of executive compensation on corporate risk management examines derivatives as the only measure of corporate risk management (Tufano, 1996; Knopf, Nam, and Thornton, 2002; Rogers, 2002; Bakke, Mahmudi, Fernando, and Salas, 2016), primarily because of data availability issues – a typical firm is not required to disclose insurance purchases unless the information is material. Moreover, even if the firm is required to disclose such information, it can do so in a footnote in its financial statements, minimizing the amount of information available. Fortunately, the U.S. insurance industry requires more complete and detailed data of a firm's risk management behavior (including insurance and derivatives), and thus provides an ideal and unique laboratory to study the impact of managerial risk-taking incentives on corporate risk management. In this paper, we are able to consider firms' use of both derivatives and insurance in quantifying firms' risk management behaviors. By focusing our analysis on a sample of publicly traded U.S. property and casualty insurers, we are able to broaden the examination of risk management to include not only corporate use of derivatives but also the purchase of insurance. This is especially important since our data shows that these two hedging instruments are complements. If they were substitutes, examining only one instrument might be sufficient in the sense that it would be analyzing the other side of the same coin. However, since derivatives and insurance are complements, considering both insurance and derivatives is crucial in gaining a more complete understanding of firm's corporate risk management behavior.

Further, we not only broadly consider insurance and derivatives, we also are able to identify the use of insurance and derivatives that is specifically utilized for hedging purposes.[2] We identify insurance and derivative positions specifically utilized for hedging purposes by eliminating intragroup insurance transactions and derivative positions for trading purposes. Thus, we include only hedging positions in measuring the extent of insurance and derivative usage, allowing us to provide the most inclusive and cleanest test of corporate risk management in the literature.

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[2] Insurance may be used not only for hedging purpose but also as internal capital market (ICM) transfers among members of insurance groups (Powell, Sommer and Eckles, 2008; Fier, McCullough, and Carson, 2013). In addition, only some reported derivative transactions are for risk reduction purposes, while others are for speculation purposes (Guay, 1999a).

We find a significant relation between a CEO's risk-taking incentives and corporate risk management demand, based on four different measures of corporate risk management. We use total risk management of an insurer as the sum of their derivative usage and reinsurance purchases.[3] In addition, we investigate derivative usage (in terms of expenditure and notional amount) and insurance demand separately. Controlling for other possible determinants of hedging, we find firms hedge 0.498% less with a 1% increase in the sensitivity of a manager's stock and stock option portfolio to stock return volatility, and firms hedge 0.441% more with a 1% increase in the sensitivity of manager's stock and stock option portfolio to stock price. With median assets of about $10 billion in our sample, this translates into an average of $49.8 million less spending on total risk management with a 1% increase in the sensitivity of a manager's stock and stock option portfolio to stock return volatility and an average of $44.1 million more spending on risk management expenditure with a 1% increase in the sensitivity of a manager's stock and stock option portfolio to stock price. With median risk management expenditure of about $176 million in our sample, this translates into an economically significant 28% ($49.8M/$176M) less spending on total risk management expenditures with a 1% increase in the sensitivity of manager's stock and stock option portfolio to stock return volatility and an equally economically significant average of 25% ($44.1M/$176M) more spending on risk management expenditure with a 1% increase in the sensitivity to stock price.

When we analyze insurance and derivatives separately, we find an average of $47.8 ($43.4) million less spending on insurance with a 1% increase in the sensitivity of manager's stock and stock option portfolio to stock return volatility (stock price). Again, these are both

[3] Reinsurance is insurance purchased by an insurer, whereby the insurer transfers some of the risk it has assumed in writing insurance coverage for others (e.g., homeowners, auto, D&O, and other types of insurance). Since our sample and data consist of insurers, we will use the term reinsurance in denoting firm's insurance demand. We refer the reader to Mayers and Smith (1990) for a more detailed description of reinsurance.

economically significant when considering median insurance usage of about $169 million in our sample; this translates into 28% (26%) less (more) spending on total hedging expenditures with a 1% increase in the sensitivity of manager's stock and stock option portfolio to stock return volatility (stock price). However, we do not find a significant relation between managerial incentives and firm's derivative usage.

Knopf, Nam, and Thornton (2002) also finds that managerial incentives and corporate hedging policy have a significant relation. However, Knopf, Nam, and Thornton (2002) limit their study to firms in the S&P 500 in 1996 excluding financial institutions. Our panel data set of insurers not only captures the influence of time-series trends but also offers a more homogenous sample. In addition, the insurance industry discloses much more value-relevant information than other industries. This information is useful as it lessens the possibility of contamination due to omitted variables, such as insurance usage. The data also enable us to refrain from potentially analyzing spurious results that would result from including non-hedging derivative usage in measuring the notional amount of a firm's derivative position.

To address potential endogeneity and establish causality between managerial incentives and corporate risk management, we utilize a 2005 regulation that changed the accounting treatment of stock-based compensation as an exogenous shock (Bakke, Mahmudi, Fernando, and Salas, 2016). Prior to FAS 123R, firms could expense executive stock options either at their intrinsic value or fair value. FAS 123R required all firms to begin expensing stock-based compensation at fair value, significantly increasing the cost of granting stock options. We find a significant decrease in the usage of stock options after the adoption of FAS 12R. Using a difference-in-differences (DID) analysis, we find that decline in the convexity of executive compensation led firms to increase their corporate risk management, primarily through increased insurance demand.

We make several contributions to the corporate risk management literature. First, we measure corporate risk management activity by considering both derivatives and insurance, controlling for simultaneity. Moreover, we specifically capture hedging-driven usage of derivatives and insurance and eliminate non-hedging uses of derivatives and insurance. Second, we contribute to the literature that measures corporate risk management with insurance by explicitly accounting for managerial incentives in the form of executive compensation. Prior literature largely focuses on shareholder value maximization motives but neglects to account for managerial incentives.[4] Aunon-Nerin and Eling (2008) discuss managerial incentives as an important motivation for corporate insurance demand but do not include compensation variables in the empirical analysis as it significantly reduces their sample size. In our analysis, compensation variables are statistically and economically significant, suggesting that controlling for these variables is important in order to reduce potential bias from omitted variables.

The remainder of the paper is organized as follows. The second section develops the research hypotheses and variables. The third section provides details on the sample, data, and methodology. The fourth section discusses the variables and summary statistics. The fifth section presents the empirical approach and results, and the final section summarizes and concludes.

[4] One exception, however, is Adams, Lin and Zou (2011), which identified the effects of CEO cash compensation and bonus plan on the corporate demand for insurance for Chinese firms in 2002.

2. Hypotheses and Variable Development

In their seminal paper on managerial risk aversion and hedging, Smith and Stulz (1985) argue that for managers who are assumed to be risk averse utility maximizers, complete hedging is optimal.[5] Thus, managers may choose to maximize their own expected utility even though doing so may be costly to the firm. However, through the design of compensation contracts, the concavity of a manager's utility function can be mitigated. Specifically, if a manager's wealth is a convex function of firm value, then the manager's utility will be less concave in firm value and will provide an incentive for managers to take on more risk.[6]

We first analyze CEO risk-taking incentives arising from equity compensation. The first proxy, *LVega*, measures the CEO's wealth sensitivity to risk. *LVega* is the log of the change in the value of the CEO's option portfolio in response to a one percent increase in the annualized standard deviation of the firm's stock return.[7] [8] Therefore, higher *LVega* suggests that the value of the CEO's wealth increases with increases in the firm's stock return volatility. Managers with high *LVega* will have greater incentive to take on more risk and demand less hedging. We denote this hypothesis as the "Offsetting Concavity Hypothesis."

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[5] Since the expected value of a concave function of a random variable is smaller than the value of the function evaluated at the expected value of the random variable, the expected utility of the manager is maximized if the firm is completely hedged.

[6] Smith and Stulz (1985) discuss bonus plans and executive stock options as examples of convex compensation contracts.

[7] We use a log specification for Vega (and Delta) as in Tufano (1996), Knopf, Nam, and Thornton (2002), Brockman, Martin, and Unlu (2010), and Chava and Purnanandam (2010). Knopf, Nam, and Thornton (2002) argue that taking the log of the variables is consistent with manager's concave utility function and alleviates the skewness. More specifically, we define *LVega* as log(1+*Vega*) and *LDelta* as log(1+*Delta*). We add one dollar to all Vega and Delta to not lose observations that have zero values.

[8] Common stock in a levered firm also can be viewed as a call option. However, Guay (1999b) finds that stock contributes very little to risk taking incentives. Therefore, we assume that *Vega* for stock is zero and only calculate *Vega* of the option portfolio. We use partial derivatives of the option price with respect to stock return volatility that are based on the Black and Scholes (1974) option pricing model adjusted for dividends (Merton, 1973).

H1a (Offsetting Concavity Hypothesis): A CEO's incentive to increase firm risk (LVega) is negatively related to their demand for corporate risk management.

On the other hand, we also must consider the impact of termination risk on the CEO. While CEOs have an incentive to take on risky projects in response to higher *LVega*, it is important to note that the increase in risk taking is also associated with an increased probability of poor performance (Bloom and Milkovich, 1998). Chakraborty, Sheikh, and Subramaian (2007) find that higher convexity in the compensation schedule is associated with an increased termination risk, and increased termination risk is associated with less CEO risk taking. A higher probability of being fired due to poor performance provides an incentive to the manager to hedge against left-tail risk. Under this scenario, we would expect a positive relation between a CEO's incentive to increase firm risk (*LVega*) and their demand for insurance since hedging with insurance reduces left-tail risks. We denote this hypothesis as the "Career Concern Hypothesis."[9] Given these two competing hypotheses, the effect of *LVega* is an empirical question when measure hedging intensity with insurance usage.

H1b (Career Concern Hypothesis): A CEO's incentive to increase firm risk (LVega) is positively related to their demand for corporate risk management.

The second proxy, *LDelta*, measures the CEO's incentive to increase the firm's stock price. This variable is the log of the change in the value of the CEO's stock and option portfolio due to a one percent increase in the price of the firm's common stock.[10] A higher sensitivity of the manager's wealth to stock price should give a risk-averse manager an incentive to decrease

[9] Empirical literature that measures corporate risk management with derivative usage predicts a negative relation between CEO's *Vega* and demand for hedging (Knopf, Nam, and Thornton, 2002; Bakke, Mahmudi, Fernando, and Salas; 2016). However, we introduce a competing hypothesis since hedging with insurance eliminates specifically left-tail risks.
[10] We again use partial derivatives of the option price with respect to stock return volatility that are based on the Black and Scholes (1974) option pricing model adjusted for dividends (Merton, 1973).

risk. Guay (1999b) and Knopf, Nam, and Thornton (2002) argue that a higher *LDelta* increases a manager's exposure to risk and variance of wealth. Therefore, we expect a positive relation between a CEO's incentive to increase stock price (*LDelta*) and risk management demand. We denote this hypothesis as the "Stock Price Sensitivity Hypothesis."

H2 (Stock Price Sensitivity Hypothesis): A CEO's incentive to increase stock price (LDelta) is positively related to their demand for corporate risk management.

Thus, we examine the Offsetting Concavity Hypothesis, the Career Concern Hypothesis, and the Stock Price Sensitivity Hypothesis in the context of corporate hedging with detailed insurer data and their demand for derivatives and insurance.

3. Sample and Data

We examine property-casualty insurance companies in the U.S. between 2000 and 2009. Prior literature on corporate hedging has largely focused on the oil and gas industry due to its detailed disclosure of corporate risk management activities (Haushalter, 2000; Rajgopal and Shelvin, 2002; Jin and Jorion, 2006; Kumar and Rabinovirch, 2013; Acharya, Lochestor, and Ramadorai, 2013; Bakke, Mahmudi, Fernando, and Salas, 2016). Given the detailed and inclusive dataset of hedging for the insurance industry, including derivatives and insurance, we focus here on insurer corporate risk management.

There are many advantages of focusing on the insurance industry. First, focusing on one industry provides a homogenous sample with reduced unobservable differences. Second, insurance firms are exposed to substantial cash flow volatility. For instance, Hurricane Andrew in 1992 resulted in $15 billion (1992 dollars) in insurance claims resulting in several insurer insolvencies. Due to this substantial cashflow volatility, insurance firms may have higher incentive to actively engage in corporate risk management compared to firms in other industries.

Third, the majority of prior research studying the effect of executive compensation on corporate risk management includes derivatives as the only measure of firm hedging (Tufano, 1996; Knopf, Nam, and Thornton, 2002; Rogers, 2002; Bakke, Mahmudi, Fernando, and Salas, 2016).[11] However, our data allow us to consider both derivatives and insurance in quantifying firms' risk management behavior as insurers are required to report their insurance purchases. By focusing our analysis on a sample of insurers, we are able to include data on both derivatives and insurance.

Fourth, our data enable us to not only broadly consider insurance and derivatives, but also identify insurance and derivative usage specifically utilized for hedging.[12] We identify insurance and derivative positions specifically utilized for hedging purposes and we eliminate non-hedging transactions such as intragroup insurance transactions and investment-based derivative positions. Thus, we only include hedging positions in measuring the extent of insurance and derivative usage, providing a cleaner test of corporate risk management. Ultimately, using insurance companies allows for a complete picture of a firm's risk management behavior, which was not possible in prior studies using non-insurer data.

Fifth, our sample and data allow us to provide the first evidence on the effect of executive compensation on corporate risk management for financial institutions. Prior studies have largely

[11] This is likely because of data availability issues – a typical firm is not required to disclose insurance purchases unless the information is material. Moreover, even if the firm is required to disclose such information, it can do so at the footnote-level in its financial statements.

[12] In addition to their hedging purposes, insurance transactions are used as internal capital market (ICM) transfers among members of insurance groups (Powell, Sommer and Eckles, 2008; Fier, McCullough, and Carson, 2013) and derivatives are used for trading purposes (Guay,1999a).

focused on a single industry (oil and gas) and, even when considering a broader set of firms, have excluded financial firms from their analysis (Knopf, Nam, and Thornton, 2002).

Sixth, prior research on the incentives of derivative usage has been criticized in that managerial sophistication and demand for derivatives are highly correlated, and therefore results may be spurious due to omitted variable bias. Our focus on insurers, whose core business is managing risk, suggests the presence of greater homogeneity regarding their knowledge of (though not necessarily expertise in) hedging.

We next discuss our sources of data. Compensation data for our research are from Compustat North America's Executive Compensation (ExecuComp) database, financial data are from Compustat, monthly stock returns are from the Center for Research in Security Prices (CRSP), institutional ownership data are from Thomson Reuters, monthly market returns are from the Fama French Research Data, and accounting data are from annual statutory statements filed with the National Association of Insurance Commissions (NAIC). Our dataset spans 2000 to 2009.[13] Firms that report nonpositive values for assets, equity, or premiums written are removed. Also, firms that do not have monthly stock returns for all 12 months during the year are excluded. We winsorize variables at the 1st and 99th percentiles.

Insurance companies are mostly organized as groups (Petroni and Shackelford, 1995; Powell, Sommer, and Eckles, 2008) composed of a parent company and several subsidiaries. In 2010, of the 3,077 total U.S. property and casualty (P-C) insurers, 2,164 P-C insurers were

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[13] The NAIC provides digitally recorded derivative trading data from 2000. Prior to 2010, derivative usage is divided into "hedging" or "other." From 2010, the objective of derivative usage is further divided into five categories: hedging effective, hedging other, replication, income generation, and other.

members of 415 groups. We analyze insurers at the group level, as ExecuComp reports compensation data at the group level.[14]

Insurers within the same group can exchange capital by engaging in reinsurance transactions (among other methods such as dividends). Since we analyze firms at the group level, we can focus on true insurance-related hedging transactions and eliminate transactions related to capacity shifting within the group (e.g. capital costs, internal risk shifting, tax minimization, etc.; Skog, 2009). In 2010, only 23% of insurer purchases ($112 billion) of insurance (i.e., reinsurance) were classified as external (as opposed to purchases from within-group affiliates) transactions.[15] Affiliated insurers are required to report transactions in mandatory filings to state insurance regulators.[16] In measuring hedging-driven usage of insurance, we include only insurance transactions with non-affiliates (i.e., true hedging transactions, as opposed to simply corporate capital structure transactions).

Cummins and Song (2008) highlight that prior studies on derivative hedging consider all derivative positions as hedging driven. In fact, only some of these reported derivative transactions are for risk reduction purposes, while others are for speculation purposes. Guay (1999a) attempts to discern different motivations by examining the relation between changes in derivative usage and changes in firm risk. If firms use derivatives to hedge risk, a reduction in risk is expected. The opposite effect is expected if firms use derivatives for speculation.

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[14] This extends the prior literature as previous studies on corporate insurance demand utilize firm level data. Firm level data do not allow us to determine whether firms are using insurance for hedging or for internal capital market transactions.

[15] As discussed earlier, reinsurance is insurance purchased by an insurer where the insurer transfers some or all of the risk(s) it assumed by writing insurance coverage. Since our sample and data consist of insurers, the term "reinsurance" is used to denote an insurer's purchase of insurance. Reinsurance is a significant transaction for insurers. In 2010, $120 billion in premium was ceded to reinsurers in the U.S. property and casualty insurance industry. This is 24% of total premiums written in 2010.

[16] Reinsurance transactions with affiliates are reported in the Underwriting and Investment Exhibit Part 2B-Premiums written.

The insurance industry provides a unique opportunity to identify the purpose of derivative usage. Schedule DB in the annual statutory statement requires insurers to report the purpose of derivative transaction as “hedging” or “other”. To measure hedging activity, we include only the derivative transactions reported as a “hedging” transaction. This enables us to identify the true amount of derivative hedging and refrain from including non-hedging derivative usage. Figure 1 provides a summary of the relative proportion of cost of derivative usage for our sample. Of the expenditures on derivatives, 67.42% was identified as hedging. Therefore, assuming all derivative positions as hedging-driven would cloud the results.

[Insert Figure 1 About Here]

Schedule DB also allows us to examine all derivative transactions undertaken during the year as well as open positions at year-end by the type of instrument.[17] Prior literature on corporate hedging has focused its analysis on year-end derivative positions due to data availability issues. This might underestimate firms’ derivative usage since some firms might close out their positions at year-end for reasons such as regulatory window-dressing (Cummins, Phillips, and Smith, 2001). In our sample, the mean derivative expenditure would be 5 times less using the year-end criterion rather than the within-year criterion ($2,094,322 v. $10,754,585). By using the within-year transactions, we are able to capture *all* derivative transactions in place during the year. In addition, since our reinsurance variable measures all reinsurance positions taken throughout the year, it is reasonable to use within-year transactions for the derivative usage to create a more consistent variable.

[17] In each part of Schedule DB, Section 1 reports all derivative positions that are still being held by the company at 12/31 of the year and Section 2 reports derivative holdings that were purchased/acquired during the year. In this paper, we retrieve data from Section 2 of Schedule DB.

Our final sample includes 310 firm-year observations from 49 publicly traded property-casualty insurers.[18] Among the 310 firm-year observations, all firms report reinsurance usage while roughly 10% (33) include derivative usage.[19]

4. Variables and Summary Statistics

4.1. Measures of Hedging Intensity

We use four different measures of corporate risk management intensity as our dependent variable. First, *External Reinsurance Usage* is the ratio of reinsurance premiums ceded to non-affiliates over total assets. *External Reinsurance Usage* is measured at the group level which enables us to capture the reinsurance demand for hedging purpose and eliminate non-hedging related capacity shifting within the firm (e.g. capital costs, internal risk shifting, tax minimization, etc.), (Skog, 2009). Therefore, we include only reinsurance transaction with non-affiliates.

Second, *Derivative Usage* is the cost of all derivative positions for hedging purposes acquired during the year scaled by total assets.[20]

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[18] Net premiums written by our sample of insurers represent approximately 40 percent of the industry. Our sample is the population, not the subset, of the publicly-traded property-casualty insurers.

[19] Four observations in our sample reported negative reinsurance usage. These are companies whose contract with their reinsurer was terminated. In these cases, the companies may receive the premiums back that they have ceded to the reinsurer. For instance, AMBAC Financial Group reported -$112,345,403 for reinsurance demand in 2009. In 10-K report, AMBAC states that during 2009, AMBAC terminated a significant amount of reinsurance contracts as a result of either the financial instability of their reinsurers or certain multi-line reinsurers exiting the financial guarantee business. Since these are firm's "decision" to have their hedging "undone" we leave these values negative. Results are robust when we drop these four observations with negative reinsurance usage.

[20] Schedule DB Part A Section 2 provides information on Cost/Option Premium for options, caps, floors, and insurance futures options acquired during the year. Schedule DB Part B Section 2 provides information on Consideration Received for options, caps, floors, and insurance futures options written during the year. Schedule DB Part C Section 2 provides information on Cost or Consideration Received for collar, swap, and forwards. Schedule DB Part D Section 2 provides information on Net Additions to Cash Deposits for Futures Contracts and Insurance Futures Contracts.

Third, *Derivative Usage in Notional Amount* is the notional value of all derivative positions for hedging purposes acquired during the year scaled by total assets.[21]

Fourth, *Total Risk Management* is the ratio of the sum of derivative usage and reinsurance premiums ceded to non-affiliates scaled by total assets. This measure can be understood as the total firm expenditure on hedging instruments scaled by total assets.[22] Prior literature studying the effect of executive compensation on corporate risk management primarily examines derivatives as the only measure of firm risk management (Tufano, 1996; Knopf, Nam, and Thornton, 2002; Rogers, 2002; Bakke, Mahmudi, Fernando, and Salas, 2016). Moreover, these studies consider all derivative positions shown in the annual statement as hedging-driven. Our proxy *Total Risk Management* not only includes both insurance and derivative usage but also captures only hedging-driven usage of both instruments in quantifying a firm's hedging intensity. This provides us an inclusive and clean proxy of corporate risk management.

Table 1 shows the Pearson correlation matrix between our dependent variables measured in dollars. The correlation between *External Reinsurance Usage* and *Derivative Usage* and the correlation between *External Reinsurance Usage* and *Derivative Usage in Notional Amount* are both positive. This suggests that reinsurance and derivatives are complements. Thus, considering both reinsurance and derivatives is especially important in constructing a comprehensive measure of firm's hedging behavior.

[Insert Table 1 About Here]

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[21] Where the notional values for some of the derivatives are not provided, we estimate the notional values of these derivatives following the methodology by Cummins, Phillips, and Smith (1997). 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.

[22] In measuring derivative usage, we use cost instead of notional amount of derivative usage as notional amount is the amount of security's underlying asset at its spot price. To capture the amount of money spent on the transaction in order to have a consistent scale with reinsurance premiums, we use cost of derivative transactions.

4.2. Control Variables

4.2.1. Other managerial incentives

Prior literature often includes the sum of salary and bonus as a proxy for cash compensation (Guay, 1999b; Knopf, Nam, and Thornton, 2002; Rogers, 2002; Coles, Daniel, and Naveen, 2006). However, while salary provides a flat payoff structure (Doherty, 2000), bonus plans often provide a payoff structure that resembles a generic "call spread" (Kim, Nam, and Thornton, 2008; Eckles and Halek, 2010). In this paper, we separate these types of cash compensation as they may provide different implications for corporate risk management demand.

Bonus payoff structures often have both a convex and a concave region. Therefore, depending on which part of the payoff structure that managers face, managers have incentives to either increase or decrease firm risk in order to maximize their bonus payments. Kim, Nam, and Thornton (2008) indicate that the lower threshold (i.e. the first "strike price") introduces convexity and gives manager an incentive to take on more risk while the cap (i.e. the second "strike price") introduces concavity and gives a manager incentive to reduce risk and lock in the performance. Unfortunately, we do not have detailed information about each manager's bonus plan. Therefore, we interpret a negative relation between bonus and hedging usage to indicate managers facing a convex bonus payoff function and a positive relation to indicate managers facing a concave bonus payoff function. We define *Bonus* as the ratio of the amount of bonus compensation to total compensation.[23]

Salary is included to control for the manager's diversifiable wealth. We would expect to

[23] The Securities and Exchange Commission amended the reporting requirements of executive compensation for fiscal years ending on or after December 15, 2006 and some bonuses have been reclassified as nonequity incentive compensation. To obtain a consistent measure of our bonus variable across time, bonus is calculated as BONUS (from annual compensation) plus NON_EQ_TARG (from plan-based awards) (Hayes, Lemmon, and Qiu, 2012).

find a negative coefficient on salary since salary can be invested outside the company, giving managers the opportunity to diversify, mitigating their risk aversion (Guay, 1999b; Knopf, Nam, and Thornton 2002). *Salary* is defined as the ratio of salary to total compensation.

To control for the variation in manager-specific risk aversion and diversification of wealth, we include *Age*, the log of the CEO's age. Tufano (1996) suggests age as a proxy for the degree of risk aversion. Managers facing retirement may prefer to avoid risky investments to manage risk.

To control for managerial discretion, we include *InstitutionalHolding*, the ratio of the total number of shares owned by the institutional investors divided by the total number of shares outstanding. We expect firms with higher percentage of institutional ownership will be better monitored and therefore managers will be less entrenched and hedge less.

4.2.2. Value-maximizing motivations for hedging

Under perfect capital markets, a firm's risk reduction behavior is not beneficial to stockholders since shareholders can achieve their own desired levels of risk through portfolio diversification. Moreover, the adoption of projects that reduce the variance of the firm's income may adversely affect equity holders by transferring wealth from stockholders to bondholders. Prior literature attempts to explain corporate demand for hedging in the context of imperfect capital markets. Rationales as to why shareholders may hedge include expected bankruptcy costs, the underinvestment problem, and tax incentives (Mayers and Smith, 1990; Nance, Smith, and Smithson, 1993). We include variables to control for these effects, and we discuss these variables below.

Expected bankruptcy costs

Transactions costs arise when firms go bankrupt. Warner (1997) finds that bankruptcy costs are not proportional to size but are larger for smaller firms. To control for firm size, we include *Size* as the natural log of total admissible assets.[24]

Leverage is also a possible determinant of corporate hedging. A highly levered firm generally has a higher probability of bankruptcy (Carson and Hoyt, 1995) and firms can decrease the probability of bankruptcy by hedging. We define *Leverage* as the ratio of direct business written to surplus.

Underinvestment problem

Myers (1977) argues that risky debt may lead firms to forgo positive net present value projects because the benefits accrue to bondholders. Mayers and Smith (1987) suggest that hedging can alleviate this underinvestment problem by transferring the risk of large losses to a third party. Since highly levered firms are more likely to face the underinvestment problem, leverage is included as a control variable.

Tax incentives

Smith and Stulz (1985) suggest that due to the convex structure of the tax code, hedging can reduce the firm's expected tax liability by reducing the variance of income. We use two proxies. First, tax convexity is measured following Barton (2001) and Adams, Hardwick and Zou (2008).[25] *TaxConvexity* is the excess of the marginal tax rate over the annual effective tax rate (total tax expenses/annual taxable income). Second, we control for insurers' marginal tax rate

[24] Our results are robust when *Size* is measured with log of total admissible assets, and when Vega and Delta are measured with *LVega* and *LDelta*.

[25] Tax Convexity is measured as the excess of marginal tax rate over annual effective tax rate (total tax expenses/annual taxable income). The rationale for this method is that a convex structure of taxable income implies that marginal tax rates exceed average tax rates. A higher positive value implies higher tax convexity.

following Plesko (2003). *MarginalTaxRate* is a binary variable equal to the highest statutory rate, if there are no net operating loss carryforwards (prior year Compustat data item 52 equal to zero) and the firm reports positive pretax book income, and zero otherwise

4.2.3. Hedging substitute

Lin, Wen, and Yu (2012) suggest that geographic diversification, business diversification, insurance, and financial derivatives are commonly used risk management tools. We include variables for diversification, derivative usage, and insurance demand to control for their role in managing the overall risk of the firm.

Firms can reduce risk by diversifying their business. Carson, Elyasiani, and Mansur (2008) provide evidence that diversification decreases earnings volatility and makes well-diversified firms safer. Because insurance demand may have a positive relation to both business concentration and geographic concentration, we control for both in our examination of the demand for insurance. *GeoHHI* is the geographic Herfindahl index and *LineHHI* is the line-of-business Herfindahl index.

Berkman and Bradbury (1996) further suggest liquidity as a substitute for hedging. Firms with more liquid assets are expected to demand less insurance, since they have a larger financial buffer. Therefore, in our analysis of insurance demand, we also control for *Liquidity* as the ratio of liquid assets (sum of cash and shares) to total admissible assets.

Two conflicting views arise in determining the relation between insurance and derivatives. The first is the substitution hypothesis which argues that the goal of both insurance and derivatives is to reduce the variance of a firm's value and taxable income. Therefore, it is possible that insurance and derivatives may be used as substitutes to manage the overall risk exposure of the firm (Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 2001; Shiu, 2016). On the other hand, the complementary hypothesis suggests that a firm's use of insurance might simply show the firm's predisposition to hedge its risk (Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 2001; Shiu, 2016).

Two streams of literature empirically test these conflicting hypotheses. First, Colquitt and Hoyt (1997) and Cummins, Phillips, and Smith (2001) examine the impact of insurers' usage of insurance on insurer use of derivatives. Both studies find that the proportion of premiums ceded to reinsurers has a positive relation to derivative usage, providing support for the complementary hypothesis. On the other hand, Cummins and Song (2008) and Shiu (2016) consider the effects of insurance on derivative volume under a simultaneous equation framework. Both studies find a negative relation between insurance and derivatives, providing support for the substitution hypothesis. Thus, the findings on the relation between insurance and derivatives are mixed. We therefore include a firm's use of derivatives as a control variable in our estimation of insurance demand, and firm's demand for insurance as a control variable in our estimation of derivative usage.

The alternative risk management tools discussed above may be determined simultaneously, and Cummins and Song (2008) argue that they cannot be treated as exogenous. To address this possible endogeneity problem, we construct lags for hedging substitute variables.

4.2.4. Risk exposure

Systematic and nonsystematic risk

Smith (2008) argues that different types of risks are managed with different hedging instruments. When managers choose to hedge, they should adopt hedging instruments congruent with their firm's specific risk exposures. Market-wide (systematic) risks, such as exposure to interest rates, foreign exchange rates, or oil prices, can be managed with specialized derivative instruments.

On the other hand, insurance is employed to manage firm-specific (nonsystematic) risks (e.g., fire, theft, wind, etc.). Thus, managers of insurers with higher nonsystematic risk have greater incentives to demand more insurance.

Insurance is a mechanism for reducing insurer-specific nonsystematic risks. While insurers manage the nonsystematic risk, in part, by issuing many policies, this approach cannot completely diversify away the nonsystematic risk. Insurers can further reduce the remaining nonsystematic risk by purchasing reinsurance (Berger, Cummins, and Tennyson, 1992). Therefore, since firms with higher nonsystematic risk exposure likely demand more reinsurance, we control for the level of a firm's nonsystematic risk.

We therefore include systematic risk as a control variable in our estimation of derivative usage and nonsystematic risk as a control variable in our estimation of reinsurance demand.

Beta is measured by regressing the market risk premium on the total risk premium of company *i* as in Berndt (1991, pp. 34-35):

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_{i.t}(R_{M,t} - R_{f,t}) + \varepsilon_{i,t}, \qquad (1)$$

Following Zou, Adams, and Buckle (2003), we use *Nonsystematic* risk to proxy for firm specific risk (see also Copeland and Weston, 1992), as follows:

$$NONSYS_{i,t}^2 = \sigma_{i,t}^2 - \beta_{i,t}^2 \sigma_{M,t}^2, \qquad (2)$$

where $\sigma_{i,t}^2$ is the variance of firm *i*'s monthly stock returns for year t and $\sigma_{M,t}^2$ is the variance of the market index's monthly returns for year *t*. $\beta_{i,t}^2$ is the systematic risk of firm ***i*** in year *t*.

Catastrophe risk

Cummins and Song (2008) find that catastrophe exposure had a strong positive impact on insurer demand of reinsurance. We therefore control for catastrophe risk as we expect systematic differences across insurers that are / are not exposed to high catastrophe risk. *Catastrophe* is defined as the proportion of total premium written in lines potentially affected by catastrophes in catastrophe-prone states.[26]

The predicted signs and descriptions of all variables used in our analysis are summarized in Table 2.

4.3. Univariate Results

Table 3 shows descriptive statistics of the 310 observations in our sample. Panel A reports the summary statistics of firm characteristics and Panel B reports the summary statistics of managerial characteristics. The average value of reinsurance ceded to non-affiliates is approximately $534 million. The average value of derivative usage in expenditure is $10,759,280. Insurers in our sample are hedging more with reinsurance than with derivatives. Of 310 observations, 277 reported zero derivative usage.

[Insert Table 3 About Here]

[26] Catastrophe lines of insurance include farmowners multiple peril, homeowners multiple peril, commercial multiple peril, ocean marine, inland marine, and earthquake. Catastrophe prone states and catastrophe prone states include Alabama, California, Florida, Georgia, Hawaii, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina and Texas.

In Panel B, we provide the descriptive statistics of managerial characteristics. *Vega* and *Delta* are presented without the log transformation. The average CEO's wealth increases by $163,840 with a 1% increase in the firm's stock return volatility and by $1,164,669 with a 1% increase in stock price. For comparison, Chava and Purnanandam (2010) report that *Vega* has a mean of $97,000 and *Delta* has a mean of $607,00 for all firms covered in the Compustat database excluding financial and utility firms from 1993 to 2005. Higher values for *Vega* and *Delta* in our sample can be explained by companies utilizing option compensation more frequently than in the past (Knopf, Nam, and Thornton, 2002). Higher values can also be attributed to the focus on the insurance industry in our sample, as Skog (2009) notes that financial companies often make higher use of options compensation than firms in other industries. The mean value of annual bonuses earned relative to total compensation is 24 percent and the mean value of annual salary earned relative to total compensation is 25 percent.

5. Empirical Approach and Results

5.1. Baseline Regressions

We use the following baseline regression model to examine the relation between executive compensation and the firm's hedging behavior. The model is given as:

$$
\begin{aligned}
&External\ Reinsurance\ Usage_{i,t} \\
&\quad = \beta_0 + \beta_1 LVega_{i,t-1} + \beta_2 LDelta_{i,t-1} + \beta_3 Bonus_{i,t} + \beta_4 Salary_{i,t} \\
&\quad + \beta_5 InstitutionalHolding_{i,t} + \beta_6 Age_{i,t} + \beta_7 Nonsystematic_{i,t} + \beta_8 Catastrophe_{i,t} \\
&\quad + \beta_9 Size_{i,t} + \beta_{10} Leverage_{i,t} + \beta_{11} MarginalTaxRate_{i,t} + \beta_{12} TaxConvexity_{i,t} \\
&\quad + \beta_{13} GeoHHI_{i,t-1} + \beta_{14} LineHHI_{i,t-1} + \beta_{15} Derivative_{i,t-1} + \beta_{16} Liquidity_{i,t-1} + \nu_t + \varepsilon_{it}
\end{aligned} \tag{3}
$$

$$
\begin{aligned}
&Derivative\ Usage_{i,t} \\
&\quad = \beta_0 + \beta_1 LVega_{i,t-1} + \beta_2 LDelta_{i,t-1} + \beta_3 Bonus_{i,t} + \beta_4 Salary_{i,t} \\
&\quad + \beta_5 InstitutionalHolding_{i,t} + \beta_6 Age_{i,t} + \beta_7 Beta_{i,t} + \beta_8 Size_{i,t} + \beta_9 Leverage_{i,t} \\
&\quad + \beta_{10} MarginalTaxRate_{i,t} + \beta_{11} TaxConvexity_{i,t} + \beta_{12} GeoHHI_{i,t-1} + \beta_{13} LineHHI_{i,t-1} \\
&\quad + \beta_{14} ExternalReinsurance_{i,t-1} + \beta_{15} Liquidity_{i,t-1} + \nu_t + \varepsilon_{it}
\end{aligned} \tag{4}
$$

$$
\begin{aligned}
&Derivative\ Usage\ in\ Notional\ Amount_{i,t} \\
&\quad = \beta_0 + \beta_1 LVega_{i,t-1} + \beta_2 LDelta_{i,t-1} + \beta_3 Bonus_{i,t} + \beta_4 Salary_{i,t} \\
&\quad + \beta_5 InstitutionalHolding_{i,t} + \beta_6 Age_{i,t} + \beta_7 Beta_{i,t} + \beta_8 Size_{i,t} + \beta_9 Leverage_{i,t} \\
&\quad + \beta_{10} MarginalTaxRate_{i,t} + \beta_{11} TaxConvexity_{i,t} + \beta_{12} GeoHHI_{i,t-1} + \beta_{13} LineHHI_{i,t-1} \\
&\quad + \beta_{14} ExternalReinsurance_{i,t-1} + \beta_{15} Liquidity_{i,t-1} + \nu_t + \varepsilon_{it}
\end{aligned} \tag{5}
$$

$$
\begin{aligned}
&TotalRiskManagement_{i,t} \\
&\quad = \beta_0 + \beta_1 LVega_{i,t-1} + \beta_2 LDelta_{i,t-1} + \beta_3 Bonus_{i,t} + \beta_4 Salary_{i,t} \\
&\quad + \beta_5 InstitutionalHolding_{i,t} + \beta_6 Age_{i,t} + \beta_7 Nonsystematic_{i,t} + \beta_8 Catastrophe_{i,t} + \beta_9 Beta \\
&\quad + \beta_{10} Size_{i,t} + \beta_{11} Leverage_{i,t} + \beta_{12} MarginalTaxRate_{i,t} + \beta_{13} TaxConvexity_{i,t} \\
&\quad + \beta_{14} GeoHHI_{i,t-1} + \beta_{15} LineHHI_{i,t-1} + \beta_{16} Liquidity_{i,t-1} + \nu_t + \varepsilon_{it}
\end{aligned} \tag{6}
$$

We utilize an OLS regression with standard errors clustered at the firm level. We lag *Vega* and *Delta* to minimize endogeneity concerns that could result from the joint determination of firm policies and managerial incentives. We do not lag bonus and salary as these are contemporaneous variables. The subscript *i* represents the individual insurers, while the subscript *t* represents the year (2000 to 2009).[27] υ_t is the firm-invariant period-specific effects that capture the time-related changes.

[Insert Table 4 About Here]

Table 4 shows the results for our OLS estimation. The coefficient on *LVega* is negative and significant at the 1% significance level when the dependent variable is *Total Risk Management* or *External Reinsurance Usage*. This supports the Offsetting Concavity Hypothesis. More specifically, a 1% increase in *Vega* is associated with a 0.5% decrease in *External Reinsurance* and *Total Risk Management*. Managers with higher *Vega* demand less hedging because the value of a managers' wealth increases with higher stock return volatility. In addition, the coefficient on *LDelta* is positive and significant at the 5% significance level when the dependent variable is *Total Risk Management* or *External Reinsurance*. This provides evidence that when managers have an incentive to decrease firm risk, they demand more hedging. More specifically, a 1% increase in *Delta* is associated with 0.4% increase in *Total Risk Management* and *External Reinsurance Usage*.

These results are statistically and economically significant. It is important to note that our dependent variables *Total Risk Management or External Reinsurance Usage* are scaled by total assets. With median assets in our sample of approximately $10 billion, this translates into an average of $50 million less spending on hedging expenditure with 1% increase in *Vega* and an

[27] We do not use firm fixed effects in our model because our measures of CEO compensation show relatively little within-firm variation and significantly larger between-firm variation. That is, most of the variation arises in the cross section rather than in the time series. In our sample, the correlation between Vega and its lagged value is 79% and the correlation between Delta and its lagged value is 81%. Zhou (2001) points out that if the explanatory variables change slowly over time, firm fixed-effect regressions may fail to detect relationships in data even when they exist. Thus, firm fixed effects likely are an inadequate specification for this empirical context.

average of $40 million more spending on expenditure with 1% increase in *Delta*.[28] With median corporate risk management expenditure of about $176 million in our sample, this translates into 28% ($50M/$176M) less spending on total hedging expenditures with a 1% increase in *Vega* and an average of 23% ($40M/$176M) more spending on hedging expenditure with 1% increase in *Delta*. Thus, managerial incentives have a significant impact on corporate hedging policy.

The coefficient on *Nonsystematic* is positive and significant. This finding suggests that managers of firms with higher nonsystematic risk exposure demand more reinsurance. The coefficient on *Derivative Usage* is positive and significant when the dependent variable is *External Reinsurance Usage*. This confirms our findings in Table 2 showing that derivatives and reinsurance are complements after controlling for other possible determinants.

5.2. Difference-in-Differences Approach

5.2.1. Endogenous choice of managerial compensation

Corporate decisions, including executive compensation and corporate hedging, are made simultaneously. For instance, Aggarwal and Samwick (1999) note that managers of riskier firms may require lower pay-performance sensitivity. This increases the difficulty to establish causality between CEO compensation and hedging. In our analysis thus far, we lag *Vega* and *Delta*, which is expected to reduce possible endogeneity concerns. However, to overcome the endogeneity concern in a more direct way, we utilize the implementation of FAS 123R as an exogenous shock to the use of equity-based compensation.

[28] It can be calculated as 10,000,000,000,000*0.005= 50,000,000,000 and 10,000,000,000,000*0.004= 40,000,000,000.

Effective starting in 2005, the Financial Accounting Standards Board (FASB) issued FAS 123R, changing the accounting treatment of stock-based compensation. Prior to the implementation of FAS 123R, firms could expense executive stock options in either of two ways. First, firms could expense stock options at their intrinsic value (the difference between the market price of the stock and the exercise price) on the measurement date. Because most firms grant stock options at-the-money, no expenses for option-based compensation were reported on the income statement. Alternatively, firms could expense stock options using the fair value method. This approach required firms to charge the cost of stock options on the grant date based on an option valuation model such as Black and Scholes. Thus, prior to FAS 123 R, nearly all firms employed the intrinsic value method (Bakke, Mahmudi, Fernando, and Salas, 2016).

The implementation of FAS 123R in 2005 required all firms to begin expensing stock-based compensation at its fair value, significantly increasing the explicit cost of granting stock options. As would be expected, prior literature finds a significant decrease in usage of stock options after the adoption of FAS 123R (Hayes, Lemmon, and Qiu, 2012; Bakke, Mahmudi, Fernando, and Salas, 2016).

FAS 123R became effective beginning from June 15, 2005 for large public firms. In our empirical design, we use a difference-in-differences (DID) methodology, and we exclude 2005 to ensure that firms are not in the process of transition (Mao and Zhang, 2018). We define 2001-2004 as the pre-FAS 123R period and 2006-2009 as the post-FAS 123R period, balancing our pre- and post- periods. In the DID analysis, we include only firms that have at least one year of data in both pre- and post-treatment periods.

We define two categories of firms as our control group, following Bakke, Mahmudi, Fernando, and Salas (2016). The first group are firms that did not grant any options to their

CEOs in the pre-treatment period. This group is not affected by the regulation change since these firms do not have any options granted to be expensed differently. The second group consists of firms that voluntarily expensed the fair value of executive stock options on or before 2000.[29] We identify these firms using Bear Stearns Equity Research (McConnell, Pegg, Mott, and Senyek, 2004). Firms in this group are not impacted as they already implemented fair value method before FAS 123R. We use the combined group as our control group, and the remaining firms as the treatment group. The DID specification is given as:

$$Risk\ ManagementIntensity_{i,t} = \alpha + \beta Treatment_i + \gamma Post_t + \theta Post_t * Treatment_i + \delta Controls_{i,t} + \varepsilon_{it}. \quad (7)$$

The subscript *i* represents the individual insurers; the subscript *t* represents the year (2001 to 2009); *Risk Management Intensity* represents our four proxies including *External Reinsurance Usage*, *Derivative Usage*, *Derivative Usage in Notional Amount* and *Total Risk Management*; *Treatment* is a dummy variable that equals 1 if the firm belongs to the treatment group and zero otherwise; *Post* is a dummy variable that equals 1 after the event of FAS 123R and 0 otherwise; *Controls* is a vector of control variables as defined above. When the dependent variable is *External Reinsurance Usage*, we do not include *Derivative Usage* as a control variable, and when the dependent variable is *Derivative Usage*, we do not include *External Reinsurance* as a control variable. We expect event FAS 123R to negatively impact firm's option grants, leading

[29] The reason we consider the second group of firms that voluntarily expensed the fair value of executive stock options on or before 2000 instead of 2004 is to rule out the possibility that firms are in transition period of their compensation leading to the change in corporate policy (Bakke, Mahmudi, Fernando, and Salas, 2016).

to more hedging. Therefore, *External Reinsurance Usage* and *Derivative Usage* are both influenced by the treatment.[30] Standard errors are clustered at the firm level.

Our variable of interest is θ and we expect θ to be positive. As treated firms are affected by FAS 123R, they will reduce the option grants in CEO compensation due to the increased cost. The decreased convexity will reduce the managerial incentives to take more risk and therefore we expect managers will increase their hedging.

We first check whether treated firms changed their CEO compensation structure relative to the control group following the FAS 123R. In doing so, we investigate whether treated firms decreased the use of option grants. We also analyze whether treated firms changed their cash compensation in response to a change in option grants. Table 5 shows the DID regression results with current fiscal year's *Vega*, *Delta, Bonus, and Salary* as the dependent variable. Columns 1, 4, 7, and 10 are specifications with neither control variables nor firm or year fixed effects; columns 2, 5, 8, and 11 are with control variables; and columns 3, 6, 9, and 12 are with both control variables and firm and year fixed effects. The estimated coefficient of interest is *Post*Treatment*. The results in the first three columns consistently show that treated firms significantly reduced *Vega* after the regulation. The results in column 4 through 6 and 10 through 12 uniformly show that firms in the treated group did not make significant change to *Delta* and *Salary* after FAS 123R. The results in column 5 through 7 show some evidence that treated firms increased *Bonus* after the regulation. In sum, Table 4 shows that the FAS 123R reduced *Vega* and in return substituted it with an increase in *Bonus* in CEO compensation.

[30] Including either External Reinsurance, or Derivative, as a control variable violates the exogeneity assumption where the controls are not influence by the treatment. Including endogenous variable will estimate only part of the causal effect that is not already captured by the other endogenous variable (Lechner, 2010).

[Insert Table 5 About Here]

Now we examine whether FAS 123R led to an increase in insurers' risk management intensity via its negative shock to *Vega*. Table 6 shows the DID regression results with four measures of risk management intensity on the dependent variable. The coefficients on *Post*Treatment* are positive and significant at the 1% level throughout different specifications when the dependent variable is *Total Risk Management* and *External Reinsurance Usage*. When we examine column 2, the coefficient on *Post*Treatment* is 46.382. This suggests that *Total Risk Management* increased by 4.6% of total assets in treated firms relative to control firms in the Post period. When the dependent variable is *Derivative Usage* and *Derivative Usage in Notional Amount*, the coefficient is also positive but not statistically significant at conventional levels. Overall, these results show that the decline in *Vega* due to FAS 123R led mangers to increase their corporate hedging, primarily via insurance demand. This is consistent with the result found in Table 4.

[Insert Table 6 About Here]

5.2.2. Parallel trends assumption

The key identifying assumption in DID estimators is the "parallel trend" assumption. In the absence of treatment, the average change in the outcome variable would be the same across treatment and control firms. It is not possible to directly test the parallel trends assumption here because we cannot observe the counterfactual. Thus, we conduct a series of tests to examine whether the parallel trends assumption is reasonable, as suggested by Roberts and Whited (2012).

First, we check whether there was a significant difference between our treatment and control group in the trend of hedging before FAS 123R. That is, we estimate the following model using individual year indicator and interaction variables (Bertrand and Mullainathan, 2003):

$$\begin{aligned} HedgingIntensity_{i.t} &= \alpha + \beta Treatment_i + \gamma_1 Yr2002_t + \gamma_2 Yr2003_t + \gamma_3 Yr2004_t + \gamma_4 Yr2006_t + \gamma_5 Yr2007_t \\ &+ \gamma_6 Yr2008_t + \gamma_7 Yr2009_t + \theta_1 Treatment_i * Yr2002_t + \theta_2 Treatment_i * Yr2003_t \\ &+ \theta_3 Treatment_i * Yr2004_t + \theta_4 Treatment_i * Yr2006_t + \theta_5 Treatment_i * Yr2007_t \\ &+ \theta_6 Treatment_i * Yr2008_t + \theta_7 Treatment_i * Yr2009_t + \tau_i + \varepsilon_{i,t}, \end{aligned} \tag{8}$$

In equation (7), the interactions of *Treatment* and each of the post-FAS 123R years (i.e., θ_4, θ_5, θ_6, θ_7) are our variables of interest. We expect them to be significantly positive if the passage of FAS 123R has a persistent effect on corporate hedging of treated firms relative to control firms. In addition, if the parallel trends assumption is satisfied, we expect the coefficients θ_1,θ_2, θ_3 to be insignificant. Standard errors are clustered at the firm level.

Table 7 shows the results of model (7). Coefficients on the interaction of treatment and year 2006 are positive and generally statistically significant. The regression result indicates that treated firms that did not expense options at fair value before FAS 123R significantly increased hedging intensity in 2006 compared with firms that did not use options or expense their options voluntarily prior to FAS 123R. As well, coefficients on the interaction of treatment and pre-FAS 123R years are not statistically significant, indicating that the parallel trends assumption is satisfied.

[Insert Table 7 About Here]

Second, we conduct several placebo (falsification) tests. The first placebo test falsely assumes that the shock occurred one prior to the actual event (Almeida, Campello, and Laranjeira, and Weisbenner, 2012). When we assume that treatment occurred one year prior to the actual event, 2000-2003 is the pre-treatment period and 2005-2008 is the post-treatment period. The second placebo test uses an alternative control group. So far, we have defined the second control group as firms that voluntarily expensed the fair value of executive stock options on or before 2000. We now construct the second control group as firms that voluntarily expensed the fair value of executive stock options on or before 2005. In all tests, the specification is identical to our baseline specification in Table 6.

In Table 8, the coefficient estimates on *Post*Treatment* are not statistically significant throughout specifications across all panels. The results support that the parallel trends assumption holds. Our treatment effect is unique to FAS 123R and there is no treatment effect at times when there was no treatment.

[Insert Table 8 About Here]

6. Summary and Conclusions

We exploit data from the U.S. insurance industry to investigate managerial incentives via executive compensation and corporate hedging. The measures of corporate risk management decisions examined in this paper are cleaner and more complete measures than those used in previous studies. We consider both derivative and insurance usage in quantifying firms' hedging behavior. Further, we not only broadly consider insurance and derivatives, we identify insurance and derivative positions specifically utilized for hedging purposes by eliminating intragroup insurance purchases and derivative positions that were made for trading purposes. Thus, we include only hedging positions in measuring the extent of insurance and derivative usage, allowing us to provide the most inclusive and cleanest test of corporate hedging in the literature.

We find a significant relation between a CEO's risk-taking incentives and corporate hedging demand. Controlling for other possible determinants of hedging, we find that firms hedge 0.498% less with 1% increases in the sensitivity of a manager's stock and stock option portfolio to stock return volatility, and that firms hedge 0.441% more with 1% increases in sensitivity of a manager's stock and stock option portfolio to stock price. With median assets of approximately $10 billion in our sample, this translates into an average of $49.8 million less spending on total hedging expenditures with a 1% increase in the sensitivity of a manager's stock and stock option portfolio to stock return volatility, and an average of $44.1 million more spending on hedging expenditure with 1% increase in sensitivity of a manager's stock and stock option portfolio to stock price. When we analyze insurance and derivatives separately, we find an average of $47.8 million less spending on insurance with a 1% increase in the sensitivity of a manager's stock and stock option portfolio to stock return volatility and an average of $43.4 million more spending on insurance with 1% increase in sensitivity of a manager's stock and stock option portfolio to stock price. However, we do not find a significant relation between managerial incentives and firm's derivative usage.

To further establish causality between managerial incentives and corporate hedging, we utilize a 2005 regulation that changed the accounting treatment of stock-based compensation as an exogenous shock (Bakke, Mahmudi, Fernando, and Salas, 2016). Using a difference-in-differences (DID) analysis, we find that the decline in the convexity of executive compensation led firms to increase their hedging, primarily through increased insurance demand.

Our findings imply that managerial incentives have a significant impact on insurance demand but not on derivative usage. This shows that when risk averse managers underinvest and reduce risk in a suboptimal manner, they utilize insurance rather than derivatives.

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Figure 1. Purpose of Derivative Transaction

This figure reports the relative proportion of cost of derivative usage (hedging or speculation) for our sample. Costs are for derivative positions acquired during the year.

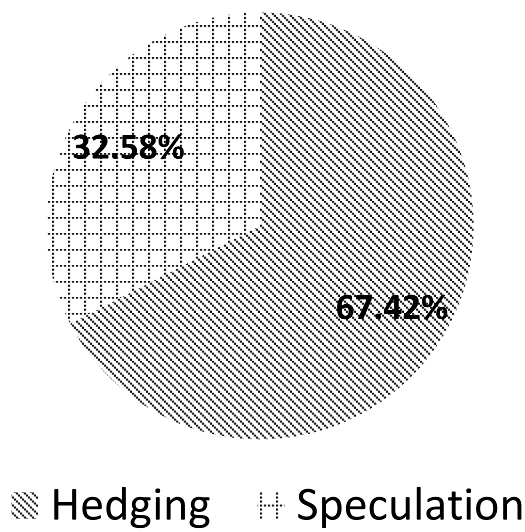

Table 1. Correlation Matrix between Hedging Activities

This table reports Pearson correlation matrix between our dependent variables measured in dollar amount. *External Reinsurance Usage* is reinsurance premiums ceded to non-affiliates. *Derivative Usage* is cost of all derivative positions for hedging purpose acquired during the year. *Derivative Usage in Notional Amount* is notional amount of all derivative positions for hedging purpose acquired during the year. *Total Risk Management* is the sum of *External Reinsurance* and *Derivative Cost*.

	(1)	(2)	(3)
(1) *External Reinsurance Usage*			
(2) *Derivative Usage*	0.146***		
(3) *Derivative Usage in Notional Amount*	0.329***	0.618***	
(4) *Total Risk Management*	0.997***	0.217***	0.371***

Table 2. Variable Definitions

Variables	Predicted Sign	Description
Dependent Variables		
External Reinsurance Usage		Ratio of reinsurance premiums ceded to non-affiliates over direct business written plus reinsurance assumed from non-affiliates
Derivative Usage		Ratio of cost of all derivative positions for hedging purposes acquired during the year to total assets
Derivative Usage in Notional Amount		Ratio of notional value of all derivative positions for hedging purposes acquired during the year to total assets
Total Risk Management		Ratio of sum of cost of derivative usage and reinsurance premiums ceded to non-affiliates scaled by total assets
Variables of Interest		
LVega	+/-	Log (1+partial derivatives of the dividend-adjusted Black-Scholes equation with respect to annual standard deviation of stock returns)
LDelta	+	Log (1+partial derivative of the dividend-adjusted Black-Scholes equation with respect to stock price)
Control Variables		
Bonus		Ratio of bonus to total compensation
Salary		Ratio of salary to total compensation
Institutional Holding		Percentage of common shares owned by institutional investors.
Age		Log (Age of CEO)
Beta		Equation (1)
Nonsystematic		Equation (2)
Catastrophe risk		Percentage of total premium written in catastrophes affected lines (farmowners multiple peril, homeowners multiple peril, commercial multiple peril, ocean marine, inland marine, and earthquake) in Alabama, California, Florida, Georgia, Hawaii, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina and Texas
Size		Natural logarithm of total admissible asset
Leverage		Direct business written to surplus
Marginal tax rate		Binary variable equal to statutory rate if there are no net operating loss carryforwards (prior year Compustat data item 52 equal to zero) and the firm reports positive pretax book income, zero otherwise
Tax convexity		Excess of marginal tax rate over annual effective tax rate (total tax expenses/annual taxable income)
GeoHHI		Geographic Herfindahl index
LineHHI		Line-of-business Herfindahl index
Derivative		Ratio of notional amount of derivative positions for hedging purpose held at year end to total assets
Liquidity		Ratio of sum of cash and stock to total admitted assets

Table 3. Descriptive Statistics

This table presents descriptive statistics of 310 firm-year observations over the years 2000 through 2009. Panel A reports the summary statistics of firm characteristics. Panel B reports the summary statistics of managerial characteristics.

Variables	Mean	Standard deviation	Min	25th Percentile	50th Percentile	75th Percentile	Max
Panel A: Firm characteristics							
Total Risk Management ($000)	545,673.160	997,482.489	-800.424	72,968.448	175,611.960	492,867.200	5,929,371.648
Derivative Usage in Expenditure ($000)	10,759.280	59,682.058	0.000	0.000	0.000	0.000	472,223.200
Derivative Usage in Notional Amount ($000)	1,197,129.615	4,831,341.353	0.000	0.000	0.000	0.000	32,446,707.712
External Reinsurance ($000)	533,559.091	986,301.001	-800.424	72,968.446	169,325.276	484,080.510	5,929,371.880
Total Hedge Ratio	0.026	0.029	0.000	0.006	0.015	0.040	0.149
Derivative Usage in Expenditure Ratio	0.000	0.002	0.000	0.000	0.000	0.000	0.019
Derivative Usage in Notional Amount Ratio	0.012	0.047	0.000	0.000	0.000	0.000	0.304
External Reinsurance Usage Ratio	0.026	0.029	0.000	0.006	0.015	0.038	0.149
GeoHHI	0.135	0.188	0.037	0.048	0.065	0.119	1.000
LineHHI	0.387	0.325	0.082	0.133	0.248	0.498	1.000
Liquidity	0.165	0.115	0.014	0.083	0.140	0.211	0.532
Nonsystematic	0.007	0.021	0.000	0.001	0.002	0.004	0.156
Catastrophe	2.118	2.179	0.000	0.000	1.473	3.571	8.501
Size	22.435	1.265	19.811	21.575	22.305	23.170	25.326
Leverage	1.439	0.640	0.231	0.986	1.428	1.824	3.593
Marginal tax rate	0.252	0.158	0.000	0.000	0.350	0.350	0.350
Tax Convexity	0.009	0.275	-0.929	-0.164	0.056	0.143	0.898
Institutional Holding	72.777	19.774	20.552	61.117	74.974	88.502	100.000
Panel B: Managerial characteristics							
Vega ($000)	163.840	198.340	0.000	23.770	99.039	214.045	926.422
Delta ($000)	1,164.669	3,328.622	3.802	120.658	336.466	866.681	26,426.783
Bonus	0.239	0.205	0.000	0.089	0.222	0.317	1.157
Salary	0.250	0.197	0.000	0.099	0.192	0.351	0.935
Age	57.210	7.719	43.000	52.000	56.000	61.000	84.000

Table 4. Results from OLS Estimation of Equation (1)

This table reports the results of ordinary least squares (OLS) regressions that estimate the relationship between managerial risk-taking incentive and hedging behavior. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. (For reading convenience, dependent variables are

Independent Variables	Predicted Sign	*Total Risk Management*	*External Reinsurance Usage*	*Derivative Usage*	*Derivative Usage in Notional Amount*
LVega	+/-	-4.981***	-4.780***	-0.145	2.139
		(1.672)	(1.674)	(0.097)	(2.082)
LDelta	+	4.407**	4.341**	0.084	-6.420
		(2.083)	(1.977)	(0.112)	(4.895)
Nonsystematic		175.269**	147.013*		
		(87.065)	(84.635)		
Catastrophe		1.617	1.872		
		(2.786)	(2.816)		
Beta		-1.333		0.083	1.257
		(1.943)		(0.119)	(3.268)
External Reinsurance Usage				0.000	0.000
				(0.000)	(0.000)
Derivative Usage			0.001**		
			(0.001)		
Constant		221.651*	240.789*	-5.563	-478.411*
		(127.566)	(126.982)	(5.184)	(281.627)
Observations		310	310	310	310
R-Squared		0.345	0.358	0.110	0.224

scaled up by a thousand.)

Table 5. Effect of FAS 123R on CEO compensation

This table reports the results of difference-in difference (DID) regression that analyzes CEO compensation for treated firms compared to the control firms following the FAS 123R. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	LVega			*LDelta*			*Bonus*			*Salary*		
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
*Post*Treatment*	-3.909***	-3.578**	-2.903***	1.846	0.151	-0.658	0.261**	0.189	0.130	0.108	0.007	0.199
	(1.099)	(1.558)	(0.714)	(1.144)	(1.309)	(1.309)	(0.114)	(0.115)	(0.133)	(0.175)	(0.183)	(0.164)
Post	2.745**	2.595		-2.495**	-0.691		-0.168	-0.113		-0.067	0.041	
	(1.054)	(1.540)		(1.118)	(1.292)		(0.104)	(0.114)		(0.173)	(0.186)	
Treatment	3.616***	3.140*		-1.862***	-0.873		-0.053	0.006		-0.292***	-0.173	
	(1.110)	(1.545)		(0.436)	(0.708)		(0.094)	(0.094)		(0.094)	(0.118)	
Constant	1.145	-6.667	45.206*	7.789***	- 22.437***	2.419	0.255***	-0.822	2.476	0.516***	1.558**	2.324
	(1.085)	(8.010)	(26.151)	(0.350)	(7.897)	(18.580)	(0.092)	(0.618)	(3.787)	(0.090)	(0.732)	(2.742)
Year and firm fixed effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
R-squared	0.204	0.541	0.796	0/095	0/483	0.811	0.066	0.189	0.480	0.101	0.471	0.723
Observations	219	219	219	219	219	219	219	219	219	219	219	219

Table 6. Results from DID Estimation

This table reports the results of difference-in difference (DID) regression that analyzes firm's hedging behavior for treated versus control group following FAS 123R. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. (For reading convenience, dependent variables are scaled up by a thousand.)

	Total Risk Management			*External Reinsurance Usage*			*Derivative Usage*			*Derivative Usage in Notional Amount*		
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
*Post*Treatment*	41.198**	46.382***	38.543***	40.744**	45.521***	36.791***	0.453	1.013	1.521	3.862	19.190	3.463
	(15.072)	(14.126)	(8.964)	(15.059)	(13.709)	(8.845)	(0.287)	(0.667)	(1.000)	(8.774)	(22.202)	(42.119)
Post	-48.271***	-55.587***		-48.271***	-55.088***		0.000***	-0.759		2.854	-29.449	
	(14.446)	(14.856)		(14.446)	(14.511)		(0.000)	(0.585)		(2.489)	(23.151)	
Treatment	-51.269**	-45.353**		-51.511**	-44.710**		0.242	-0.215		14.073*	-11.210	
	(19.895)	(18.592)		(19.880)	(18.642)		(0.228)	(0.777)		(7.047)	(12.805)	
Constant	79.763***	435.900**	1,290.827***	79.763***	452.249**	1,266.264***	-0.000***	-3.193	17.647	-0.000	-680.141	1,085.813
	(18.769)	(178.441)	(238.268)	(18.769)	(178.096)	(236.696)	(0.000)	(4.454)	(29.126)	(0.000)	(426.717)	(786.695)
Year and firm fixed effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
R-Squared	0.117	0.411	0.921	0.122	0.424	0.924	0.014	0.154	0.432	0.008	0.244	0.775
Observations	219	219	219	219	219	219	219	219	219	219	219	219

Table 7. Hedging intensity by year

This table reports results of test examining the difference between the treatment and control group in the trend of hedging by year. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. (For reading convenience, dependent variables are scaled up by a thousand.)

Independent Variables	Predicted Sign	*Total Risk Management* (1)	*External Reinsurance Usage* (2)	*Derivative Usage* (3)	*Derivative Usage in Notional Amount* (4)
Treatment		-106.832***	-108.349***	1.516***	148.346***
		(26.856)	(26.840)	(0.423)	(12.970)
Yr2002		-11.114	-11.114	-0.000***	-0.019
		(26.657)	(26.657)	(0.000)	(0.015)
Yr2003		-16.871	-16.871	-0.000***	-0.019
		(26.657)	(26.657)	(0.000)	(0.015)
Yr2004		-28.997	-28.997	-0.000***	-2.355
		(24.324)	(24.324)	(0.000)	(2.193)
Yr2006		-74.522***	-74.522***	-0.000	0.019
		(26.657)	(26.657)	(0.000)	(0.015)
Yr2007		-59.192	-59.192	-0.000***	-2.355
		(37.212)	(37.212)	(0.000)	(2.193)
Yr2008		-58.272	-58.272	-0.000***	-2.355
		(37.785)	(37.785)	(0.000)	(2.193)
Yr2009		-56.323	-56.323	-0.000***	7.158
		(36.460)	(36.460)	(0.000)	(6.579)
Treatment Yr2002*		15.332	15.700	-0.368	-18.250
		(26.878)	(26.881)	(0.413)	(14.464)
Treatment Yr2003*		19.358	19.813	-0.455	-17.566
		(26.727)	(26.725)	(0.448)	(14.687)
Treatment Yr2004*		27.083	27.528	-0.445	-13.334
		(24.579)	(24.557)	(0.486)	(14.920)
Treatment Yr2006*	+	67.522**	67.358**	0.164	-17.080
		(27.073)	(27.071)	(0.231)	(13.560)
Treatment Yr2007*	+	53.732	53.517	0.215	-10.497
		(37.629)	(37.591)	(0.930)	(15.915)
Treatment Yr2008*	+	53.233	53.145	0.088	-4.716
		(38.159)	(38.120)	(0.810)	(19.056)
Treatment Yr2009*	+	49.328	49.466	-0.137	-14.490
		(36.936)	(36.894)	(0.812)	(20.567)
Constant		116.085***	116.085***	0.000	-0.019
		(26.657)	(26.657)	(0.000)	(0.015)
Firm fixed effects		Yes	Yes	Yes	Yes
R-squared		0.845	0.851	0.341	0.742
Observations		219	219	219	219

Table 8. Placebo dates and placebo control group

This table reports the results of placebo tests assuming that the event occurred either one year prior to the actual event or using an alternative control group. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. (For reading convenience, dependent variables are scaled up by a thousand.)

Panel A: Placebo date												
	Total Risk Management			*External Reinsurance Usage*			*Derivative Usage*			*Derivative Usage in Notional Amount*		
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			
*Post*Treatment*	-7.273	-3.218	1.686	-7.064	-3.097	0.935	0.033	0.055	0.287	2.205	10.602	34.624
	(6.067)	(9.737)	(9.336)	(5.943)	(9.154)	(8.972)	(0.317)	(0.485)	(0.672)	(7.212)	(16.243)	(27.628)
Post	-1.861	-6.991		-1.861	-7.746		0.000	-0.406		-0.000	-18.945	
	(3.174)	(9.657)		(3.174)	(9.147)		(0.000)	(0.626)		(0.000)	(16.147)	
Treatment	-5.157	4.515		-5.913	5.064		0.515	-0.236		15.593**	-18.581	
	(17.254)	(20.239)		(17.192)	(19.831)		(0.412)	(0.539)		(6.981)	(17.507)	
Constant	37.375**	212.975	1,255.741*	37.375**	231.487	1,165.146*	-0.000	-6.440	42.970	0.000	-411.018*	1,493.464*
	(15.359)	(137.546)	(318.007)	(15.359)	(140.726)	(345.937)	(0.000)	(8.323)	(34.614)	(0.000)	(222.285)	(721.948)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year and firm fixed effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
R-Squared	0.025	0.387	0.905	0.025	0.392	0.906	0.003	0.117	0.516	0.007	0.187	0.712
Observations	219	219	219	219	219	219	219	219	219	219	219	219

Panel B: Placebo control group												
	Total Risk Management			*External Reinsurance Usage*			*Derivative Usage*			*Derivative Usage in Notional Amount*		
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			
*Post*Treatment*	-5.056	-4.653	2.529	-5.606	-4.876	1.587	0.550	0.736	-6.320	-6.233	-20.468	-5.056
	(8.818)	(8.014)	(5.097)	(8.705)	(7.811)	(4.970)	(0.525)	(0.714)	(14.903)	(14.077)	(16.847)	(8.818)
Post	-7.152*	-9.138		-7.295*	-9.341*		0.143		8.902	-7.006		-7.152*
	(3.939)	(5.521)		(3.849)	(5.444)		(0.210)		(12.122)	(15.600)		(3.939)
Treatment	14.670	4.210		15.048	4.168		-0.379		10.105	27.833		14.670
	(13.286)	(10.536)		(13.207)	(10.374)		(0.398)		(13.766)	(18.821)		(13.286)
Constant	24.822***	298.409	1,335.784*	24.416***	315.704*	1,313.292*	0.406	15.489	8.401*	-835.709*	1,186.572	24.822***
	(7.102)	(178.457)	(405.275)	(6.953)	(179.009)	(392.681)	(0.398)	(31.564)	(4.778)	(469.346)	(819.438)	(7.102)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year and firm fixed effects	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
R-Squared	0.067	0.361	0.905	0.071	0.374	0.909	0.014	0.432	0.007	0.270	0.781	0.067
Observations	219	219	219	219	219	219	219	219	219	219	219	219