The Causal Effect of Option Pay on Corporate Risk Management*

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Abstract

This study provides strong evidence of a causal effect of risk-taking incentives provided by option compensation on corporate risk management. We utilize the passage of FAS 123R, which required firms to expense options, to investigate how CEO option compensation affects the hedging behavior of oil and gas firms. Firms that did not expense options before FAS 123R significantly reduced option pay, which resulted in a large increase in their hedging intensity compared to firms that did not use options or expensed their options voluntarily prior to FAS 123R.

JEL Classification: G30; G32; G38; G39

Keywords: Corporate risk management, FAS 123R, oil and gas firms, managerial compensation, executive stock options.

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1. Introduction

The 1990s experienced an explosion in the use of stock options in executive pay packages (Murphy (1999)), and options-based pay has represented a significant proportion of executive compensation ever since. The rationale for managerial option compensation is based on the premise that an increase in convexity of the pay-to-performance relation helps overcome managerial risk aversion and align interests of executives with those of shareholders (Jensen and Meckling (1976)). Unlike diversified shareholders, the undiversified wealth portfolios and firm-specific human capital of managers can make them risk averse, leading them to forgo risky positive net present value (NPV) projects. The convex payoff of stock options purportedly provides managers with incentives to take more risk.[1] However, the extensive empirical literature on this relation has failed to settle whether and how stock option compensation alters managerial risk attitudes.[2] This study helps resolve this open research question in the managerial compensation literature while making an important contribution to the corporate risk management literature by providing strong causal evidence in support of the managerial risk aversion motive for corporate hedging (Smith and Stulz (1985)).

Establishing causality between option pay and managerial risk-taking is difficult because empirical measures of executive risk-taking behavior and option pay are usually endogenously determined. For example, firms with risk-averse boards may choose to compensate managers with fewer options and simultaneously encourage the use of derivatives to mitigate risk. Alternatively, due to manager-firm matching in the labor market, more risk-averse managers

[1] The theoretical literature underlying the premise that stock options enhance risk-taking incentives is not unequivocal; option compensation can also motivate taking less risk, depending on the risk aversion coefficient of the CEO and the moneyness of the option. See, for example, Lambert, Larcker, and Verrecchia (1991), Carpenter (2000), Ross (2004), Tian (2004), Braido and Ferreira (2006), and Ju, Leland, and Senbet (2012).

[2] See, for example, Guay (1999), Cohen, Hall, and Viceira (2000), Knopf, Nam, and Thornton (2002), Rajgopal and Shevlin (2002), Chen, Steiner, and Whyte (2006), Coles, Daniel, and Naveen (2006), Lewellen (2006), Brockman, Martin, and Unlu (2009), Dong, Wang, and Xie (2010), Chava and Purnanandam (2010), Hayes, Lemmon and Qiu (2012) and Gormley, Matsa and Milbourn (2013).

who hedge more could work for firms that award fewer options to their executives. Thus, drawing a causal inference between option pay and risk-taking incentives is not straightforward, and any empirically documented association between option compensation and risk-taking could be spurious.

To overcome these endogeneity concerns, this paper examines the relation between option compensation and risk-taking (corporate hedging), utilizing the quasi-natural experiment created by the 2005 mandate that firm comply with FAS 123R. This new regulation required firms to expense executive stock options at fair value, and resulted in a significant cutback in option pay thereby reducing the sensitivity of CEO's wealth to stock return volatility (vega). Using a difference-in-differences (DID) methodology, we find that the reduction in option pay by firms that were affected by FAS 123R results in a significant increase in their hedging intensity compared to similar firms that were unaffected by FAS 123R. The sharp change in compensation that arises from FAS 123R does not change the risk management incentives of shareholders but potentially changes the risk-taking incentives of executives affected by the compensation change. Therefore, this setting allows us to examine the causal relation between stock option compensation and corporate risk management.

We use a unique hand-collected dataset on the hedge positions of firms from the oil and gas industry during 2003 to 2006, the years around the FAS 123R compliance date. Our sample firms are independent exploration and production firms (SIC 1311) that are undiversified in terms of physical assets. As in Tufano (1996), we develop a firm-wide measure of the level of risk management, or hedging intensity, based on the delta of the firm's derivatives portfolio. The first advantage of this dataset is that our main hypothesis is best tested in an industry, such as oil and gas, where cash flow volatility is high enough to make risk management economically important and widespread. Second, focusing on one industry improves identification by yielding a homogenous sample with less unobservable differences in firm characteristics. Finally, oil and

gas firms extensively disclose their hedging activities at a level of detail that enables rigorous empirical analysis.[3]

In our tests, we define fiscal year 2005 as the beginning of the post-123R period because FAS 123R became effective as of the first interim or annual reporting period that begins after December 15, 2005. We identify two groups of firms that are unlikely to be affected by FAS 123R. The first group includes firms that did not use options in their CEO compensation packages in 2003 and 2004. The second group consists of firms that voluntarily expensed the fair value of executive stock options starting prior to 2003. These two groups of control firms are unlikely to be affected by the new regulation on expensing option grants. Our tests compare changes in corporate hedging intensity of treated firms to those of the control firms in pre-123R and post-123R periods.

As expected, we find in DID regressions that the adoption of FAS 123R leads to a sharp reduction in CEO's compensation convexity (vega), which indicates that FAS 123R made option pay less attractive. This result also validates that our natural experiment operates primarily through a large negative shock to vega. Additionally, it points to the fact that despite the limited size of our industry-specific sample, our DID technique has enough power to uncover significant effects of the policy change.

The cutback in the use of option pay following the issuance of FAS 123R may also change the sensitivity of CEO wealth to stock price (delta). Higher delta is seen as aligning the incentives of managers with the interests of shareholders by increasing the extent to which managers share gains and losses with shareholders. However, a higher delta decreases the willingness of risk-averse managers to bear risk, and therefore may induce them to hedge more.

[3] Several prior studies of corporate hedging, including Haushalter (2000), Rajgopal and Shevlin (2002), Jin and Jorion (2006), Kumar and Rabinovitch (2013) and Acharya, Lochstoer, and Ramadorai (2013), have exploited the informativeness of oil and gas firm hedging data to test theoretical predictions, and other studies verify the validity of findings for the oil and gas industry in broader multi-industry samples (see, for example, Knopf, Nam, and Thornton (2002)).

We find that firms in our treatment group replaced stock options with restricted stock and longer-term incentive plans, resulting in CEO deltas after FAS 123R that are larger, on average. Although in our analysis we control for changes in CEO delta, we show that the shock has an insignificant differential effect on delta, indicating that the overall changes in delta were similar for both treated and control groups and not caused by FAS 123R. This is comforting as potential differential changes in delta around FAS 123R could have affected hedging behavior and contaminated our causal inference.

We document a sharp increase in corporate hedging caused by the decline in vega. In our main specification, the DID estimator is 0.27, which means that hedging more than doubled relative to the 2003-2004 (pre-treatment period) average (from around 23% to 50% of production hedged). The results are qualitatively similar for the change in hedging as a percentage of reserves. Taken together, these findings suggest that the FAS-123R induced decline in vega caused increased hedging in our sample of oil and gas exploration firms.

Next, we verify that our treatment firms were similar to our control firms pre-123R in terms of various firm characteristics. In addition, we conduct multiple falsification tests where we find that our results only hold around FAS 123R and not around any of the placebo events. Together, these results suggest that the parallel trends assumption, which is the key identifying assumption behind our DID estimation technique, is likely to hold for our sample.

What is the implication of the documented increase in hedging for shareholders? To address this question we take advantage of our difference-in-differences specification and investigate the change in volatility of treated firms compared to control firms after FAS 123R. Consistent with the increased hedging, we find a sharp drop in cash flow volatility caused by FAS 123R.

Our study contributes to the large, but hitherto inconclusive literature that explores the effect of managerial compensation on corporate policies and in particular on corporate risk

management. Theoretical work (e.g., Smith and Stulz (1985)) predict a negative relation between CEO stock option compensation and corporate hedging. However, the empirical evidence is mixed. On one hand, Tufano (1996) finds a negative relationship between option pay and hedging. On the other hand, Geczy, Minton and Schrand (1997) and Haushalter (2000) find conflicting results. The empirical evidence on the effect of option pay on other corporate policies is also inconclusive. While Chava and Purnanandam (2010) and Gormley, Matsa, and Milbourn (2013) find a positive relationship between option pay and corporate risk-taking behavior, Hayes, Lemmon and Qiu (2012) fail to find such a relationship. In contrast to these studies, we focus on an exogenous change in option pay in an industry where risk management is of first-order importance. This approach enables our study to contribute to the literature by providing strong causal evidence that a compensation induced reduction in risk-taking incentives increases corporate hedging.

We review the effect of FAS 123R in the next section. Section 3 discusses our data and methodology. Section 4 presents our identification strategy and Section 5 presents our empirical results. Section 6 concludes.

2. FAS 123R and the Accounting Treatment of Executive Stock Options

The natural experiment we use to identify the causal effect of sensitivity of CEO wealth to stock return volatility (vega) on corporate risk management is a significant change in the accounting regulations governing how executive stock options are expensed. After decades of debate over whether the value of executive stock options should be charged against earnings, in 2004 the FASB issued FAS 123R that required the use of fair values in the income statements. The accounting rules for executive stock options prior to FAS 123R were established by FAS 123. FAS 123 offered firms two alternative ways to expense executive stock options. The first approach allowed firms to opt for the "intrinsic value" method prescribed by *Accounting Principles Board Opinion No. 25* (APB 25), provided the information about the fair value of

options as of the grant date was disclosed in a financial statement footnote.[4] Under the intrinsic value method, firms could avoid expensing options by granting them with exercise prices equal to or above the grant-date market price of the underlying stock. Alternatively, firms could opt for a second approach that required them to expense executive stock options using the fair value on the grant date based on an option valuation model such as Black Scholes. Although FAS 123 encouraged the "fair-value" method, it was not required. Consequently, it was no surprise that nearly all firms followed the intrinsic value method, and issued at-the-money options, which allowed them to issue option pay without having to record any expenses on their income statements.

The paucity of executive stock option expensing came under regulatory scrutiny after Enron, WorldCom, and other major accounting scandals. Investors argued that the intrinsic-value method resulted in financial statements that did not reflect the economic cost of stock options.[5] It was also suggested that the avoidance of expensing the fair value of options contributed to the stock option grant explosion in the 1990s (Murphy (2002); Hall and Murphy (2003)). To address these concerns the FASB issued an exposure draft in March 2004 followed by a final standard, FAS 123R, in December 2004, which required firms to expense option grants using the fair-value method. While the FASB provided that the effective date for most companies would be the first fiscal quarter beginning after June 15, 2005, the U.S. Securities and Exchange Commission (SEC) allowed a six-month deferral. Therefore, for large public corporations this new regulation became effective for financial reporting in fiscal years commencing after December 15, 2005. The main accounting difference imposed by FAS 123R relates to the expensing of fixed stock

[4] Accounting Principles Board is the predecessor organization of the Financial Accounting Standards Board (FASB) which established Generally Accepted Accounting Principles (GAAP).

[5] It is important to note that the premise of these investor arguments in favor of expensing stock options at their fair value is that the stock market does not already incorporate the cost of options, i.e., the market does not incorporate all publicly available information. Regardless of the veracity of this argument, it seems apparent that the move toward adopting FAS 123R was driven by the desire to make accounting statements more transparent and the cost of option compensation more explicit. See Lyke and Shorter (2005) for further discussion.

options, in which the exercise price and the number of shares are known at the grant date. Under FAS 123R, companies are required to expense all employee stock options using the fair value method. Other equity-based compensation was largely unaffected by this regulatory change.[6] FAS 123R also did not affect the tax treatment of executive stock options.

In sum, the main consequence of the regulation change was to reduce the attractiveness of issuing executive stock options for the vast majority of firms, i.e., those firms that previously elected the intrinsic value method. Therefore, it is no surprise that option usage declined significantly following the issuance of FAS 123R. Brown and Lee (2011) find that the median firm issued 36% fewer options after FAS 123R. Hayes, Lemmon and Qiu (2012) find that this decline resulted in a significant decrease in the CEO's sensitivity to option volatility (vega) after the regulatory change. Thus, the event had a large impact on CEO compensation and created significant potential to impact CEO risk-taking incentives.

It is common for firms to lobby for or against regulatory change – and such lobbying activity may be correlated with outcome variables. Such political economy concerns have the potential to reduce the effectiveness of the natural experiment in identifying causal effects and may lead to biased estimation. We address this issue both conceptually and by examining actual lobbying activity for or against the adoption of FAS 123R. At the conceptual level, political economy concerns are unlikely to be critical in our setting for two reasons. First, most firms had incentives to lobby against the adoption of FAS 123R. In fact, in 2003, strong lobbying against a contemplated regulatory reform similar to FAS 123R led to a drastic watering down of the proposed change. Second, even if some firms had incentives to lobby in favor of the reform (i.e., one could make a case that both our control groups could obtain competitive benefits from the elimination of the favorable accounting treatment of options allowed before FAS 123R and

[6] See Hayes, Lemmon and Qiu (2012) for a comprehensive assessment of how other equity-based compensation such as Restricted Stock Units (RSU) and equity awards with performance-based vesting conditions were affected by FAS 123R.

availed of by firms in the treatment group) it is difficult to imagine that any such incentive would be correlated with their hedging strategies.

To further alleviate political economy concerns, we examine the corporate lobbying activity pertaining to the adoption of FAS 123R. As in Hill, Shelton and Stevens (2002) we use as our proxy the letters received by the Financial Accounting Standards Board (FASB) in response to its solicitation of comments on the adoption of FAS 123R. The FASB received 6536 comment letters.[7] The vast majority of these letters were received from high-technology firms and their employees (together, Cisco Systems and its employees alone sent in around 2300 letters), reflecting the much higher usage of executive stock options by high-technology firms (Schneider (2004)).[8] Only one of these comment letters was connected to our sample, which was a letter received from the Comptroller of Occidental Petroleum lobbying in favor of the adoption of FAS 123R. We verify that our results remain unchanged when Occidental is removed from our sample. While oil and gas companies are no strangers to lobbying, especially pertaining to federal and state petroleum tax rules and environmental regulations, the evidence suggests that their lobbying activity did not extend to the adoption of FAS 123R.

3. Data and Methodology

Our analysis is based on a sample of oil and gas producing firms (SIC code 1311) between 2003 and 2006. SIC 1311 firms engage primarily in exploration and extraction of natural gas and crude petroleum. We choose SIC 1311 firms as these firms are relatively homogeneous in their exposure to commodity prices and use similar hedging strategies (see Jin and Jorion (2006)). These industry characteristics help minimize the problems of omitted

[7] These comment letters are listed at: http://www.fasb.org/jsp/FASB/CommentLetter_C/CommentLetterPage&cid=1218220137090&project_id=1102-100.

[8] See Alsheimer (2006) for a detailed analysis of why members of the venture capital, entrepreneurial and technology sectors were heavily opposed to FAS 123R. As oil and gas exploration and production firms share few characteristics with companies in these sectors, they had less incentives to lobby against FAS 123R.

variables and/or spurious correlations that we would face if we did a cross-industry study or focused on a more complex heterogeneous industry. Even within the petroleum industry, the SIC 1311 classification excludes many large oil companies (Exxon, Chevron, Conoco, etc.) which belong to SIC code 2911 (Petroleum Refining). These firms are vertically integrated and are more naturally hedged than pure-play SIC 1311 firms. Thus their hedging demands are more diverse and more difficult to estimate precisely.

Another advantage of studying hedging behavior in the oil and gas industry is that while changes in financial and investment policies have high adjustment costs (Cooper and Haltiwanger (2006) and Strebulaev (2007)) and require more time to take effect, firms can change their hedging policy literally overnight. Therefore, we would expect management to react to their change in compensation incentives by first adjusting hedging policies.[9]

A further benefit of focusing on the oil and gas industry is that firms in this industry are exemplary in disclosing detailed derivative activity to the public. Purnanandam (2008) discusses the difficulty in identifying contract-specific information for commodity derivative holdings of U.S. corporations. The oil and gas exploration and production industry is unique in that firms provide detailed information of each derivative contract, including the notional amount, derivative type, specific details of the underlying commodity, and maturity. Consequently, SIC 1311 oil and gas firms have been the basis of several previous empirical corporate hedging studies, including Haushalter (2000), Rajgopal and Shevlin (2002), Jin and Jorion (2006), and Kumar and Rabinovitch (2013), while studies such as Knopf, Nam, and Thornton (2002) verify that findings for the oil and gas industry are generalizable to broader multi-industry samples.

A fourth advantage of focusing on oil and gas firms stems from a lower likelihood that these firms use stock grants with performance-based vesting provisions, which introduce

[9] In support of this conjecture we find that in the SIC 1311 firms in our sample have a coefficient of variation of hedging intensity that is higher compared to the coefficient of variation for cash holdings, capital expenditures and leverage.

convexity in executive compensation without options and potentially confound the measurement of vega. Bettis, Bizjak, Coles and Kalpathy (2010) note that the use of performance-based vesting conditions has been growing recently, especially in the aftermath of FAS 123R, and is more common among complex firms, such as diversified firms and firms with higher investment in R&D and stock price volatility. The SIC 1311 oil and gas firms in our sample are far from this description, being characterized by low levels of diversification, complexity, and R&D investment.[10]

To quantify hedging behavior, we hand-collect financial derivatives positions and operational hedging contracts from 10-K filings on Edgar. Firms usually disclose derivative positions in item 7A. In the oil and gas industry, in particular, firms typically report their use of oil and gas derivative contracts clearly (most times in tabulated format). Firms also report fixed price delivery operational hedging contracts in item 7A and in management footnotes. We collect the contract type (forward, future, call, put, swap, etc.), the contract maturity, amount sold in the future (firms sometimes provide these figures on a per day basis and sometimes in aggregate), type of commodity (oil or gas) and price of the commodity in the agreement. As in Jin and Jorion (2006), we only consider directional contracts and therefore ignore basis spreads and other such non-directional contracts. After collecting the information on each derivative contract, we collect volatility and futures prices for all types of oil and gas commodities from Bloomberg. This information allows us to calculate delta for each of the derivative contracts. Deltas for futures, forwards, swaps, loans and other such linear contracts are assumed to be 1. For options contracts, we use the Black and Scholes delta to estimate the sensitivity of a contract to movement in oil and gas prices.

[10] Nonetheless, as we discuss later, we screen our entire sample of firms for the presence of performance-based vesting provisions in their CEO and CFO compensation.

We use two measures of hedging intensity in our analysis. First, as in Tufano (1996), we measure the extent of derivatives usage by a hedge ratio (h_{it}^{p}) for each firm *i* and time *t* that is defined as follows:

$$Total\ Hedge\ Ratio\ (Production) = \frac{-Portfolio\ delta\ (derivative\ contracts)}{Expected\ production\ (one\ year\ ahead)} \quad (2)$$

The portfolio delta is the amount of oil and/or gas that the firm has effectively sold short, computed as the sum of the deltas of all of a firm's financial derivatives positions and operational hedging contracts in barrels of oil equivalent. Expected production is a firm's expected oil and/or gas production over the next year in barrels of oil equivalent, which we proxy as in Jin and Jorion (2006) with actual production figures reported in the 10-K disclosures since production estimates are not available. Thus, this hedge ratio represents the fraction of a firm's oil and gas production that is being hedged.

Since some measurement error may enter the computation of this hedge ratio due to deviations between actual production and the amount of oil and gas the firm expects to produce at the time it places the hedge, we also calculate a second hedge ratio that reflects the fraction of a firm's total oil and gas reserves that has been hedged, as in Jin and Jorion (2006). This ratio (h_{it}^{r}) is defined as follows:

$$Total\ Hedge\ Ratio\ (Reserves) = \frac{-Portfolio\ delta\ (derivative\ contracts)}{Reserves} \quad (3)$$

Fiscal year-end oil and gas reserve estimates in barrels of oil equivalent are hand collected from the firms' financial statements. Thus, this hedge ratio represents the fraction of a firm's oil and gas reserves that is being hedged.[11]

Compensation data is primarily from ExecuComp; however, if the firm is not covered by ExecuComp we hand collect the data from the firm's proxy statements. We collect the stock and option holdings for CEOs and use this to estimate the sensitivities of stock and option holdings to

[11] For both hedge ratios, for robustness we have repeated our analysis using one-year hedge ratios where the hedge horizons are limited to one year. Our results remain unchanged.

changes in stock price level (delta) and volatility (vega) following the methodology of Core and Guay (2002). We calculate the delta (vega) of each executive's compensation as the sum of the deltas (vegas) of all outstanding options plus the delta (vega) of the executive's shareholdings. The Appendix describes our delta and vega estimation procedure in detail.

Next, we obtain financial data from Compustat and stock price data from CRSP. This data is used to calculate measures of firm size, ROA, cash holdings, investment growth, leverage, dividend policy, Altman's (1968) Z-score and cash flow volatility. All variable definitions are provided in the Appendix. To ensure that outliers in the data do not drive our results, we winsorize all continuous variables at the 5th and 95th percentiles.[12]

We locate 10-K filings covering fiscal years 2003 to 2006 with information that allows calculation of hedge ratios and available CEO compensation data for 154 firm-year observations. This includes 42 unique firms that have at least one year of data in each pre- and post-treatment period (154 firm-year observations). [13] All the variables are measured at the end of each fiscal year. The first group contains firms that did not pay any options to their executives in 2003 and 2004 (the pre-treatment period). We identify these firms using ExecuComp. The second control group contains firms that started expensing options using the fair-value method on or before 2002 (prior to commencement of pre-treatment period). Similar to Carter, Lynch and Tuna (2007) and Brown and Lee (2011), we identify SIC 1311 firms that voluntarily expensed stock options based on Bear Stearns Equity Research dated December 16, 2004 (McConnell, Pegg, Senyek and Mott (2004)). The combined control group has 15 unique firms with data available in at least one year in the pre- and post-treatment periods (54 firm-year observations). This is comprised of ten and seven unique firms in the first and second control groups,

[12] Because of our small sample size we winsorize at 5th and 95th percentiles instead of 1st and 99th percentiles.

[13] Our sample includes nine unique firms and 34 firm-years in SIC 1311 that are not covered by ExecuComp. The required data for these firm-year observations is hand collected.

respectively, with two firms satisfying the criteria for both control groups. The first and second control groups consist of 36 and 26 firm-year observations, respectively.

In our sample, Apache Corporation is an example of a firm that did not include any options in their CEO pay in 2002, 2003 and 2004. Although Apache's CEO did receive options prior to 2002 he was not granted any options in the pre-FAS 123R period. It therefore satisfies our requirement to be included in the first control group. Apache also voluntarily started using the fair-value method to expense executive stock option pay prior to the implementation of FAS-123R. Therefore, Apache Corporation satisfies the criteria to be included in both control groups. The only other firm that is included in both control groups is Anadarko Petroleum Corporation. Except for these two firms, the two control groups do not have any intersection and both include a mix of large and small companies.

4. Identification Strategy

Most studies that attempt to link executive compensation and risk management suffer from various endogenity concerns, making it hard to infer causality. One reason for this is that CEO compensation, corporate hedging, and many other important corporate decisions are made simultaneously. Second, important determinants of both CEO compensation and hedging, such as the strength of corporate governance, investment opportunities and CEO risk aversion, are not observable. Omitting or relying on poor proxies for these variables in hedging regressions can significantly bias the coefficient estimates and lead to unreliable inference. Third, in the managerial labor market, CEOs optimally select firms that offer compensation contracts compatible with their attributes, e.g., a CEO's risk aversion may determine both her hedging decisions as well as which firm she chooses to join. This selection bias may also lead to an endogenous relationship between corporate hedging and CEO compensation. While Rajgopal and Shevlin (2002) use a simultaneous equations approach to potentially address endogeneity concerns, Coles, Daniel and Naveen (2006) use the same approach to show that the causality in

simultaneous regressions goes both ways, thereby reinforcing the importance of identifying exogenous changes to be able to accurately establish causal relationships.

The implementation of FAS 123R in 2005 allows us to take advantage of a source of exogenous variation in executive compensation contracts, more specifically in CEO option pay. That is, in response to FAS 123R, firms significantly reduced the number of options granted to executives, thus reducing the convexity of the contracts (vegas). In others words, this event constitutes an exogenous shock to firms' willingness to compensate managers with stock options. Importantly, this shock is arguably exogenous to hedging, which allows us to identify the causal effect of executive stock option grants on corporate hedging.

We identify two different sets of firms that are unlikely to be affected by the event. The first control group contains firms that did not pay any options to their executives in the pre-treatment period. This group is not affected by the regulation change as the executives of these firms are not impacted by the large reductions in vegas induced by FAS 123R.[14] The second control group are firms that preemptively adopted FAS 123R on or before 2002, i.e., used the fair-value method for expensing their executive stock options in the pre-treatment period.[15] Again, this group is not impacted by the regulation change as they have already implemented the main provisions in the change. In our test we combine these control groups. The advantage of focusing on the combined group is that our treated sample will not include firms that are likely to be unaffected by the treatment (i.e., firms in the other control group). However, in untabulated results we also check that our main results are robust if we instead consider the two groups separately.

[14] Firms in this group did not grant any options to their CEOs in 2003 and 2004. However, three firms in this group have positive, but small CEO vegas due to options granted prior to 2003.

[15] Carter, Lynch and Tuna (2007) show that firms choosing to voluntarily expense option grants prior to FAS 123R decreased their use of options and increased their use of restricted stock following their expensing decisions. Therefore, to ensure that the control firms are not in the process of transitioning their corporate policies in response to changes in CEO compensation vega, we use firms that voluntarily elected to expense options on or before 2002. Moreover, no firm that elected to expense stock options on or before 2002 reversed its decision in 2003 or 2004.

Non-random assignment to treatment and control groups can be a concern if the reasons for either opting to comply with FAS 123R or not granting CEO stock options prior to the event are correlated with hedging outcomes post-123R. However, as we show in section 5.1, the treatment and control groups are similar on many different dimensions prior to FAS 123R which makes this less of a concern. Additionally, Carter, Lynch and Tuna (2007) find that firms that choose to expense options have similar governance characteristics such as compensation committee independence to firms that do not expense options.[16]

In our analysis we focus on a short window (two years in both the pre- and post-event periods) around the implementation of FAS 123R to strengthen the internal validity of our empirical strategy. Note that the short window should be sufficient to capture the major effects of FAS 123R on hedging decisions as hedging reacts fairly quickly to new developments.[17] As shown in Angrist and Krueger (1999) a DID methodology is well placed to identify the effects of a sharp change in compensation policy such as FAS 123R on risk management. Thus, we estimate the following DID specification:

$$h_{it} = \alpha + \beta d_t + \omega T_i + \theta d_t T_i + z_{it}\delta + \varepsilon_{it}. \quad (1)$$

Here h_{it} is the hedging intensity of firm *i* at time t, T_i is an indicator variable that equals one if the firm belongs to the treatment group and zero otherwise, d_t is an event dummy that equals one after the event and zero before and z_{it} is a vector of controls variables. The coefficient on the interaction term θ gives the DID estimate of the effect of FAS 123R on hedging, h_{it}. FAS 123R noticeably reduced vegas in treated firms, thus reducing the sensitivity of CEO wealth to stock return volatility. This is predicted to increase hedging intensity in treated

[16] Aboody, Barth, and Kasznik (2004) investigate firms' decisions to voluntarily adopt the fair-value method to expense options. They find that firms that adopt FAS 123R prior to 2005 vary along several dimensions such as the extent of participation in the capital markets, the incentives of executives, and the level of information asymmetry. If these differences are correlated with hedging outcomes it could bias our results. However, we feel that this is unlikely to be an issue in our study as we study a more homogenous industry specific sample.

[17] Our results are robust to changing the horizons to one year for the pre-and post-treatment periods.

firms relative to control firms. Therefore we expect to observe that $\theta > 0$. As the presence of differential trends in the treated and control groups can induce bias in θ, we conduct a battery of tests to ensure that the parallel trends assumption is likely to hold in our setting. In addition, to further ensure our estimates of θ are consistent and robust, we employ a variety of methods, including different control variables, placebo tests as well as firm and year fixed effects.[18]

5. Empirical Results

5.1. Main Results

Our sample of 154 firm-year observations from 2003 to 2006 is summarized in Table 1. As shown in Panel A, the firms in our sample are relatively frequent hedgers. Roughly 82% of the sample firms hedge their oil and/or gas production in a given year and all firms hedge at least once during the sample period. Firms hedge an average of about 24% of their oil and gas production or 2% of their reserves. As shown in Panel B of Table 1, which separates our sample period into the pre-123R (2003-2004) and post-123R (2005-2006) sub-periods, the ratio of option pay to total pay and convexity (vega) decline following the adoption of FAS 123R, while pay-performance sensitivity (delta) increases. While firms hedge more in the two years following the event, we also observe some changes in other variables across the two sub-periods. This reinforces the importance of carefully separating the effect on hedging intensity due to changes in compensation terms, from any effect of changes in other factors.

[Insert Table 1 here]

We now investigate the impact of FAS 123R on executive compensation. Since FAS 123R made option pay less favorable, we expect to see treated firms cut back on options, thereby reducing vega relative to control firms. However, firms may also substitute options with other

[18] In all specifications that include firm and year fixed effects we exclude T_i and d_t as the treatment is fully absorbed by the firm fixed effects and the event is fully absorbed by the year dummies. In all specifications the standard errors are clustered at the firm level to account for the possible serial correlation in ε_{it}, however, in specifications which include firm-fixed effects we do not use firm-clustered standard errors due to our small sample size.

forms of performance-based pay resulting in higher deltas post-123R. To study this more carefully, in Table 2 we report difference-in-differences (DID) regressions for both CEO vega and delta as left-hand side variables.[19]

[Insert Table 2 here]

The first three columns of Table 2 show that FAS 123R resulted in a significant decline in CEO vega. This result is robust to the inclusion of firm and CEO controls as well as firm and year fixed effects. These results also underscore the fact that despite the small sample size imposed by our industry-specific sample, our DID technique has enough power to uncover significant effects of the policy change. The declines in vega are consistent with Carter, Lynch and Tuna (2007), Brown and Lee (2011) and Hayes, Lemmon and Qiu (2012), who show that financial reporting costs play an important role in the design of executive compensation contracts. This is reassuring since we confirm that our natural experiment operates primarily through a large negative shock to vega. As we can see in Figure 1, this negative shock to vega is induced by declines in option pay ratios for treated firms.[20]

In the last three columns of Table 2, we find statistically insignificant changes in delta due to FAS 123R. Our finding that the shock had an insignificant effect on delta indicates that the overall increases in delta were similar for both treated and control groups and not caused by FAS 123R. This is consistent with the overall trend of an increase in pay performance sensitivity over time for all firms.

[Insert Figure 1 here]

Next, we examine whether the decline in vega induced by FAS 123R affects corporate hedging. A simple examination of hedge ratios pre- and post-123R (see Table 1: Panel B)

[19] To alleviate the concerns that arise from the skewness of Vega and Delta, we replace Vega and Delta with Log(1+Vega) and Log(1+Delta) in our analysis. All our results are unchanged if we do not use log transformations.
[20] In unreported results we repeat the DID regression in Table 2 substituting the ratio of option pay to total pay for vega. We find that FAS 123R significantly reduced option pay for treated firms relative to control firms.

suggests that total hedge ratios mostly increased after 2005. We investigate this more rigorously by running DID regressions. The results are in Table 3. The coefficient on the interaction term is positive and significant at the five percent level in all specifications. In the basic specification with firm and CEO characteristics as control variables, the DID estimator is 0.27. This means that hedging increased by 27% of production in treated firms relative to control firms, raising hedging intensity to 50%, i.e., more than double the pre-treatment average of 23% of production hedged. The results are similar for hedging as a percentage of reserves. Taken together these results show that the decline in vega due to FAS 123R caused increased hedging in oil and gas exploration firms.[21]

[Insert Table 3 here]

There is no consensus on what control variables to include in hedging regressions. We survey the literature for commonly used variables and include them in our DID regressions to ensure our results are robust. Firm characteristics such as size, leverage, profitability, investment growth and cash, and CEO characteristics such as age and tenure are included as control variables since they may have an effect on corporate hedging. We also include annual incentive plans (i.e., bonus contracts) as a control variable, because they often have payoff profiles that could enhance risk-taking incentives. The typical kinked payoff profile of bonus contracts shares many similar features to options and therefore, could affect corporate hedging. If a firm's CEO changes, the arrival of a new CEO could affect hedging as the new CEO could have different characteristics. However, there is only one such turnover event in our sample, and we verify that our results do not change when this firm is removed from the sample. As shown in Table 3, our results remain qualitatively similar with additional covariates as well as firm and year fixed

[21] It is important to note that while in Table 2 we focus on CEOs compensation, in unreported work we verify that FAS 123R had a similar effect on other executives' compensation packages including CFOs. Therefore, the results we present in Table 3 capture the effect of changes not only in CEO vega but also in other executives' vega on firm hedging activities. Chava and Purnanandam (2007, 2010) provide a strong rationale for this verification.

effects.

5.2. Parallel Trends Assumption and Placebo Tests

The key identifying assumption underlying the DID estimation technique is that the parallel trends assumption is satisfied, that is, in the absence of treatment both treated and control firms should experience parallel trends in the outcome variable. This means that if FAS 123R did not occur θ should be zero. Although the parallel trends assumption cannot be directly tested, we perform a variety of tests suggested by Roberts and Whited (2013) to assess if the parallel trends assumption is likely to hold in our setting.

First, we investigate trends in the outcome variables prior to 2005. As can be seen in Figure 2, treated and control firms exhibit similar trends in hedging prior to FAS 123R for Hedge Ratios 1 and 2. In Table 4, in the pre FAS 123R period, we compare the means and medians of Hedge Ratio 1, Hedge Ratio 2 and the change in both Hedge Ratios 1 and 2 from 2003 to 2004, and find no statistical differences in these means or medians between the treated and control firms.

[Insert Figure 2 here]

Second, we compare firm and CEO characteristics of the treated and control firms in the pre-treatment period to make sure that prior to FAS 123R the two groups are similar. As shown in Table 4, treated and control groups are indeed similar as we find only a few statistically significant differences between the means of observable characteristics of the two groups. The most striking differences are evident in vegas and option pay. This is by construction since the inclusion requirement for the first subgroup of our combined control group is that firms did not grant options to their CEOs in the pre-treatment period, which results in a lower CEO vega. The overall similarity in observable firm and CEO characteristics, which is in support of the parallel trends assumption, is reassuring because it makes it less likely that unobserved differences between the groups are driving our results.

[Insert Table 4 here]

The most notable difference between the treated and control firms is that treated firms have significantly higher mean cash holdings than control firms. This is a potential concern as firms with more liquid assets may be less financially constrained and this may affect their hedging behavior. We find that the difference in mean cash holdings is an artifact of our relatively small sample and attributable to a single firm, Harvest Natural Resources. This firm, which is included in the treatment group, has a cash ratio of 0.34 compared to the mean cash ratio of 0.042 for the full sample. Our results are unchanged if we exclude this firm from our sample.

Third, to better assess that our results are unique to FAS 123R, we perform several placebo (falsification) tests in which we falsely assume a treatment occurs. More specifically, we repeat the baseline experiment during time periods that precede and follow FAS 123R. For the first placebo experiment, we use 2000-2001 and 2002-2003 as our pre-event and post-event periods respectively. We then examine the change in hedging intensity around the false 2002 shock by running our baseline DID regressions. We perform this falsification test using the same treated and control firms we use in our real tests. The second placebo experiment defines control firms as firms that did not have option grants in the placebo pre-event period. This design replicates how we defined control group 1 in our main tests. For this test we use 2006 and 2007 as the pre-event and post-event periods respectively.[22] Table 5 outlines the results of these falsification tests. The estimated treatment effect is statistically insignificant in both experiments. This means that changes in hedging intensity are similar for treated and control groups in the placebo periods. These findings support our main results that the changes in corporate risk

[22] We do not use year 2002 as the placebo event year (as in the first placebo) because only three firms did not grant options to their CEOs in year 2001, making the control group much smaller than the treated group. We focus on only one year for the pre-event and post-event periods for this falsification test to avoid the financial crisis period as well as the period of our main study (i.e., 2003-2006) as much as possible.

management likely stem from changes in option pay due to FAS 123R in 2005. Overall, these placebo tests reinforce that the treated and control firms tend to exhibit similar trends in hedging behavior outside of the tight window around the passage of FAS 123R.

[Insert Table 5 here]

Our findings for corporate hedging policy are consistent with the findings of Chava and Purnanandam (2010) for other corporate financial policies around FAS 123R. In contrast, Hayes, Lemmon, and Qiu (2012) find no relation between a FAS 123R-induced reduction in vega and changes in five proxies of corporate risk-taking: R&D expenditure, capital expenditure, leverage, cash holdings and firm risk. It is worth highlighting an important methodological difference between Chava and Purnanandam (2010) and Hayes, Lemmon, and Qiu (2012) that may partially explain their different findings. Chava and Purnanandam (2010) use the difference between 2001 and 2005 data to avoid the potentially contaminating effect of firms that voluntarily expensed their options before fiscal year 2005, whereas Hayes, Lemmon, and Qui (2012) use all the data around the implementation of FAS 123R, which can include both treatment and control firms (i.e., firms that were already expensing their options using the fair-value method).

5.3. Robustness Tests

In this section, we conduct a number of robustness tests as well as implement an extensive set of additional investigations to better understand how CEO compensation vega affects corporate hedging intensity.

5.3.1. Intensity of Changes in Compensation Convexity and Hedging

A natural extension of our test of the causal relationship between CEO vega and hedging intensity is to explore if larger drops in vega during the event period result in higher levels of hedging intensity. Specifically, we calculate *Reduction in Vega* as the difference between the average vega pre-FAS 123R (2003-2004) and the average vega post-FAS 123R (2005-2006) for each firm. Next, in Table 6, we estimate a triple difference specification where the coefficient of

interest is the triple interaction *Reduction in Vega*Treated*Post-FAS 123R*.[23] The results are reported in Table 6.

[Insert Table 6 here]

As expected, the coefficient on *Reduction in Vega*Treated*Post-FAS 123R* is positive and economically large in all specifications. However, the coefficient on the triple interaction is only statistically significant for hedge ratio 1.[24] The lack of statistical significance for hedge ratio 2 could be attributable to hedging as a fraction of reserves being an indirect and potentially noisier measure of the percentage of expected production hedged, since expected production is not perfectly correlated with reserves and reserve changes are lumpier than changes in expected production. Nonetheless, the results in Table 6 provide some evidence that firms that experienced larger reductions in vega around FAS 123R hedged more. This is largely consistent with our main finding that changes in CEO compensation vega lead to changes in hedging intensity.

5.3.2. CEO Outside Wealth and Hedging

Next we investigate whether our main result varies with CEOs' outside wealth. As theory suggests, CEOs are more likely to react in a risk-averse manner when they have lower levels of wealth outside the firm (i.e., they more under-diversified). This implies that a CEO with more of his personal wealth that is not tied to the firm's performance should increase hedging intensity less dramatically following the FAS 123R induced reduction in vega. Unfortunately, a clean measure of the CEO's outside wealth is not available. Therefore, we follow the methodology in Chava and Purnanandam (2010) and construct a proxy for CEO outside wealth based on the

[23] In an alternative and more conventional triple difference specification reduction in vega would be defined as a dummy variable ((Reduction in Vega Dummy) in which the sample is split by the median reduction in vega. However, as all the firms that experienced large reductions in vega around FAS 123R are in the treated group, the triple difference cannot be estimated due to collinearity (*Reduction in Vega Dummy*Treated*Post-FAS 123R* and *Reduction in Vega Dummy*Post-FAS 123R* are perfectly correlated. Similarly Reduction in Vega Dummy*Treated and Reduction in Vega Dummy are also perfectly correlated).

[24] Untabulated results including control variables are substantively similar in both statistical and economic significance.

CEO's historical cash-based compensation. This is a good proxy if CEO's wealth is mostly derived from his observable employment history as an executive. For each year in our sample starting with 2003 we first collect CEOs' salaries and bonuses for the past five years. We require that the data is available in ExecuComp, which means that the CEO was either an employee of the current firm or of any other firm in ExecuComp during the past five years. This results in 102 firm-year observations (28 unique firms). CEO outside wealth is defined as the CEO's average cash-based compensation which is the sum of his annual salary and bonus averaged over the past five years.[25]

Low Outside Wealth equals one for firms with CEOs who rank below the median of the proxy for CEO outside wealth in our sample. Next, we estimate triple difference regressions where the coefficient of interest is each specification is the triple interaction *Treated*Post-FAS 123R* Low Outside Wealth*. The results are reported in Table 7. As expected the coefficient on the triple interaction is positive and economically large in all specifications. However, the coefficient is statistically significant only in specifications with hedge ratio 1. This could potentially be due to the smaller sample size as we only have 102 firm-year observations in the tests reported in Table 7.[26] In sum, these tests yields some evidence that consistent with theory, managers who are more likely to be under-diversified increase their hedging intensity more sharply as a result of FAS 123R.

[Insert Table 7 here]

[25] Similar to Chava and Purnanandam (2010) we tried to construct CEO outside wealth over the past ten years for every firm-year. However, lack of historical data availability results in a small sample of only 55 firm-year observations, which is insufficient for our empirical tests. We observe a high correlation (0.9) between the average past five and past ten years of CEO cash-based compensation, which gives us confidence that our measure is an acceptable proxy for CEO's outside wealth.

[26] Similar to the specifications in Table 6, because of the small sample size of each subsample and the possibility of over-fitting the model, Table 7 does not include any control variables. Untabulated results including controls are substantively similar in both statistical and economic significance.

5.3.3. Oil and Gas Price Volatility

In the pre-123R period, 2003-2004, oil and natural gas price volatility was lower than in the post-123R period, 2005-2006 (0.57 and 3.36 versus 1.21 and 6.12, for natural gas and oil respectively).[27] Since all firms in our sample were affected by the increase in oil price volatility, any change in hedging behavior due to a volatility increase should be the same for both treated and control firms. The DID method assures that this effect is differenced out.

However, there may also exist a differential effect of changes in volatility that could possibly impact our results. If a CEO is granted options as part of his compensation contract, an increase in the volatility of oil or natural gas prices will give him an incentive to hedge less because both the option pay ratio and vega of the CEO increases with the return volatility. In contrast, CEOs who did not receive options in their compensation (10 of the 15 control firms) would not be affected by changes in oil and gas price volatility, leaving their hedging policies unchanged. Therefore this differential trend biases against our finding any result associated with FAS 123R. However, the documented increase in hedge ratios for the treated firms relative to the control firms after FAS 123R (Figure 2 and Table 3) indicates that the effect of reduction in vega is strong enough to dominate any differential effect of a change in volatility.

5.3.4. Additional Robustness Tests

First, we screen our entire sample to check for the possibility that firms may have substituted option grants with performance-vesting stock grants to reintroduce convexity in compensation contracts following FAS 123R. The presence of performance-based vesting provisions in our sample is minimal, which is consistent with the finding of Bettis, Bijzak, Coles and Kalpathy (2010) that such provisions are more likely in the case of firms that are complex, unlike the firms in our sample. We find that during our sample period only six treated firms

[27] The figures are based on average monthly standard deviations of natural gas prices (dollars per thousand cubic feet) and oil prices (dollars per barrel).

granted compensation contracts subject to performance-based vesting provisions, with the amounts in each case being modest. Nonetheless, in untabulated work we verify that our results persist when these firms are removed from the sample.

Sundaram and Yermack (2007), Edmans and Liu (2011) and Wei and Yermack (2011) argue that CEO pension benefits can constitute inside debt and, in turn, reduce risk-taking incentives. Therefore, if pension benefits are systematically different between our treated and control firms or change differentially around FAS 123R, this may bias our results. To investigate this possibility we ideally need a proxy for inside debt such as the present value of accumulated pension benefits. However, this measure is difficult to quantify prior to 2006 as a consequence of inadequate disclosure. To get around this difficulty we exploit the fact that only defined benefit pension plans affect CEO risk-taking incentives (see Sundaram and Yermack (2007)). Screening proxy statements we find that ten firms in our sample (six treated and four control firms) offer defined benefit plans as part of their CEO compensation contracts. We then repeat our main tests for all firms that do not sponsor defined benefit plans. This test allows us to avoid potential risk-seeking implications associated with defined benefit plans that could affect treated and control firms differentially. In untabulated results, it is reassuring to observe that our results remain unchanged even after excluding all firms in which pension benefits could potentially affect risk-taking incentives. In addition, the persistence of defined benefits makes it less likely that defined benefit plans caused significant differential changes in risk-taking incentives around FAS 123R.[28]

Roberts and Whited (2013) point out that using multiple control groups may be beneficial as each control group may induce different biases in our tests. We therefore first verify that the differences between the means and medians of firm characteristics in the treated group and each

[28] Defined benefit plans are persistent for many different reasons that include the reluctance of firms to start new defined benefit plans as well as IRS tax rules that make significant changes in these plans costly and termination prohibitively expensive (see Rauh (2006)).

of the control groups are statistically insignificant (this is equivalent to Table 4 for the combined control group). Given the small intersection of the two control groups (two firms), running the DID specification separately for both groups for robustness is informative for ruling out alternative explanations for our results. Therefore, we re-run our main tests in Tables 2 and 3 using each of the control groups separately. In untabulated tests we find results similar to those we found for the combined control group. This is especially comforting as these tests have less power due to the smaller sample size of the control groups.

Furthermore, to make sure that the exclusion of vega in our main tests is not biasing our results, we run simple difference regressions. All variables are differences of the average values of the variables in the pre- and post-treatment periods. The results can be found in Table 8. As expected we find a significant negative coefficient on changes in vega. This implies that a reduction in vega increases hedging around the adoption of FAS 123R. The downside of this estimation is that the single difference does not control for parallel trends around the event.

[Insert Table 8 here]

Theory suggests that when CEOs are sufficiently risk-averse option compensation may not provide risk-seeking incentives (Carpenter, (2000) and Ross (2004)). Therefore, as a robustness test we consider the possibility that the Black-Scholes vega that we use in our previous tests may not perfectly capture the risk-preferences of risk-averse managers. This is because CEO risk aversion and the inability of the CEO to trade his firm's stocks and options (resulting in CEO under-diversification) are ignored in the estimation of vega. Thus, as an alternative measure to vega we use a certainty equivalent approach to estimate CEO risk-seeking incentives that incorporates both CEO's risk aversion and under-diversification (see Lambert, Larcker and Verrecchia (1991), Hall and Murphy (2002), Lewellen (2006), and Chava and Purnanandam (2010)). The alternative measure of CEO risk-seeking incentives is estimated as the change in the certainty equivalent of the CEO's stock and option holdings by changing the

volatility of the stock returns by 1%. In untabulated tests we substitute vega with the alternative CEO risk-seeking incentives measure and run similar specifications as those in Table 2. Our main results remain unchanged. That is, the coefficient on the interaction term (Treated *Post-FAS 123R) remains negative and statistically significant, which is consistent with our findings using vega in Table 2.[29]

To address the concern that both vega and CEO risk-seeking incentives (discussed above) are estimated based on models, we conduct an additional robustness test where we replace vega with (i) the total number of options held by the CEO and (ii) the number of options granted in the current year to the CEO. Both measures are deflated by the current year's number of shares outstanding. The advantage of these two measures is that they are model free, although they do not directly measure compensation induced risk-incentives of the CEO. In untabulated results we run similar DID specifications to those in Table 2 and continue to find that the coefficient on the interaction term (Treated *Post-FAS 123R) is negative and significant. This gives further support to our finding that FAS 123R causes the risk-taking incentives of CEOs to decline in treated firms relative to control firms.

It is important to note that the measurement of CEO risk-seeking incentives do not affect the assignment of treated and control firms. Therefore, our main findings that hedging intensity drops as a result of FAS 123R (Table 3) is independent of the procedure used to measure CEO risk-seeking incentives. However, the validity of our natural experiment relies on a differential reduction in CEO risk-seeking incentives among the treated firms relative to the control firms after FAS 123R (Table 2). It is comforting that this differential reduction is robust to alternative measurement techniques that incorporate CEO risk aversion and under-diversification.

[29] Our results are robust to using different combinations of CEO relative risk aversion coefficients and outside wealth in the simulations to estimate the alternative measure of CEO risk-seeking incentives.

Finally, it is possible that oil and gas producers face differential trends around FAS 123R. For instance, firms that are primarily oil producers are likely to react differentially to an increase in oil price volatility relative to gas producing firms. To investigate this possibility we calculate the percentage of oil revenues for our treated and control firms in the pre-event period. In untabulated results we find that the difference in percentage of oil revenues between treated and control firms is not statistically significant. Therefore, it is unlikely that different exposures to oil and gas prices bias our main results.

5.4. Implications for Shareholders

In this section we discuss potential shareholder implications of increased hedging activity resulting from FAS 123R. Increased hedging activity should result in a lower level of volatility for treated firms relative to control firms after FAS 123R. As a measure of volatility we focus on cash flow volatility instead of other measures such as stock return volatility. We do this as changes in hedging are likely to directly affect cash flows from operations. Stock return volatility captures not only changes in cash flow volatility from operations but is also highly sensitive to market volatility. Although we use a DID methodology to control for common trends, stock returns volatility is more likely to be affected by market forces that could lead to differential trends around the event period.

We calculate cash flow volatility as the standard deviation of quarterly net cash flows from operating activities deflated by assets.[30] For each firm-year, we estimate cash flow volatility using eight quarters of data from that year and the previous year.[31] We then estimate the difference-in-differences regressions with cash flow volatility as the dependent variable. The results are reported in Table 9. We find that in all specifications cash flow volatility declined

[30] Since net cash flows are calculated based on the firm's realized selling price, cash flow volatility incorporates the effect of changes in the firm's hedging activities as well as any other financial or operational changes implemented as a consequence of FAS 123R.

[31] Our results are robust to including twelve past quarters of data when calculating cash flow volatility for each firm-year observation.

more for the treated group relative to the control group. This result is both statistically and economically significant. In column (1) of Table 8, we find that the coefficient on the interaction variable (Treated *Post-FAS 123R) is -0.01. This implies that cash flow volatility drops by 50% more in the treated group as a result of FAS 123R relative to the mean of cash volatility in our sample.

[Insert Table 9 here]

The results in Table 9 are consistent with increased hedging activity leading to a reduction in the volatility of firms' cash flows. This additional test suggests that the increased hedging has a material effect on the riskiness of the firm. However, the results in Table 9 are also consistent with CEOs reacting to the lower level of option compensation by adjusting other corporate policies (e.g., leverage, investment, cash, dividends, etc.) to mitigate risk as in Chava and Purnanandam (2010). Consequently, it is not possible to isolate the principal cause of the lower observed cash flow volatility.

The cash flow volatility results raise the question of whether the increased hedging activity resulting from the decline in risk-taking incentives after FAS 123R affects firm value. However, it is challenging to draw any definite conclusions about the value implications of FAS-123R on hedging for two main reasons. First, our shock provides an exogenous decline in option compensation, which allows us to infer that the link between reductions in vega and hedging is causal.[32] However, the change in stock option ownership may have other value implications that are unrelated to hedging. For example, several previous studies have found positive associations between stock option holdings and both manipulation of corporate earnings and accounting fraud

[32] To better study the causal effect of changes in hedging intensity on firm value one needs an exogenous shock that directly affects hedging policy (e.g., makes hedging less or more costly). As an example of this approach see Gilje and Taillard (2014) who use an exogenous shock to the cost of hedging to study the value implications of hedging.

to boost market valuations.[33] Thus, any differential impact of FAS 123R on firm value in our setting could be due to both changes in hedging intensity and the change in the likelihood of earning management or corporate fraud. Moreover, as shown by Chava and Purnanandam (2010), FAS 123R also led to changes in other corporate policies such as leverage and investment, which in turn could have value implications. Second, it is challenging to convincingly control for all other variables that could have affected shareholder value differentially during the 2003-2006 event window. Thus, it is hard to isolate the value effect of hedging using FAS-123R.

6. Conclusions

We use the quasi-natural experiment created by the issuance of FAS 123R, and a difference-in-differences methodology to re-examine the unresolved question of whether a change in the convexity of managerial compensation causes a corresponding change in managerial risk-taking. We focus on the causal link between stock option compensation and corporate risk management. Consistent with other studies of the effect of FAS 123R on stock option issuance, we find a sharp reduction in compensation convexity (vega) following the adoption of FAS 123R. We find that the reduction in vega induced by FAS 123R caused a significant decline in managerial risk-taking that manifests itself via an increase in corporate hedging.

Our findings contribute to the literature on managerial compensation by helping to affirmatively resolve the open question of whether managerial stock option compensation has a positive causal effect on corporate risk-taking. Our findings contribute to the corporate risk management literature by providing strong evidence of the negative causal relation between option compensation and corporate hedging predicted by Smith and Stulz (1985).

[33] See Cheng and Warfield (2005), Bergstresser and Philippon (2006), Burns and Kedia (2006, 2008) and Peng and Roell (2008).

We also find evidence consistent with the increased hedging intensity resulting in lower firm-level cash flow volatility after FAS-123R. While it would be interesting to also revisit the causal effect of corporate hedging on shareholder value, our setting does not allow us to clearly identify this effect. We leave this topic for future research.

Appendix: Definition of Variables

This Appendix lists all the variables used in the paper, provides their definitions and explains how they are constructed. The principal data sources are Compustat, CRSP, ExecuComp, firms' annual reports and 10-K forms.

Altman-Z: Defined as: $Z = 1.20 * X_1 + 1.40 * X_2 + 3.30 * X_3 + 0.60 * X_4 + 0.999 * X_5$

where X_1 = working capital (current assets – current liabilities)/total assets; X_2 = retained earnings/total assets; X_3 = earnings before interest and taxes/total assets; X_4 = market value of equity/ book value of total debt; and X_5 = sales/total assets.

CAPEX: Measure of investment defined by the ratio: (capital expenditures)/ total assets

Cash: Measure of corporate liquidity defined by the ratio: (cash + cash equivalents) / total assets.

Cash Flow Volatility: The standard deviation of quarterly net cash flows from operating activities over assets estimated using eight previous quarters.

Cash Pay: Salary plus bonus of the CEO in thousands of dollars.

Delta and Vega: CEO (aggregate) compensation delta is the change (in thousands of dollars) in the dollar value of the executive's wealth derived from ownership of stock and stock options in the firm when the firm's stock price changes by one percent. CEO (aggregate) compensation vega is the change (in thousands of dollars) in the dollar value of the executive's wealth derived from ownership of stock and stock options in the firm when the annualized standard deviation of the firm's stock price changes by 0.01. We calculate the (aggregate) delta of the executive's compensation as the sum of the deltas of the options holdings and the delta of the stock holdings. We obtain the (aggregate) vega of the executive's compensation as the sum of the vegas of the executive's options holdings. Following Coles, Daniel and Naveen (2006) we disregard the vega of stock holdings. The delta and vega of options holdings are calculated based on the methodology in Guay (1999) and Core and Guay (2002).[34]

The deltas of stock and options holdings are given by:

$$Delta(stock\ holdings) = 0.01S \times number\ of\ shares\ owned \qquad (A.1)$$

[34] Following the convention in previous studies, while all the delta and vega measures we use in our analysis are aggregates over the executive's entire holdings in the firm, we omit using the qualifier "aggregate" when referring to compensation deltas and vegas elsewhere in the paper.

$$Delta(options\ holdings) = 0.01e^{-dt}N(Z)S \times number\ of\ options\ owned \quad (A.2)$$

where $Z = \frac{In\left(\frac{S}{X}\right)+T\left(r-d+\frac{\sigma^2}{2}\right)}{\sigma T^{0.5}}$, S = underlying stock price, X = option exercise price, T = time to maturity of the option (number of years), r = ln [1 + risk-free interest rate], d = ln [1 + expected dividend rate on the stock], σ = annualized stock return volatility, N = cumulative density function for normal distribution.

The vega of options holdings is given by:

$$Vega(options\ holdings) = 0.01e^{-dt}N'(Z)ST^{0.5} \times number\ of\ options\ owned \quad (A.3)$$

where N = probability density function for normal distribution.

For the underlying stock price (S) we use the end-of-year stock price from Compustat. For the risk-free interest rate (r) we use the yield on the Treasury bond whose maturity is closest to the maturity of the stock option. We compute stock return volatility (σ) from weekly adjusted stock returns obtained from CRSP.

ExecuComp provides details on compensation packages such as size, exercise price, and time to maturity for each of the current year's option grants, but for previously granted options (exercisable or unexercisable), it merely gives aggregate size and realizable value (the potential gains from exercising all options at the fiscal-yearend price). Core and Guay's method is used to estimate the exercise price and time to maturity for these options so that the formulae A.2 and A.3 can be applied.

First, we directly apply the above formula to calculate the delta and vega of each current-year option grant. The delta and vega of the portfolio of newly granted options are the sum of the delta and vega of each new grant.

Then, after removing newly granted options, if any, from the fiscal year-end option portfolio, we obtain a portfolio of previously granted options only. Some of these options are exercisable (vested) and others are unexercisable (unvested). We compute the delta and vega separately for the portfolio of exercisable options and the portfolio of unexercisable options. To find the exercise price, for each portfolio, we first divide the aggregate realizable value by the number of options in the portfolio, which gives the average of (stock price – exercise price). We then subtract this number from the stock price to arrive at the average exercise price.

To estimate time to maturity, for unexercisable options, we set the average time to maturity equal to one year less than the time to maturity of the current year's options grants, or equal to 9 years if no grant was made in the current year; for exercisable options, we set the average time to maturity equal to 4 years less than the time to maturity of the current year's options grants, or 6 years if no grant was made in the current year. Using the imputed average exercise price and average time to maturity, we can apply the formulae A.2 and A.3 to calculate the delta and vega of the two portfolios of previously granted options. The delta and vega of an executive's entire option portfolio is the sum of the delta and vega of the portfolio of newly granted options, the portfolio of previously granted, unexercisable options, and the portfolio of previously granted, exercisable options.

Dividend dummy: Equals one if a firm paid cash dividends in the given year and is zero otherwise.

Equity Pay: The value of equity grants to the CEO in thousands of dollars.

Hedge dummy: Equals one if a firm is hedging (using derivatives) in a specific time period and is zero otherwise.

Hedge ratio 1 and Hedge ratio 2: The hedge ratio is the fraction of the firm's expected oil and gas production for Hedge ratio 1 (or reserves for Hedge ratio 2) that it has hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to expected production or reserves (in barrels of oil equivalent).

Investment Growth: Percentage change in capital expenditures between year *t* and *t*-1.

Leverage: Calculated as the book value of long-term debt divided by the sum of book values of preferred stock, common equity, and long-term debt.

Option Pay: The Black Scholes value of stock option grants to the CEO in thousands of dollars.

Portfolio delta: Portfolio delta is the amount of oil and gas that the firm has effectively sold short, computed as the sum of the firm's individual derivatives positions (in barrels of oil equivalent) weighted by their respective deltas.

Production: Amount of oil and gas produced by the firm during the year (in barrels of oil equivalent).

Reserves: Proven reserves of oil and gas (in barrels of oil equivalent) owned by the firm at the end of the fiscal year.

ROA: Return on assets. This is calculated as the ratio of net income to assets.

Size: The natural logarithm of the market value of assets. The market value of assets equals book value of assets minus book value of common stock plus market value of equity.

Total Pay: Total CEO compensation (ExecuComp TDC1) in thousands of dollars.

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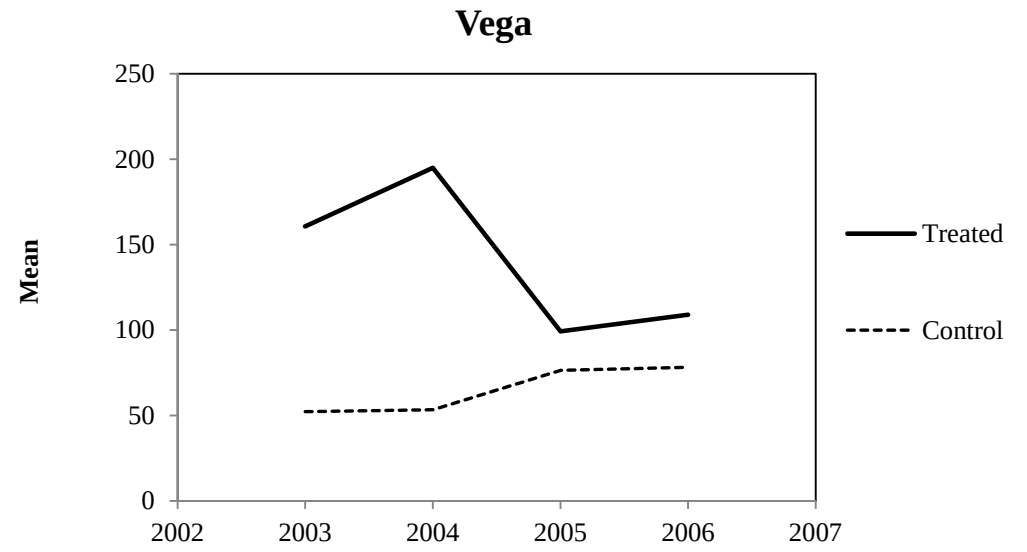
Figure 1. Average Vegas and Option Pay Ratios

These figures look at the time trend in CEO vega and the ratio of option pay to total pay around the adoptions of FAS 123R. We plot the average vega and option pay/total pay for 2003-2006 for the treated and control groups. Control group includes firms that did not pay options prior to FAS 123R or adopted the fair value method prior to FAS 123R, and Treated group includes the remaining sample firms. The pre-FAS period is 2003-2004; the post-FAS 123R period is 2005-2006. Vega is the change (in thousands of dollars) in the dollar value of the executive's wealth when the annualized standard deviation of the firm's stock price changes by 0.01.



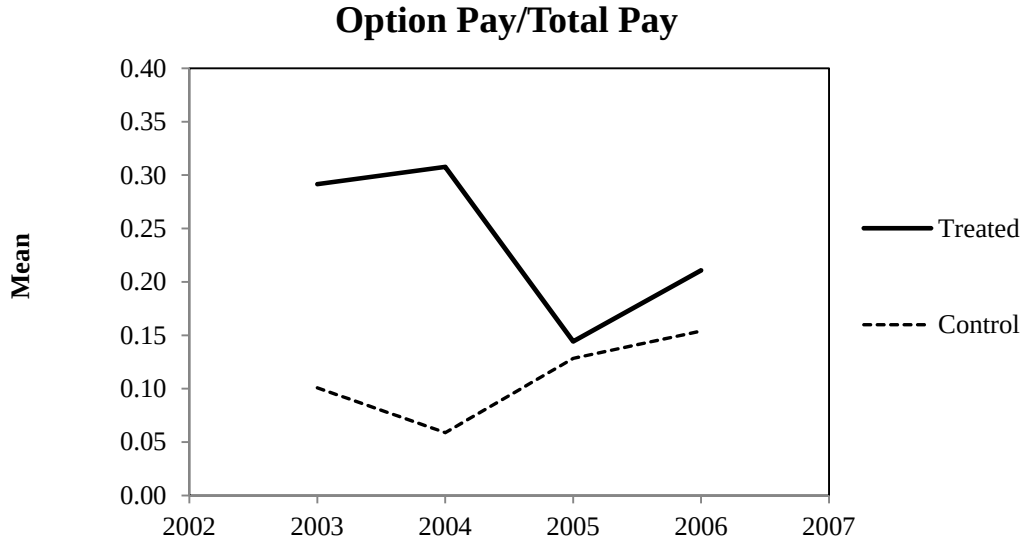
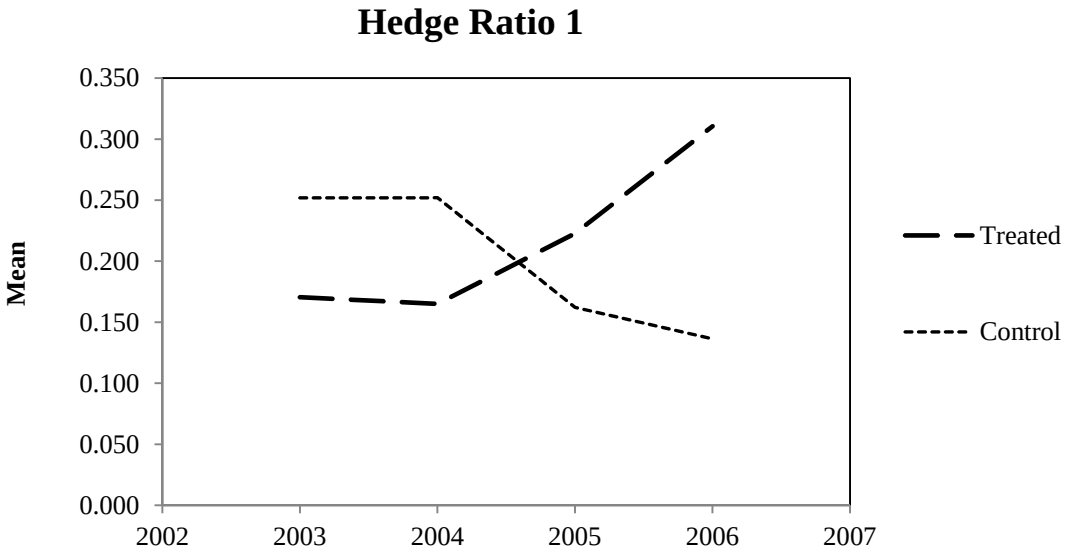


Figure 2. Average Total Hedge Ratios

These figures look at the time trend in hedge ratios around the adoptions of FAS 123R. We plot the average hedge ratios for 2003-2006 for the treated and control groups. Control group include firms that did not pay options prior to FAS 123R or adopted the fair value method prior to FAS 123R and Treated group includes the remaining sample firms. The pre-FAS period is 2003-2004; the post-FAS 123R period is 2005-2006. *Hedge Ratio 1* is the fraction of the firm's expected oil and gas production that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to expected production. *Hedge Ratio 2* is the fraction of the firm's oil and gas reserves that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to reserves.



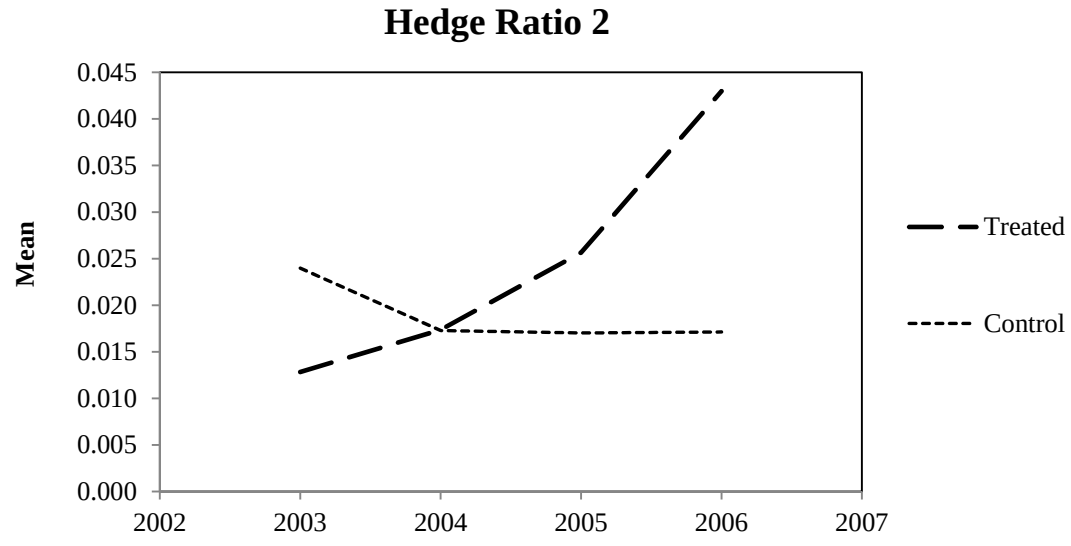


Table 1. Summary Statistics

Panel A contains summary statistics for the variables used in the analysis from the full sample. The sample consists of 154 firm-year observations from SIC code 1311 over fiscal years 2003 through 2006 surrounding the adoption of FAS 123R. FAS 123R became effective for all firms with fiscal years beginning after December 2005. The pre-FAS 123R period is defined as fiscal years from 2003-2004 and the post-FAS 123R period is defined as fiscal years from 2005-2006. Panel B contains summary statistics for the full sample divided between the pre- and post-FAS 123R sub-periods. All variables are defined in the Appendix

Panel A: Full Sample

	Mean	Standard Deviation	25th Percentile	Median	75th Percentile
Delta	402.608	670.809	59.313	168.710	598.309
Vega	110.693	274.185	12.013	55.025	152.363
Total Pay	7,551.222	13,107.54	1539	3,650.94	6,809.03
Option Pay	1,752.464	5405.1	0	305.8505	1,384.905
Stock Pay	2,629.691	5,605.117	0	791	2100
Equity Pay	5,075.47	10,751.74	672.787	2,122.28	4,825.344
Bonuses	1,218.27	3,667.73	158.85	450.00	1,126.21
Option Pay/Total Pay	0.232	0.182	0.00	0.149	0.330
Stock Pay/Total Pay	0.348	0.252	0.00	0.242	0.455
Equity Pay/Total Pay	0.672	0.240	0.447	0.580	0.793
Hedge Ratio 1	0.236	0.393	0.011	0.086	0.344
Hedge Ratio 2	0.022	0.032	0.001	0.009	0.030
Hedge Dummy	0.821	0.385	0	1	1
Size	7.893	1.297	7.001	7.604	8.802
ROA	0.077	0.067	0.046	0.073	0.105
Investment Growth	0.215	0.101	0.146	0.198	0.271
Altman-Z	2.547	1.303	1.604	2.350	3.063
Leverage	0.239	0.124	0.167	0.242	0.329
Dividend	0.546	0.499	0	1	1
Cash	0.042	0.072	0.002	0.012	0.049
CEO Age	55.049	5.797	51	54	58
CEO Tenure	8.071	6.796	4	6	11
Cash flow Volatility	0.021	0.021	0.011	0.015	0.019

Panel B: Full Sample pre- and post-FAS 123R

	Pre-FAS 123R (2003-2004)			Post-FAS 123R (2005-2006)		
	Mean	Median	N	Mean	Median	N
Delta	356.744	158.16	80	452.083	171.917	74
Vega	125.183	74.271	80	95.022	45.224	74
Option Pay/Total Pay	0.294	0.206	80	0.164	0.116	74
Total Pay	6,193.04	2,745.74	80	9,028.90	4,543.97	74
Hedge Ratio 1	0.229	0.084	80	0.244	0.094	74
Hedge Ratio 2	0.017	0.007	80	0.028	0.015	74
Size	7.649	7.405	80	8.192	7.863	74
ROA	0.076	0.073	80	0.081	0.081	74
Investment Growth	0.212	0.188	80	0.218	0.219	74
Altman-Z	2.572	2.350	80	2.516	2.307	74
Leverage	0.254	0.246	80	0.223	0.236	74
Dividend	0.562	1	80	0.527	1	74
Cash	0.043	0.013	80	0.041	0.011	74
CEO Age	54.802	54	80	55.311	55	74
CEO Tenure	7.769	6	80	8.412	7	74
Bonuses	898.96	400	80	1,604.11	500	74

Table 2. Difference-in-Differences Regressions: Effect of FAS 123R on Delta and Vega

This table contains the results of estimating difference-in-differences (DID) regressions to investigate the effect of FAS 123R on *Delta* and *Vega. Post-FAS 123R* is an indicator variable that equals one if the observation is after the adoption of FAS 123R. *Treated* is an indicator variable that is one if the observation is part of the treated group. *Treated* is equal to zero if the firm is in the control group. Control group includes firms that did not have option pay prior to FAS 123R or adopted the fair value method prior to FAS 123R. *Treated *Post-FAS 123R* is the DID estimate. *Delta* is the change (in thousands of dollars) in the dollar value of the executive's wealth when the firm's stock price changes by one percent. *Vega* is the change (in thousands of dollars) in the dollar value of the executive's wealth when the annualized standard deviation of the firm's stock price changes by 0.01. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values with the exception of those in the firm-fixed effects regressions are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Log(1+Vega)			Log(1+Delta)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-FAS 123R	0.464	-0.174		0.656*	-0.228	
	(0.273)	(0.674)		(0.098)	(0.223)	
Treated	1.896***	2.231***		0.416	0.576*	
	(0.002)	(0.000)		(0.240)	(0.068)	
Treated *Post-FAS 123R	-1.027**	-1.067**	-0.871***	0.134	0.126	0.119
	(0.041)	(0.025)	(0.001)	(0.798)	(0.598)	(0.477)
Investment Growth		2.431	0.042		3.236**	0.979
		(0.420)	(0.969)		(0.041)	(0.273)
Size		0.919***	0.313		0.883***	0.338*
		(0.000)	(0.277)		(0.000)	(0.094)
Leverage		3.123	0.913		-0.505	-1.578
		(0.107)	(0.551)		(0.796)	(0.160)
ROA		-2.361	-1.017		-1.318	-0.874
		(0.174)	(0.433)		(0.157)	(0.407)
Altman-Z		0.313	0.043		-0.005	-0.129
		(0.234)	(0.778)		(0.983)	(0.303)
Cash		1.323	2.746**		0.486	0.457
		(0.650)	(0.048)		(0.760)	(0.450)
Dividend		0.178	0.673**		0.172	0.616**
		(0.755)	(0.021)		(0.782)	(0.015)
CEO Age		-0.004	-0.009		-0.053*	-0.011
		(0.915)	(0.607)		(0.062)	(0.453)
CEO Tenure		0.019	-0.013		0.063***	0.002
		(0.620)	(0.741)		(0.008)	(0.956)
Log(Bonuses)		0.003	-0.011		0.060	-0.024
		(0.963)	(0.722)		(0.167)	(0.347)
Constant	2.528***	-6.573***	7.285***	4.532***	-0.389	3.551*
	(0.000)	(0.006)	(0.005)	(0.000)	(0.877)	(0.077)
Adj-R^2	0.161	0.393	0.112	0.045	0.576	0.378
Year & Firm FE	No	No	Yes	No	No	Yes
N	154	154	154	154	154	154

Table 3. Difference-in-Differences Regressions: Effect of FAS 123R on Hedging

This table contains the results of estimating difference-in-differences regressions to investigate the effect of FAS 123R on corporate hedging. *Post-FAS 123R* is an indicator variable that equals one if the observation is after the adoption of FAS 123R. *Treated* is an indicator variable that is one if the observation is part of the treated group, i.e. firms that included options in CEO pay prior to the adoption of FAS 123R and those that did not adopt the fair value method for expensing options prior to the adoption of FAS 123R. *Treated* is equal to zero if the firm is in the control group, i.e. firms that preemptively adopted the fair value method prior to FAS 123R or did not pay options prior to FAS 123R. *Treated *Post-FAS 123R* is the DID estimate. *Hedge Ratio 1* is the fraction of the firm's expected oil and gas production that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to expected production. *Hedge Ratio 2* is the fraction of the firm's oil and gas reserves that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to reserves. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values with the exception of those in the firm-fixed effects regressions are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Hedge Ratio 1			Hedge Ratio 2		
	(1)	(2)	(3)	(1)	(2)	(3)
Post-FAS 123R	-0.224**	-0.092		-0.001	-0.008	
	(0.011)	(0.115)		(0.869)	(0.349)	
Treated	-0.177**	-0.097		-0.006	-0.004	
	(0.036)	(0.404)		(0.378)	(0.593)	
Treated *Post-FAS 123R	0.407***	0.270**	0.259***	0.021**	0.032***	0.030***
	(0.001)	(0.011)	(0.001)	(0.015)	(0.009)	(0.001)
Log(1+Delta)		0.075	-0.051		0.006	-0.005*
		(0.112)	(0.410)		(0.148)	(0.088)
Investment Growth		-0.991**	-0.750		-0.075*	-0.059
		(0.044)	(0.103)		(0.065)	(0.124)
Size		-0.037	0.055		-0.002	-0.001
		(0.386)	(0.634)		(0.650)	(0.972)
Leverage		0.427	1.102*		0.021	0.020
		(0.166)	(0.087)		(0.586)	(0.628)
ROA		-0.194	0.432		-0.036	0.035
		(0.812)	(0.422)		(0.631)	(0.525)
Altman-Z		-0.037	0.039		-0.007	-0.007
		(0.530)	(0.537)		(0.192)	(0.137)
Cash		-0.626	0.138*		-0.050	-0.051
		(0.227)	(0.969)		(0.313)	(0.362)
Dividend		-0.073	-0.017		-0.001	-0.0005
		(0.351)	(0.893)		(0.972)	(0.938)
CEO Age		-0.001	0.005		-0.0001	0.0000
		(0.764)	(0.499)		(0.894)	(0.907)
CEO Tenure		-0.009	-0.001		-0.0001	-0.0001
		(0.165)	(0.990)		(0.755)	(0.845)
Log(Bonuses)		-0.021**	-0.029**		-0.007***	-0.006***
		(0.018)	(0.029)		(0.008)	(0.001)
Constant	0.321***	0.775**	-0.294	0.022***	0.088**	0.069*
	(0.000)	(0.030)	(0.775)	(0.000)	(0.026)	(0.075)
Adj-R^2	0.064	0.282	0.174	0.055	0.311	0.386
Year & Firm FE	No	No	Yes	No	No	Yes
N	154	154	154	154	154	154

Table 4. Comparison of Treated and Control Firms Pre-FAS 123R

This table contains summary statistics for the treated and control groups in the pre-FAS 123R period (2003-2004). Control firms are firms that had no option pay prior to the adoption of FAS 123R or firms that expensed options using the fair-value method prior to the adoption of FAS 123R. All remaining firms are treated firms. *Δ(Hedge Ratio 1)* is defined as the difference in *Hedge Ratio 1* from 2003 to 2004. *Δ(Hedge Ratio 2)* is defined as the difference in *Hedge Ratio 2* from 2003 to 2004. All other variables are defined in the Appendix. the notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively, in the differences in means and medians of the variables in the pre FAS-123R period (2003-2004) in the control groups and treated groups using the t-test for means and Wilcoxon signed rank-sum test for medians.

	Control Group			Treated Group		
	Mean	Median	N	Mean	Median	N
Delta	223.964	112.757	29	432.222*	188.076	51
Vega	52.821	12.838	29	165.991***	142.75***	51
Option Pay/Total Pay	0.089	0	29	0.331***	0.272***	51
Total Pay	3551.78	2,915.76	29	7694.32*	2,979.15	51
Hedge Ratio 1	0.260	0.116	29	0.184	0.0639	51
Hedge Ratio 2	0.020	0.009	29	0.015	0.005	51
Size	8.036	7.923	29	7.409	7.159	51
ROA	0.069	0.073	29	0.079	0.070	51
Investment Growth	0.184	0.185	29	0.228	0.224	51
Altman-Z	2.170	2.129	29	2.801	2.513	51
Leverage	0.281	0.246	29	0.239	0.249	51
Dividend	0.545	1	29	0.571	1	51
Cash	0.031	0.012	29	0.049*	0.011	51
CEO Age	55.072	55	29	54.644	54	51
CEO Tenure	7.333	6	29	8.018	7	51
Bonuses	743.28	600	29	994.09	341.75	51
Δ(Hedge Ratio 1)	0.003	-0.009	29	-0.012	0.022	51
Δ(Hedge Ratio 2)	-0.006	-0.007	29	0.004	0.004	51

Table 5. Placebo Tests

This table presents two placebo tests using the difference-in-differences (DID) methodology from Table 3. The first placebo experiment uses 2000-2001 and 2002-2003 as our pre- and post-event periods respectively (that is years (-5) and (-4) relative to the actual event years). This experiment uses the same treated and control firms as in Table 3. The second placebo experiment defines control firms as firms that did not have option grants in 2006. For this test we use 2006 and 2007 as the pre-event and post-event periods, respectively. *Hedge Ratio 1* is the fraction of the firm's expected oil and gas production that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to expected production. *Hedge Ratio 2* is the fraction of the firm's oil and gas reserves that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to reserves. All other variables are defined in the Appendix. We report p-values in parentheses below the difference-in-differences estimates. The notation *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	First Placebo: Similar Control Groups				Second Placebo: No Option Pay in 2006	
	Hedge Ratio 1	Hedge Ratio 2	Hedge Ratio 1	Hedge Ratio 2	Hedge Ratio 1	Hedge Ratio 2
Post-Event	-0.121*	-0.019*			0.039	-0.005
	(0.089)	(0.083)			(0.761)	(0.601)
Treated	0.049	0.011			0.019	-0.007
	(0.966)	(0.803)			(0.867)	(0.464)
Treated *Post-Event	0.072	0.012	0.019	0.013	0.049	0.007
	(0.602)	(0.594)	(0.762)	(0.452)	(0.766)	(0.580)
Log(1+Delta)	0.065	0.005	-0.081	-0.004*	0.019	-0.008
	(0.127)	(0.212)	(0.136)	(0.080)	(0.193)	(0.309)
Investment Growth	-0.425	-0.200	-0.068	-0.017	-0.259	-0.005
	(0.315)	(0.700)	(0.359)	(0.227)	(0.165)	(0.901)
Size	-0.018	-0.004	0.048	-0.008	-0.049	-0.009
	(0.640)	(0.322)	(0.832)	(0.743)	(0.727)	(0.265)
Leverage	0.012	0.003	0.217*	0.031	0.815**	0.004
	(0.635)	(0.968)	(0.097)	(0.595)	(0.043)	(0.322)
ROA	-0.066**	-0.143*	0.235	0.261	-0.033*	-0.078
	(0.012)	(0.064)	(0.293)	(0.177)	(0.053)	(0.184)
Altman-Z	-0.009	-0.005	0.017	-0.002	-0.006	-0.001
	(0.423)	(0.449)	(0.215)	(0.222)	(0.398)	(0.482)
Cash	-0.421	-0.004	0.198	-0.015	-0.305	-0.014
	(0.247)	(0.953)	(0.499)	(0.624)	(0.377)	(0.701)
Dividend	-0.062*	-0.001	-0.016	-0.0001	-0.031	-0.002
	(0.092)	(0.191)	(0.729)	(0.830)	(0.214)	(0.664)
CEO Age	-0.010	-0.0004	0.009	0.0001	-0.002	-0.0005
	(0.174)	(0.135)	(0.678)	(0.554)	(0.807)	(0.352)
CEO Tenure	-0.005	-0.0001	-0.020	0.002	-0.014*	-0.001**
	(0.477)	(0.242)	(0.418)	(0.412)	(0.063)	(0.040)
Log(Bonuses)	-0.062	-0.008	-0.059*	-0.020	-0.034*	-0.003
	(0.229)	(0.112)	(0.061)	(0.178)	(0.281)	(0.277)
Constant	0.035	0.021	-0.114	0.092	0.029	0.036
	(0.392)	(0.628)	(0.540)	(0.653)	(0.587)	(0.532)
Adj-R^2	0.127	0.106	0.171	0.163	0.235	0.043
Year & Firm FE	No	No	Yes	Yes	No	No
N	150	150	150	150	62	62

Table 6. Triple Difference Regressions: Intensity of Changes in Compensation Convexity and Hedging

This table contains the results of estimating a triple difference specification to investigate the effect of FAS 123R on corporate hedging for different intensities of changes in compensation convexity. *Reduction in Vega* is defined as the change in vega calculated as the difference between the average vega pre-FAS 123R (2003-2004) and the average vega post-FAS 123R (2005-2006). *Post-FAS 123R* is an indicator variable that equals one if the observation is after the adoption of FAS 123R. *Treated* is an indicator variable that is one if the observation is part of the treated group, i.e. firms that were likely to be affected by the passage of FAS-123R as they either had option pay or had not adopted FAS 123R prior to 2003. *Treated* is equal to zero if the firm is in the control group, i.e. firms that preemptively adopted the fair value method prior to FAS 123R or did not pay options prior to FAS 123R. *Low Outside Wealth*Treated* Post-FAS 123R* is the triple difference estimate. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values with the exception of those in the firm-fixed effects regressions are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Hedge Ratio 1		Hedge Ratio 2	
	(1)	(2)	(3)	(4)
Post-FAS 123R	-0.158**		-0.005	
	(0.034)		(0.371)	
Treated	-0.169		-0.010	
	(0.258)		(0.346)	
Reduction in log(1+Vega)	0.015		0.001	
	(0.817)		(0.837)	
Treated *Post-FAS 123R	0.133	0.153	0.018	0.019
	(0.216)	(0.127)	(0.282)	(0.181)
Reduction in Vega*Treated	0.013	-0.049	0.002	0.002
	(0.866)	(0.539)	(0.761)	(0.938)
Reduction in Vega*Post-FAS 123R	-0.014	-0.000	0.005	0.007
	(0.738)	(0.990)	(0.438)	(0.232)
Reduction in Vega*Treated* Post-FAS 123R	0.237***	0.211**	0.010	0.008
	(0.010)	(0.029)	(0.104)	(0.147)
Constant	0.307**	0.257***	0.022***	0.017**
	(0.015)	(0.000)	(0.001)	(0.014)
Adj-R^2	0.064	0.084	0.071	0.102
Year & Firm FE	No	Yes	No	Yes
N	154	154	154	154

Table 7. Triple Difference Regressions: CEO Outside Wealth and Hedging

This table contains the results of estimating a triple difference specification to investigate the effect of FAS 123R on corporate hedging for different levels of CEO outside wealth. Outside wealth is defined as the average of the CEO's past cash compensation (salary and bonuses) over the five year prior to FAS 123R (2000-2004). *Low Outside Wealth* contains treated and control firms that had levels of outside wealth below the median in the treated and control groups. *Post-FAS 123R* is an indicator variable that equals one if the observation is after the adoption of FAS 123R. *Treated* is an indicator variable that is one if the observation is part of the treated group, i.e. firms that were likely to be affected by the passage of FAS-123R as they either had option pay or had not adopted FAS 123R prior to 2003. *Treated* is equal to zero if the firm is in the control group, i.e. firms that preemptively adopted the fair value method prior to FAS 123R or did not pay options prior to FAS 123R. *Low Outside Wealth*Treated* Post-FAS 123R* is the triple difference estimate. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values with the exception of those in the firm-fixed effects regressions are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Hedge Ratio 1		Hedge Ratio 2	
	(1)	(2)	(3)	(4)
Post-FAS 123R	-0.097*		-0.009	
	(0.063)		(0.202)	
Treated	-0.009		-0.003	
	(0.919)		(0.803)	
Low Outside Wealth	0.226		-0.001	
	(0.379)		(0.993)	
Treated *Post-FAS 123R	0.138	0.236**	0.016	0.026*
	(0.139)	(0.033)	(0.130)	(0.095)
Low Outside Wealth*Treated	-0.313	-0.209	-0.009	-0.000
	(0.251)	(0.346)	(0.604)	(0.998)
Low Outside Wealth*Post-FAS 123R	-0.060	-0.135	0.017	0.015
	(0.683)	(0.232)	(0.267)	(0.332)
Low Outside Wealth*Treated* Post-FAS 123R	0.257*	0.216	0.024	0.015
	(0.098)	(0.101)	(0.189)	(0.281)
Constant	0.166***	0.267***	0.020***	0.016
	(0.002)	(0.001)	(0.002)	(0.163)
Adj-R^2	0.047	0.034	0.106	0.161
Year & Firm FE	No	Yes	No	Yes
N	102	102	102	102

Table 8. Changes in Hedging around the Regulation Event

This table contains the results of estimating difference regressions around the adoption of FAS 123R. All variables are the differences of the average pre and post-FAS 123R values. Delta is the change (in thousands of dollars) in the dollar value of the executive's wealth when the firm's stock price changes by one percent. Vega is the change (in thousands of dollars) in the dollar value of the executive's wealth when the annualized standard deviation of the firm's stock price changes by 0.01. *Hedge Ratio 1* is the fraction of the firm's expected oil and gas production that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to expected production. *Hedge Ratio 2* is the fraction of the firm's oil and gas reserves that is hedged, calculated as the ratio of the portfolio delta for derivatives contracts and operational hedges to reserves. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Hedge Ratio 1	Hedge Ratio 2
d(Vega)	-0.001*	-0.0001**
	(0.068)	(0.019)
d(Delta)	-0.000	-0.000
	(0.996)	(0.969)
d(InvGrowth)	-0.529*	-0.019
	(0.066)	(0.472)
d(Size)	0.047	0.004
	(0.184)	(0.185)
d(Leverage)	0.769**	0.047
	(0.035)	(0.128)
d(ROA)	0.174	0.010
	(0.622)	(0.765)
d(Altman-Z)	0.008	0.001
	(0.816)	(0.896)
d(Cash)	-0.337	-0.040
	(0.502)	(0.369)
d(Dividend)	-0.011	-0.000
	(0.870)	(0.992)
Constant	-0.157	-0.012
	(0.662)	(0.718)
Adj-R^2	0.164	0.132
N	42	42

Table 9. Difference-in-Differences Regressions: FAS 123R and Cash Flow Volatility

This table contains the results of estimating difference-in-differences regressions to investigate the effect of FAS 123R on cash flow volatility. *Post-FAS 123R* is an indicator variable that equals one if the observation is after the adoption of FAS 123R. *Treated* is an indicator variable that equals one if the observation is part of the treated group, i.e. firms that included options in CEO pay prior to the adoption of FAS 123R and those that did not adopt the fair value method for expensing options prior to the adoption of FAS 123R. *Treated* is equal to zero if the firm is included in the control group, i.e. firms preemptively adopted the fair value method prior to FAS 123R or did not pay options prior to FAS 123R. *Treated *Post-FAS 123R* is the DID estimate. *Cash Flow Volatility* is defined as the standard deviation of quarterly net cash flows from operating activities over assets. For each firm-year we calculate cash flow volatility using eight quarters of data from that year and the previous year. All other variables are defined in the Appendix. The table reports p-values in parentheses. All p-values with the exception of those in the firm-fixed effects regressions are computed with standard errors clustered at the firm level. The notation ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Cash Flow Volatility			
	(1)	(2)	(3)	(4)
Post-FAS 123R	0.002	0.003		
	(0.146)	(0.257)		
Treated	0.012**	0.003		
	(0.045)	(0.278)		
Treated *Post-FAS 123R	-0.010**	-0.007*	-0.011**	-0.009*
	(0.030)	(0.096)	(0.041)	(0.081)
Log(1+Delta)		-0.001		-0.002
		(0.333)		(0.301)
Investment Growth		-0.005		-0.015
		(0.749)		(0.367)
Size		-0.003***		-0.001
		(0.009)		(0.734)
Leverage		-0.030**		-0.035*
		(0.050)		(0.098)
ROA		0.003		0.014**
		(0.925)		(0.026)
Altman-Z		-0.002*		-0.002
		(0.078)		(0.426)
Cash		0.051***		0.029
		(0.001)		(0.216)
Dividend		-0.001		0.001
		(0.945)		(0.759)
CEO Age		-0.003		0.001
		(0.122)		(0.583)
CEO Tenure		-0.0001		-0.003
		(0.699)		(0.609)
Log(Bonuses)		0.001		0.001
		(0.200)		(0.185)
Constant	0.015***	0.077***	0.024***	0.065*
	(0.000)	(0.000)	(0.000)	(0.088)
Adj-R^2	0.051	0.183	0.026	0.167
Year & Firm FE	No	No	Yes	Yes
N	154	154	154	154