Essays on the Corporate Implications of Compensation Incentives

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This dissertation is comprised of three essays which examine the ramifications of executive compensation incentive structures on corporate outcomes. In the first essay, I present evidence which suggests that executive compensation convexity, measured as the sensitivity of managerial equity compensation portfolios to stock volatility, predicts firm-specific crashes. I find that a bottom-to-top decile change in compensation convexity results in a 21% increase in a firm's unconditional ex-post idiosyncratic crash risk. In contrast, I do not find robust evidence of a symmetric relation between compensation convexity and a firm's idiosyncratic positive jump risk. Finally, I exploit exogenous variation in compensation convexity, arising from a change in the expensing treatment of executive stock options, in buttressing my interpretations within a natural experiment setting. My results suggest that managerial equity compensation portfolios do not augment a firm's future idiosyncratic crash risk because they link managerial wealth to equity prices, but rather because they tie managerial wealth to the volatility of a firm's equity.

In the second essay, I exploit an exogenous negative shock to CEO compensation convexity in examining the differential ramifications of option pay and risk-taking incentives on the systematic and idiosyncratic volatility of the firm. I find new evidence that is largely consistent with the notion that compensation convexity, stemming from option convexity, predominantly incentivizes under-diversified risk-averse CEOs to increase the value of their option portfolios by increasing the systematic volatility of the firms they manage. I hypothesize that this effect manifests as systematic volatility is readily more hedgeable than idiosyncratic volatility from the perspective of

risk-averse executives who are overexposed to the idiosyncratic risk of their firms. If managers use options as a conduit through which they can gamble with shareholder wealth by overexposing them to suboptimal systematic volatility, options are not serving their intended contracting function. Instead of decreasing agency costs of risk, by encouraging CEOs to adopt innovative positive NPV projects that may be primarily characterized by idiosyncratic risk, option pay may have contributed to the same frictions it was intended to reduce.

In the third essay, I present evidence that is consistent with the notion that certain managerial debt-like remuneration structures decrease the likelihood of firm-specific positive stock-price jumps. Namely, I find that a bottom-to-top decile increase in the present value of CEO pension pay leads to a roughly 25% decrease in a firm's unconditional ex-post jump probability. However, I do not find that CEO deferred compensation decreases firm jump risk. Finally, I find that information in option-implied volatility smirks does not appear to reflect these dynamics. Together, these results suggest that not all debt-like compensation mechanisms decrease managerial risk-taking equally.

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CHAPTER 1

Executive Compensation Convexity and Firm Crash Risk

1.1. Introduction

A growing body of evidence shows that equity components of executive compensation, originally designed to mitigate agency costs within a firm, may, instead, exacerbate the frictions they are intended to remedy. For instance, Armstrong, Larcker, Ormazabal, and Taylor (2013) find that compensation convexity within executive remuneration portfolios incentivizes executives to misreport the earnings of the firms they manage. Benmelech, Kandel, and Veronesi (2010) demonstrate theoretically that the concealing of negative firm-specific information induced by stock-based compensation should precipitate substantial market overvaluations as well as subsequent crashes in the firm's stock price. In this paper, I examine empirically whether executive compensation convexity, measured as the average sensitivity of the top executives' equity compensation portfolios to stock volatility, predicts idiosyncratic firm crashes. Using four measures of idiosyncratic firm crash risk, one ex-ante and three ex-post, I provide new evidence demonstrating an economically significant positive predictive link between compensation convexity (risk-taking incentives) and idiosyncratic firm crashes.

My first measure of a firm's idiosyncratic crash risk is the steepness of its option implied volatility smirk. Within the Black-Scholes-Merton option pricing framework, all options written on the same underlying asset and time to expiration should yield identical estimates of implied volatility. Empirically, the implied volatilities of out-of-the-money put options typically exceed those of at-the-money put options. The option pricing literature suggests that the smirk reflects the option market's expectation of future crash and negative jump risk in stock prices (Bates, 1991; Dumas, Fleming, and Whaley, 1998; Bates, 2000; Pan, 2002). I find that executive compensation convexity is positively related to the slope of a firm's put smirk. This result suggests that the option market's ex-ante expectation of a firm's future idiosyncratic crash and negative jump risk increases with executive compensation convexity.

Next, I consider the ramifications of compensation convexity on a firm's ex-post idiosyncratic crash risk. Following Hutton, Marcus, and Tehranian (2009), I define an ex-post idiosyncratic firm crash as a decline in idiosyncratic firm weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return for a given firm fiscal year.[1] My first measure of ex-post idiosyncratic firm crash risk is a binary indicator specifying the occurrence of an idiosyncratic firm crash within a firm fiscal year. Using logistic, conditional logistic, and linear probability models, I identify a positive predictive relationship between executive compensation convexity and the occurrence of idiosyncratic firm crashes. All else equal, I find that moving from the bottom decile to the top decile of compensation convexity results in a 5.14 percentage point increase in a firm's idiosyncratic crash risk. This increase is economically significant as, on average, it represents roughly 21% of a firm's unconditional ex-post idiosyncratic crash risk.

My second measure of ex-post idiosyncratic firm crash risk is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. By means of Poisson, conditional Poisson, and linear model analysis, I find that executive compensation convexity is positively related to the number of idiosyncratic firm crashes within a given firm fiscal year. My third measure of ex-post idiosyncratic firm crash risk is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Using this measure, I show that executive compensation convexity is positively related to the magnitude of idiosyncratic firm crashes.

Across my empirical specifications, I find that executive compensation convexity is positively related to the realized (ex-post) occurrence, frequency, and magnitude of idiosyncratic firm stock-price crashes. This relation persists even after controlling for the idiosyncratic firm put smirk and other established predictive measures of

[1] 3.09 standard deviations is selected as the crash threshold as it yields a 0.1% probability of crashes under the normal distribution.

idiosyncratic crashes. This evidence suggests that option prices may not fully reflect the impact of compensation convexity on future firm crash risk. I also demonstrate that the positive relation between compensation convexity and the idiosyncratic firm crash measures is robust to alternate definitions of compensation convexity as well as to the inclusion of firm, year, executive, and executive spell fixed effects (CEO×Firm fixed effects).

Compensation convexity provides executives with incentives to conceal negative earnings information pertaining to the firms which they manage. This occurs as convexity within remuneration mechanisms decreases managerial aversion to the increased equity risk stemming from misreporting. The resulting discontinuous release of adverse firm-specific news, in clusters, mediates the observed empirical relation between convexity and crashes. Accordingly, the link between convexity and idiosyncratic crash risk should be more pronounced in firms in which it is more feasible for executives to withhold information from the market. Pontiff (2006) finds that idiosyncratic risk is the single largest impediment to market efficiency. As arbitrageurs are unable to fully hedge the idiosyncratic risk stemming from arbitrage positions, they must assess the costs of idiosyncratic risk exposure on expected arbitrage profits. All else equal, managers should be able to conceal more information in higher idiosyncratic volatility firms as the costs to arbitraging mispricing in the stock prices of these firms are more stringent. In accordance with the hypothesized amplification effects of informational inefficiency on the convexity-idiosyncratic crash risk relation, I find that the positive association between compensation convexity and ex-post crash risk is stronger in higher idiosyncratic volatility firms.

I assess the robustness of my inferences within a natural experiment setting by exploiting the exogenous variation in compensation convexity surrounding a change in the expensing treatment of executive stock options. Prior to FAS 123R, firms were given a choice to expense executive options at either their intrinsic or fair values. Most firms elected the intrinsic valuation methodology and issued options at-the-money so as to set their option related expenses to zero when reporting earnings. FAS 123R mandated the expensing of options at their fair value through the use of either a closed form option pricing model, such as the Black and Scholes (1973) model as modified to account for dividend payouts, or a binomial option pricing model. Using a comprehensive sample of firms, Hayes, Lemmon, and Qiu (2012) demonstrate that firms attenuate their utilization of options as a component of executive remuneration portfolios following the implementation of FAS 123R in December of 2005. As option value is a convex function of a firm's stock price, Hayes, Lemmon, and Qiu (2012) find that this reduction in options issuance to executives precipitated an exogenous decline in compensation convexity.

To mitigate endogeneity concerns, I use the cross-sectional difference-in-means identification strategy of Hayes, Lemmon, and Qiu (2012) in exploiting the exogenous variation in convexity surrounding FAS 123R. Specifically, I transform all of the independent and dependent variables by first determining the averages of the respective variables, for each firm, pre- and post-FAS 123R. I then calculate a post- minus pre-period difference for each variable and regress changes in the crash outcome variables on changes in the set of independent variables. I define the pre-FAS 123R period as spanning fiscal years 2002-2004 while setting the post-FAS 123R period to fiscal years 2005-2007. On average, I find that firms experiencing greater pre- to post-FAS 123R declines in compensation convexity experience greater reductions in the occurrence, frequency, and magnitude of realized (ex-post) idiosyncratic firm stock-price crashes. In contrast, I find no evidence indicating that the exogenous negative shock to compensation convexity had any significant effect on firms' idiosyncratic positive jump risk within this setting.

Finally, I employ a difference-in-differences identification strategy featuring a continuous magnitude of convexity treatment variable. As an ex-ante proxy for the magnitude of convexity treatment under FAS 123R, I use the level of Executive Vega in fiscal year 2002 as it is prior to when most firms began adjusting compensation contracts in anticipation of FAS 123R. All else equal, managers with higher vega in 2002 are expected to be more affected by FAS 123R from a risk-taking incentives standpoint than their lower vega counterparts. In interacting the magnitude of convexity treatment variable (Executive Vega 2002) with the post-FAS 123R period dummy, I find that firms that were, ex-ante, more likely to be affected by FAS 123R decrease their idiosyncratic crash risk by a greater amount than the firms that were less likely to be affected by FAS 123R. These results are largely consistent with my previous inferences.[2]

This paper contributes to the compensation literature by demonstrating that executive compensation convexity, measured as the average sensitivity of the top executives' equity compensation portfolios to stock volatility, predicts idiosyncratic firm crashes. Specifically, the evidence in this paper suggests that the incentives stemming from managerial equity portfolios do not appear to augment a firm's future idiosyncratic crash risk because they link managerial wealth to equity prices (delta), but rather because they tie managerial wealth to the volatility of the firm's equity (vega). All else equal, I find that this effect is economically significant as a bottom-to-top decile change in compensation convexity results in a 21% increase in a firm's unconditional ex-post idiosyncratic crash risk.

If the relation between compensation convexity and idiosyncratic crash risk is entirely mediated by the risky investments of a firm's executives, I would expect to also observe a positive relation between convexity and positive stock-price jump risk as these risky bets should, in certain states, also yield highly positive idiosyncratic returns. Empirically, I do not find robust evidence of a symmetric link between com-

[2] Unlike the cross-sectional difference-in-means research design of Hayes, Lemmon, and Qiu (2012), this specification does not capture the magnitude of the ex-post realized decline in convexity after FAS 123R.

pensation convexity and a firm's idiosyncratic positive jump risk. This asymmetry manifests as executives' incentives to conceal negative firm-specific information exceed their incentives to withhold positive firm news. As a result, the release of positive firm-specific information is more continuous in nature and, thus, does not lead to positive idiosyncratic stock price jumps. This evidence clarifies the potentially negative implications of compensation convexity on extreme corporate outcomes. Moreover, the asymmetric nature of my results suggests that executives' concealing of negative firm specific performance information plays a crucial role in propagating the observed empirical relation between compensation convexity and idiosyncratic firm crash risk.

This paper also adds to a second strand of literature which examines the factors underlying a firm's option implied volatility smirk. Namely, I provide new evidence revealing that compensation convexity is positively related to the steepness of a firm's idiosyncratic firm put smirk. Intuitively, the slope of the put smirk is more pronounced when option investors' perceptions of the likelihood of the future occurrence of idiosyncratic firm stock price crashes exceed the crash probabilities implied by a lognormal distribution.[3] My results indicate that the option market's ex-ante perception of a firm's idiosyncratic crash risk increases with compensation convexity. This paper also contributes to the option pricing literature by showing that compensation convexity is positively related to the realized (ex-post) occurrence, frequency, and magnitude of idiosyncratic firm stock-price crashes even after controlling for the put smirk and other established predictive measures of idiosyncratic crashes. This evidence suggests that option prices may not fully reflect the impact of compensation convexity on future idiosyncratic firm crash risk.

The remainder of this paper proceeds as follows. Section 1.2 reviews the related literature and institutional background. Section 1.3 develops my hypotheses and

[3]Investors can also bid up the prices and, consequently, the implied volatilities of out-of-the-money put options, relative to at-the-money put options, as they demand more crash and negative jump risk insurance on firms whose top executives are compensated with highly convex remuneration contracts.

specifies the identification strategy. Section 1.4 describes the data as well as the measurement of important variables. Section 1.5 presents the empirical analysis and Section 1.6 concludes the paper.

1.2. Related Literature and Institutional Background

1.2.1. Executive Compensation and Crash Risk

Benmelech, Kandel, and Veronesi (2010) develop a dynamic rational expectations model with asymmetric information in modeling the effects of stock based compensation on managerial effort and the concealing of firm specific information. Specifically, they demonstrate theoretically that managerial stock based compensation may induce managers to exert costly effort while also incentivizing managers to conceal negative information regarding the future growth options of the firm. Moreover, their model indicates that managers may engage in suboptimal investment policies in supporting the concealing of bad information. Benmelech, Kandel, and Veronesi (2010) predict that the concealing of bad news pertaining to the firm's performance precipitates severe market overvaluations as well as subsequent crashes in the firm's stock price.

Fahlenbrach and Stulz (2011) examine the link between the compensation incentives of bank CEOs in the years preceding the recent credit crisis and the performance of banks during the crisis. Using a sample consisting of depository and investment banks, they find little evidence indicating that CEOs whose incentives were less aligned with those of shareholders actually fared worse during the crisis. In fact, Fahlenbrach and Stulz (2011) demonstrate that bank CEOs with higher equity portfolio deltas, ex-post, performed worse than their lower delta incentives cohorts. Furthermore, neither cash bonuses nor stock options are found to have caused declines in bank performance during the crisis. Fahlenbrach and Stulz (2011) argue that CEOs with better aligned delta incentives appear to have taken risks that, ex-ante, were deemed potentially profitable for shareholders. However, the ex-post outcomes of these risks resulted in unexpected poor performance. In support of this reasoning, Fahlenbrach and Stulz (2011) find that CEOs did not attempt to decrease their share holdings prior to the credit crisis.

Kim, Li, and Zhang (2011) find that CFOs' price increasing incentives stemming from option pay (option portfolio deltas) are positively related to a firm's future crash risk. In contrast, they show that delta incentives stemming from stock holdings do not appear to be significantly associated with crash risk. As managerial losses from option holdings are bounded by the strike price, the positive delta incentive effects of option portfolios on crash risk should exceed those provided by the symmetric payoff structures of stock portfolios. Kim, Li, and Zhang (2011) find no evidence of a significant positive link between vega and a firm's future crash risk. They state that it "may be desirable for future analytical research to consider the different features of options and stocks, as well as the different characteristics of CFOs and CEOs, when modeling the relation between managerial equity incentives and stock price crash risk."

1.2.2. Compensation Convexity and Misreporting

Armstrong, Larcker, Ormazabal, and Taylor (2013) survey the literature that examines the relation between managerial equity incentives and financial misreporting and find that the empirical evidence yields mixed inferences. For instance, Bergstresser and Philippon (2006) use a regression research design in showing that the use of discretionary accruals to manipulate earnings is more prominent at firms where the CEO's equity pay is more sensitive to the firm's stock price (higher equity portfolio delta). Similarly, Burns and Kedia (2006) demonstrate that the sensitivity of the CEO's option portfolio to stock price (option delta) is positively related to a firm's likelihood to misreport. In contrast, Armstrong, Jagolinzer, and Larcker (2010) use a propensity-score matching approach and find little evidence of a positive association between a CEO's equity portfolio delta and misreporting after matching CEOs on the observable characteristics of their contracting environments. Armstrong, Larcker, Ormazabal, and Taylor (2013) reconcile these findings by showing that the relation between equity portfolio delta and misreporting is contingent on the choice of research design. Namely, they find a positive link between delta and misreporting using a regression design, but no evidence of a link between delta and misreporting when exploiting a matched-pair design.

In contrast to the research design contingent relation between delta and misreporting, Armstrong, Larcker, Ormazabal, and Taylor (2013) find strong evidence of a robust positive relation between equity portfolio vega (compensation convexity) and misreporting. More importantly, they demonstrate that the misreporting incentives provided by equity portfolio vega subsume those of equity portfolio delta when the full incentives of the manager's equity portfolio are simultaneously considered. Furthermore, Armstrong, Larcker, Ormazabal, and Taylor (2013) demonstrate the robustness of the positive link between compensation convexity and managerial misreporting for, both, the top management team (top five executives) as well as for CEOs. This result is consistent with the intuition in Jiang, Petroni, and Wang (2010) and Feng, Ge, Luo, and Shevlin (2011) as executives other than the CEO appear to have a prominent role in a firm's misreporting decision.

1.3. Hypothesis Development and Research Design

1.3.1. Hypothesis Development

Armstrong, Larcker, Ormazabal, and Taylor (2013) postulate that as misreporting augments both equity risk and equity values, it is crucial to simultaneously consider both equity portfolio delta (sensitivity of the manager's total equity portfolio to changes in stock price) and equity portfolio vega (sensitivity of the manager's total equity portfolio to changes in stock volatility) in analyzing managerial misreporting decisions. Theoretically, equity portfolio delta provides two countervailing incentive effects on the manager's decision to misreport. On the one hand, equity portfolio delta will encourage managerial misreporting as delta is a measure of the increase in the value of a manager's equity portfolio from a given increase in the firm's stock price. Namely, if a manager misreports in order to bolster the firm's stock price, managers with higher equity portfolio delta will benefit more from a fixed increase in their firm's stock price. Armstrong, Larcker, Ormazabal, and Taylor (2013) refer to this as the reward effect of equity portfolio delta. In contrast, equity portfolio delta also discourages managerial misreporting as it amplifies the ramifications of equity risk on the total riskiness of a manager's equity portfolio. Armstrong, Larcker, Ormazabal, and Taylor (2013) refer to this as the risk effect of equity portfolio delta. Accordingly, the net effect of equity portfolio delta on the misreporting decision is theoretically ambiguous.

In contrast to delta, equity portfolio vega provides unambiguous incentives to misreport. All else equal, risk-averse managers who are compensated with more highly convex remuneration contracts will have more incentives to misreport. This occurs as convexity within the compensation mechanism decreases managerial aversion to the increased equity risk stemming from misreporting. Armstrong, Larcker, Ormazabal, and Taylor (2013) interpret their evidence as suggesting that "equity holdings provide managers with incentives to misreport not because they tie their wealth to equity values, but because they tie their wealth to equity risk." In accordance with the theoretical framework of Benmelech, Kandel, and Veronesi (2010), the concealing of negative firm-specific information should precipitate substantial market overvaluations as well as subsequent crashes in the firm's stock price. Accordingly, there should exist a positive relation between compensation convexity and measures of idiosyncratic firm crash risk.

My first measure of a firm's idiosyncratic crash risk is the steepness of its option implied volatility smirk. If the option market discerns the augmented crash risk stemming from compensation convexity, the steepness of a firm's idiosyncratic put smirk should increase with the convexity of managerial equity portfolios. This intuition leads to my first hypothesis:

Hypothesis 1a. *All else equal, the option market's ex-ante expectation of a firm's future idiosyncratic crash and negative jump risk increases with executive compensation convexity.*

Armstrong, Larcker, Ormazabal, and Taylor (2013) find that compensation convexity within executive remuneration portfolios incentivizes executives to misreport earnings information pertaining to the firms they manage. Once the market discovers and updates its information set to incorporate the concealed negative information, the firm's stock price should experience an ex-post decline or, in extreme cases, an idiosyncratic crash. Accordingly, I expect the following:

Hypothesis 1b. *All else equal, the ex-post probability of the occurrence of idiosyncratic firm crashes increases with executive compensation convexity.*

Jin and Myers (2006) predict a higher frequency of large, negative idiosyncratic return declines in countries where firms are more opaque. As compensation convexity augments managerial inclinations to misreport, it should consequently increase the frequency of idiosyncratic firm stock-price crashes. This leads to my next hypothesis:

Hypothesis 1c. *All else equal, the ex-post number of idiosyncratic firm crashes increases with executive compensation convexity.*

Managers who are compensated with more highly convex remuneration contracts are likely to be more incentivized to continue concealing negative firm-specific information. Once the negative information is finally revealed, it is likely to precipitate a greater decline in a firm's stock price. Thus, I expect that:

Hypothesis 1d. *All else equal, the ex-post magnitude of idiosyncratic firm crashes increases with executive compensation convexity.*

As the effects of compensation convexity on idiosyncratic crash risk are partially mediated by convexity's provision of executive incentives to conceal negative earning information, the link between convexity and idiosyncratic crash risk should be more pronounced in firms in which it is more feasible for executives to withhold information from the market. Pontiff (2006) finds that idiosyncratic risk is the single largest impediment to market efficiency. As arbitrageurs are unable to fully hedge the idiosyncratic risk stemming from arbitrage positions, they must assess the costs of idiosyncratic risk exposure on expected arbitrage profits. All else equal, managers should be able to conceal more information in higher idiosyncratic volatility firms as the costs to arbitraging mispricing in the stock prices of these firms are more stringent. This leads to my final hypothesis:

Hypothesis 2. *All else equal, the relation between executive compensation convexity and idiosyncratic crash risk is more pronounced in higher idiosyncratic volatility firms.*

1.3.2. Research Design

Within my primary analysis, I employ equations of the following form in analyzing the implications of compensation convexity on firms' ex-ante and ex-post idiosyncratic crash risk:

$$\textbf{IFP Smirk}_{i,t} = \lambda_0 + \lambda_1 \textbf{Convexity}_{i,t} + \sum_{j=1}^{m} \beta_j \textbf{Control}_{j,i,t} + \epsilon_{i,t} \tag{1.1}$$

$$\textbf{Crash}_{i,t} = \psi_0 + \psi_1 \textbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \mu_j \textbf{Control}_{j,i,t-1} + \eta_{i,t} \tag{1.2}$$

$$\textbf{Crash Frequency}_{i,t} = \gamma_0 + \gamma_1 \textbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \omega_j \textbf{Control}_{j,i,t-1} + \theta_{i,t} \tag{1.3}$$

$$\textbf{Sigma}_{i,t} = \phi_0 + \phi_1 \textbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \delta_j \textbf{Control}_{j,i,t-1} + \tau_{i,t} \tag{1.4}$$

where i is the firm subscript, t is the fiscal year subscript, and j is the control subscript.

If Hypothesis 1a holds, I should find that executive compensation convexity is positively related to the slope of the idiosyncratic firm put smirk (IFP Smirk). Accordingly, Hypothesis 1a implies that $\lambda_1 > 0$ within Equation 1.1. In accordance with Hutton, Marcus, and Tehranian (2009), I define an ex-post idiosyncratic firm crash as a decline in idiosyncratic firm weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return for a given firm fiscal year. My first measure of ex-post idiosyncratic firm crash risk, Crash, is a binary indicator specifying the occurrence of an idiosyncratic firm crash within a given firm fiscal year. If Hypothesis 1b holds, I expect to find that executive compensation convexity is positively related to this ex-post binary crash variable. Namely, Hypothesis 1b mandates that $\psi_1 > 0$ within Equation 1.2.

My second measure of ex-post idiosyncratic firm crash risk, Crash Frequency, is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. If Hypothesis 1c holds, I should find that executive compensation convexity is positively related to the number of idiosyncratic firm crashes within a given firm fiscal year. Therefore, Hypothesis 1c predicts that $\gamma_1 > 0$ within Equation 1.3. My third measure of ex-post idiosyncratic firm crash risk, Sigma, is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. If Hypothesis 1d holds, I expect to find that executive compensation convexity is positively related to the magnitude of idiosyncratic firm crashes. As a result, Hypothesis 1d necessitates that $\phi_1 > 0$ within Equation 1.4. Finally, I expect to find that the positive link between compensation convexity and crash risk is amplified in higher idiosyncratic volatility firms if Hypothesis 2 holds. Hence, the coefficient of the interaction term between executive compensation convexity and idiosyncratic volatility should be significantly positive across my measures of idiosyncratic firm crash risk.

1.4. Data Selection and Variable Measurement

I begin by obtaining the necessary data from Compustat in order to construct the control variables Opaque, ROE, Size, M/B, and Leverage. As in Hutton, Marcus, and Tehranian (2009), I define Opaque as the three year moving sum of the absolute value of discretionary accruals:

$$\mathbf{Opaque}_t = \sum_{i=t-3}^{t-1} |\mathbf{DiscAcc}_i| \tag{1.5}$$

Discretionary accruals are calculated by estimating the modified Jones model in Dechow, Sloan, and Sweeney (1995). For all firms within each of the 49 Fama-French industries in a given fiscal year, I estimate the following cross-sectional regression:

$$\frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} = \alpha_0 \left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] + \beta_1 \left[\frac{\Delta\mathbf{Sales}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \beta_2 \left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \varepsilon_{i,t} \tag{1.6}$$

Discretionary accruals, for each firm's fiscal year, are then defined as follows:

$$\begin{aligned}\mathbf{DiscAcc}_{i,t} = \frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} - \widehat{\alpha}_0 \left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] - \widehat{\beta}_1 \left[\frac{\Delta\mathbf{Sales}_{i,t} - \Delta\mathbf{Receivables}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] \\ - \widehat{\beta}_2 \left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right]\end{aligned} \tag{1.7}$$

where $\mathbf{TA}_{i,t}$ is the total accruals, $\mathbf{Assets}_{i,t}$ is the total assets, $\Delta\mathbf{Sales}_{i,t}$ is the change in sales, $\Delta\mathbf{Receivables}_{i,t}$ is the change in receivables, and $\mathbf{PPE}_{i,t}$ is the property, plant, and equipment of firm i in fiscal year t, respectively. Next, I remove utility firms (Fama-French industry #31) as well as financial services firms (Fama-French industry #48) from my sample. I define ROE, Size, M/B, and Leverage within Appendix B.

After constructing the necessary Compustat related variables, I use daily stock return data from the Center for Research in Security Prices (CRSP) in constructing weekly stock returns. I remove low-priced stocks (stocks whose annual average price is less than $2.50) as well as stock fiscal years with less than 26 weeks of return data. Next, I follow Hutton, Marcus, and Tehranian (2009) in estimating the below model for each stock fiscal year and I define idiosyncratic firm weekly returns as $\mathbf{ln(1+\boldsymbol{\varepsilon})}$:

$$\boldsymbol{r}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_{1,i}\boldsymbol{r}_{m,t-1} + \boldsymbol{\beta}_{2,i}\boldsymbol{r}_{j,t-1} + \boldsymbol{\beta}_{3,i}\boldsymbol{r}_{m,t} + \boldsymbol{\beta}_{4,i}\boldsymbol{r}_{j,t} + \boldsymbol{\beta}_{5,i}\boldsymbol{r}_{m,t+1} + \boldsymbol{\beta}_{6,i}\boldsymbol{r}_{j,t+1} + \boldsymbol{\varepsilon}_{it} \quad (1.8)$$

where $\boldsymbol{r}_{i,t}$ is the weekly return for stock i in week t, $\boldsymbol{r}_{m,t}$ is the weekly return for the CRSP value-weighted market index in week t, and $\boldsymbol{r}_{j,t}$ is the weekly return for stock i's value-weighted Fama-French industry index j during week t.[4] I include leads and lags of the market and industry index returns to account for non-synchronous trading (Dimson, 1979). I take the natural logarithm of the residuals from Equation 1.8 in order to render their distribution more symmetric.

I proxy for the option market's perception of a firm's future expected (ex-ante) idiosyncratic crash risk as the slope of the Idiosyncratic Firm Put Smirk. I obtain data pertaining to firm and S&P 500 put options from OptionMetrics' Ivy DB volatility surface database. My sample period begins in fiscal year 1997 as this is the first fiscal year with fully available volatility surface data. I measure the slope of the Idiosyncratic Firm Put Smirk (IFP Smirk) as the ratio of the idiosyncratic

[4] If the return data is unavailable during week $t-1$ or $t+1$, I obtain the return data from the nearest available respective weeks.

implied volatility (variance) of out-of-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. Specifically, I define IFP Smirk for a given firm i in fiscal year t as follows:

$$\textbf{IFP Smirk}_{i,t} = \frac{\hat{\boldsymbol{\sigma}}^2_{i,t-1,OTM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,OTM}\right]}{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}\right]} \tag{1.9}$$

where the deltas of out-of-the-money (OTM) put options and at-the-money (ATM) put options are -.2 and -.5, respectively. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,OTM}$ is the average implied volatility (variance) of out-of-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,OTM}$ is the average implied volatility (variance) of out-of-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. Finally, $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t.

In accordance with Frazzini and Pedersen (2014), I use the Vasicek (1973) Bayesian shrinkage estimator of a firm's time-series beta on the market portfolio to attenuate the influence of outliers within the time-series estimation framework. Specifically, $\hat{\boldsymbol{\beta}}_{\text{i,t-1,Vasicek}}$ is the Vasicek shrinkage estimator of firm i's beta on the market portfolio during fiscal year $t-1$ as estimated using weekly returns. I construct this measure as follows:

$$\hat{\boldsymbol{\beta}}_{\text{i,t-1,Vasicek}} = \boldsymbol{w}_{i,t-1}\hat{\boldsymbol{\beta}}^{TS}_{i,t-1} + \left[(1 - \boldsymbol{w}_{i,t-1}) \times \mathbf{1}\right] \tag{1.10}$$

$$\boldsymbol{w}_{i,t-1} = \frac{\text{XSVar}(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})}{\text{XSVar}(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1}) + \text{SE}^2(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})} \tag{1.11}$$

$$\boldsymbol{r}_{i,t-1} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}^{TS}_{i,t-1}\boldsymbol{r}_{m,t-1} + \boldsymbol{\varepsilon}_{i,t-1} \tag{1.12}$$

where $\hat{\boldsymbol{\beta}}^{TS}_{i,t-1}$ is the time-series estimate of firm i's fiscal year beta on the market during fiscal year $t-1$ using weekly returns. $\boldsymbol{w}_{i,t-1}$ is the Vasicek shrinkage weight on the time-series estimate of firm i's fiscal year beta on the market during fiscal year $t-1$. $\text{XSVar}(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})$ is the cross-sectional variance of the time-series estimates of firm betas on the market during fiscal year $t-1$. $\text{SE}^2(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})$ is the square of the standard error on the time-series estimate of firm i's beta on the market portfolio during fiscal year $t-1$ using using weekly returns. $\boldsymbol{r}_{i,t-1}$ denotes firm i's weekly returns during fiscal year $t-1$ and $\boldsymbol{r}_{m,t-1}$ represents the weekly returns for the CRSP value-weighted market index during fiscal year $t-1$. Intuitively, the Vasicek (1973) Bayesian shrinkage factor, $\boldsymbol{w}_{i,t-1}$, places greater emphasis on the time-series estimate of beta when the estimate has a lower standard error or when the cross-sectional variance of betas is large. Thus, the Vasicek (1973) Bayesian shrinkage approach shrinks the time series estimate of beta, $\boldsymbol{\beta}^{TS}_{i,t-1}$, towards the cross-sectional mean beta.

I use 91-day maturity options in order to address two primary factors. According to Bates (2000), jump risk is more pertinent for shorter-expiration options whereas the effects of stochastic volatility are more pronounced over longer horizons. In contrast, my control and compensation incentive variables are measured annually. Therefore, I use 91-day horizon options in attempting to accommodate both of the aforementioned maturity considerations. I use a 10-day average of implied volatilities as it decreases the reliance on data from only one day of observations. As a robustness check, I use 182-day horizon put options in constructing the longer horizon put smirk measure IFP Smirk_182.

The variable JIFP Smirk is the positive jump risk idiosyncratic firm put smirk. JIFP Smirk is the ratio of the idiosyncratic implied volatility (variance) of in-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. Specifically, I define JIFP Smirk for a given firm i in fiscal year t as follows:

$$\textbf{JIFP Smirk}_{i,t} = \frac{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ITM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ITM}\right]}{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}\right]} \tag{1.13}$$

where the deltas of the in-the-money (ITM) put options and at-the-money (ATM) put options are -.8 and -.5, respectively.

I also construct ex-post positive jump risk measures in order to examine the ramifications of compensation convexity on a firm's idiosyncratic positive jump risk. Namely, Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year and Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean.

After constructing all of the Compustat, CRSP, and OptionMetrics related variables, I use Execucomp data to formulate measures of executive compensation incentives. In order to attenuate the potential influence of unobservable executive-specific characteristics, I follow Armstrong, Larcker, Ormazabal, and Taylor (2013) in using the incentives of the top management team. As the majority of firms within the Execucomp database report compensation data for their top five executives within a specific fiscal year, I use all available information pertaining to any of the firm's top five executives in constructing my incentive measures. I refer to the top five executives within a firm as the executive team.

I define the variable Executive CashComp as the executive team's average total cash remuneration within a given firm fiscal year. Next, Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Finally, Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. In ascertaining the robustness of my results to alternate incentive measures used in the literature, I also consider scaled compensation incentive variables. Namely, Scaled Delta is the ratio of Executive Delta to Executive CashComp and Scaled Vega is the ratio of Executive Vega to Executive CashComp. My final merged primary sample, featuring non-missing values of all of the necessary Compustat, CRSP, OptionMetrics, and Execucomp variables, consists of 14,153 firm fiscal year observations spanning fiscal years 1997 through 2011. All remaining variables are defined in Appendix B.

1.5. Empirical Analysis

Table 1.1 presents the summary statistics pertaining to the variables used within my analysis. I winsorize the variables Size, Opaque, ROE, M/B, Leverage, IFP Smirk, IFP Smirk_182, JIFP Smirk, Executive CashComp, Executive Delta, and Executive Vega at the first and 99th percentiles in order to minimize the impact of outliers. As the compensation variables Executive CashComp, Executive Delta, and Executive Vega are skewed, I take the natural logarithm of these respective variables in rendering their distributions more symmetric. The average total cash remuneration (salary+bonus) received by the members of the executive team during a fiscal year is roughly $740,080. Furthermore, the average dollar change in the value of the executive team's total equity compensation portfolios associated with a 1% increase in the firm's stock price is \$314,930. In contrast, the average dollar change in the value of the executive team's total equity compensation portfolios associated with a one percentage-point increase in the standard deviation of the firm's return is roughly \$68,780.

I extract the idiosyncratic component of firm returns by estimating Equation 1.8 for each stock fiscal year and defining idiosyncratic firm weekly returns as $\mathbf{ln(1+\varepsilon)}$. Next, I calculate standardized idiosyncratic firm weekly stock returns as follows:

$$\frac{\mathbf{ln(1+\varepsilon)} - \text{Mean}\,(\mathbf{ln(1+\varepsilon)})}{\text{Standard Deviation}\,(\mathbf{ln(1+\varepsilon)})} \tag{1.14}$$

Panel A of Figure 1.1 plots the distribution of standardized idiosyncratic firm weekly stock returns expressed as the number of standard deviations from a firm's fiscal year mean. A week is classified as a crash week if a firm experiences an idiosyncratic weekly stock return decline falling 3.09 or more standard deviations below its mean idiosyncratic weekly return for a particular fiscal year. This figure also presents the deviation of the empirical distribution of standardized idiosyncratic firm returns from a theoretical normal distribution (depicted as a solid curve) with the same mean and variance. Most notably, the empirical distribution of standardized idiosyncratic firm returns is more "peaked" (leptokurtic) than a normal distribution and also features fatter tails.

Table 1.2 reports summary statistics pertaining to firm, industry, and market weekly returns during idiosyncratic firm stock-price crash weeks. The average firm weekly stock return during a crash week is roughly -19.40%. This return is significantly less than the average firm weekly return during non-crash weeks at the 1% level. In contrast, industry and market mean and median weekly returns during crash weeks are significantly greater than their non-crash week counterparts. This demonstrates empirically that the negative ramifications of idiosyncratic firm stock-price crashes are indeed, by construction, largely confined to the firm. Panel B of Figure 1.1 plots the distribution of standardized idiosyncratic firm returns during crash weeks. The empirical likelihood of an idiosyncratic firm crash week occurring within my weekly sample is the sum of the mass under this empirical distribution (roughly 0.5% (3,653/734,974)). Under a normal distribution, the probability of the occurrence of one idiosyncratic weekly stock return decline falling 3.09 or more standard deviations below the mean idiosyncratic weekly return is roughly 0.1%.

Within Panel D of Table 1.2, I classify a firm fiscal year as a crash year if a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. The empirical unconditional ex-post probability of the occurrence of a minimum of one idiosyncratic weekly return stock price crash within a fiscal year is 24.95% (24.10%+0.85%). As there are roughly 52 weeks within a fiscal year, this probability would be roughly $1 - (1 - 0.001)^{52} \approx 5.07\%$ under a normal distribution.[5] Figure 1.2 presents the temporal distribution of weekly idiosyncratic firm crashes during the calendar and fiscal year, respectively.[6] Panels A and B suggest that the probability of the occurrence of idiosyncratic crashes increases in the weeks following the end of calendar and fiscal year quarter periods. This amplification of crash likelihood is likely concurrent with the release of information pertaining to a firm's idiosyncratic performance during the previous quarter.

My first hypothesis is that the option market's ex-ante expectation of a firm's future idiosyncratic crash and negative jump risk increases with executive compensation convexity. If Hypothesis 1a holds, I should find that executive compensation convexity is positively related to the slope of the idiosyncratic firm put smirk (IFP

[5] I do not expect the empirical distribution of standardized idiosyncratic firm weekly stock returns to be normally distributed. The -3.09 standard deviation cutoff used to define idiosyncratic crashes is simply a benchmark used in the literature to reference extreme events.

[6] Each quarter is approximated as spanning roughly 13 weeks with a total of roughly 52 weeks comprising a year.

Smirk). Accordingly, Hypothesis 1a implies that $\lambda_1 > 0$ within Equation 1.1 below:

$$\textbf{IFP Smirk}_{i,t} = \lambda_0 + \lambda_1 \textbf{Convexity}_{i,t} + \sum_{j=1}^{m} \beta_j \textbf{Control}_{j,i,t} + \epsilon_{i,t} \tag{1.1}$$

I test this hypothesis within Table 1.3. Specifically, I proxy for compensation convexity with the variable Executive Vega. Consistent with Hypothesis 1a, I find that compensation convexity is positively related to the slope of the idiosyncratic firm put smirk (IFP Smirk) across my empirical specifications within Table 1.3. I include firm fixed effects in order to account for omitted time-invariant firm-specific variables that are potentially correlated with convexity. I also use year fixed effects to control for variation in the idiosyncratic firm put smirk that is common within the cross section of firms for a particular year. In addition, I include CEO fixed effects to account for omitted time-invariant CEO-specific variables that are potentially correlated with convexity. Finally, I utilize CEO spell fixed effects in allowing for the possibility that CEO fixed effects may vary across a CEO's tenure at distinct firms.

My second hypothesis predicts that the ex-post probability of the occurrence of idiosyncratic firm crashes increases with executive compensation convexity. Accordingly, my first measure of ex-post idiosyncratic firm crash risk, Crash, is a binary indicator specifying the occurrence of an idiosyncratic firm crash within a given firm fiscal year. If Hypothesis 1b holds, I expect to find that executive compensation convexity is positively related to this ex-post binary crash variable. Namely, Hypothesis 1b implies that $\psi_1 > 0$ within Equation 1.2:

$$\textbf{Crash}_{i,t} = \psi_0 + \psi_1 \textbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \mu_j \textbf{Control}_{j,i,t-1} + \eta_{i,t} \tag{1.2}$$

I test this hypothesis within Table 1.4. By employing the logistic and conditional logistic models in Table 1.4, I identify a positive predictive relationship between executive compensation convexity (Executive Vega) and the occurrence of idiosyncratic firm crashes. Next, I assess the robustness of the aforementioned relation within the linear probability models of Table 1.5. Overall, the evidence in Table 1.5 is largely in agreement with the inferences from Table 1.4. Together, the logistic, conditional logistic, and linear probability model analysis presents evidence that is consistent with the empirical implications of Hypothesis 1b.

Hypothesis 1c proposes that, all else equal, the ex-post number of idiosyncratic firm crashes should increase with executive compensation convexity. I test this hypothesis by using specifications in the form of Equation 1.3 below:

$$\textbf{Crash Frequency}_{i,t} = \gamma_0 + \gamma_1 \textbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \omega_j \textbf{Control}_{j,i,t-1} + \theta_{i,t} \tag{1.3}$$

My second measure of ex-post idiosyncratic firm crash risk, Crash Frequency, is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. If Hypothesis 1c holds, I should find that executive compensation convexity is positively related to crash frequency. Therefore, Hypothesis 1c predicts that $\gamma_1 > 0$ within Equation 1.3. In testing Hypothesis 1c, I begin by modeling the number of idiosyncratic firm stock-price crashes occurring within a firm's fiscal year using a Poisson counting process. Specifically, I employ Poisson and conditional Poisson regressions in Table 1.6. In accordance with this hypothesis, I find that executive compensation convexity is, indeed, positively related to the number of idiosyncratic firm crashes within a given firm fiscal year. Next, I examine Hypothesis 1c using a basic linear (OLS) model. The results from the linear specifications within Table 1.7 are largely in agreement with the inferences from the Poisson and conditional Poisson analysis. Together, this evidence further supports the empirical predictions of Hypothesis 1c.

All else equal, managers who are compensated with more highly convex remuneration contracts are likely to be more incentivized to continue concealing negative firm-specific information. Once the negative information is finally revealed, it is likely to precipitate a greater decline in the firm's stock price. Consequently, Hypothesis 1d asserts that the ex-post magnitude of idiosyncratic firm crashes should increase with executive compensation convexity. My third measure of ex-post idiosyncratic firm crash risk, Sigma, is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. If Hypothesis 1d holds, I expect to find that executive compensation convexity is positively related to Sigma. Equivalently, Hypothesis 1d necessitates that $\phi_1 > 0$ within Equation 1.4:

$$\mathbf{Sigma}_{i,t} = \phi_0 + \phi_1 \mathbf{Convexity}_{i,t-1} + \sum_{j=1}^{m+1} \delta_j \mathbf{Control}_{j,i,t-1} + \tau_{i,t} \tag{1.4}$$

Columns (1)-(5) of Table 1.8 present evidence that is in agreement with Hypothesis 1d. The results in Tables 4-8 indicate that executive compensation convexity is positively related to the realized (ex-post) occurrence, frequency, and magnitude of idiosyncratic firm stock-price crashes even after controlling for the idiosyncratic firm put smirk and other established predictive measures of idiosyncratic crashes. This evidence suggests that option markets do not fully incorporate the impact of compensation convexity on future firm crash risk.

Theoretically, equity portfolio delta provides two countervailing incentive effects on the manager's decision to misreport. On the one hand, equity portfolio delta will encourage managerial misreporting as delta is a measure of the increase in the value of a manager's equity portfolio from a given increase in the firm's stock price. Namely, if a manager decides to misreport in order to bolster the firm's stock price, managers with higher equity portfolio delta will benefit more from a fixed increase in their firm's stock price. Armstrong, Larcker, Ormazabal, and Taylor (2013) refer to this as the reward effect of equity portfolio delta. In contrast, equity portfolio delta also discourages managerial misreporting as it amplifies the ramifications of equity risk on the total riskiness of a manager's equity portfolio. Armstrong, Larcker, Ormazabal, and Taylor (2013) refer to this as the risk effect of equity portfolio delta. Accordingly, the net effect of equity portfolio delta on the misreporting decision is theoretically ambiguous. In accordance with this reasoning, I do not find robust evidence in Tables 4-8 indicating that the total delta (price-increasing) incentives stemming from executives' total equity compensation portfolios are significantly related to a firm's ex-post realized crash risk. While the delta incentives stemming from executives' option portfolios appear to predict firm crashes due to the limited liability property of options, the delta incentives stemming from executives' stock portfolios appear to largely negate these incentives as they expose executives to more symmetric downside risk.

In ascertaining the economic magnitude of the ramifications of compensation convexity on a firm's idiosyncratic crash risk, I use scaled decile rank linear model analysis. Namely, I transform all of my independent variables by first calculating their decile rank each fiscal year, subtracting one, and then dividing by nine. I then employ linear models in re-examining my four hypotheses in Table 1.9. The coefficient on the respective scaled decile rank variable is the change in the corresponding dependent variable stemming from a bottom-to-top decile transition in the independent variable. All else equal, I find that moving from the bottom decile to the top decile of compensation convexity results in a 5.14 percentage point increase in a firm's idiosyncratic crash occurrence probability (column(2)). This increase is economically significant as, on average, it represents roughly 21% (.0514/.2496) of a firm's unconditional ex-post idiosyncratic crash risk. Similarly, a bottom-to-top decile increase in compensation convexity results in a .1091 increase in the steepness of the idiosyncratic firm put smirk. This increase is economically significant as, on average, it represents roughly 11% (.1091/1.03) of the steepness of a firm's idiosyncratic put smirk. Next, I consider if the positive relation between compensation convexity and the idiosyncratic firm crash measures is robust to alternate definitions of compensation incentives used in the literature. Specifically, I construct the variable Scaled Delta as the ratio of Executive Delta to Executive CashComp and Scaled Vega as the ratio of Executive Vega to Executive CashComp. The results in Table 1.10 suggest that the scaled measure of compensation convexity, Scaled Vega, is positively related to a firm's idiosyncratic crash risk across my empirical specifications.

As the effects of compensation convexity on idiosyncratic crash risk are partially mediated by convexity's provision of executive incentives to conceal negative earning information, the link between convexity and idiosyncratic crash risk should be more pronounced in firms in which it is more feasible for executives to withhold information from the market. Pontiff (2006) finds that idiosyncratic risk is the single largest impediment to market efficiency. As arbitrageurs are unable to fully hedge the idiosyncratic risk stemming from arbitrage positions, they must assess the costs of idiosyncratic risk exposure on expected arbitrage profits. All else equal, managers should be able to conceal more information in higher idiosyncratic volatility firms as the costs to arbitraging mispricing in the stock prices of these firms are more stringent.

Hypothesis 2 posits that, all else equal, the relation between executive compensation convexity and idiosyncratic crash risk is more pronounced in higher idiosyncratic volatility firms. I test this hypothesis in Table 1.11 by interacting compensation convexity with idiosyncratic volatility quartile stratification dummies calculated on a fiscal year basis. The variable Q4(Idiosyncratic Volatility) is a binary indicator variable indicating a firm fiscal year's membership in the highest quartile of idiosyncratic volatility strata. Table 1.11 presents evidence that is largely in agreement with Hypothesis 2. For all of the ex-post measures of idiosyncratic crash risk in columns (2)-(4) of Table 1.11, the association between compensation convexity and realized crash risk is increasing in the idiosyncratic volatility quartile stratifications. However, the idiosyncratic volatility smirk does not appear to capture these dynamics. Instead, the information within option prices appears to indicate that the convexity-idiosyncratic crash risk relation is decreasing with idiosyncratic volatility. This evidence further suggests that option prices may not fully reflect the dynamics underlying the relation between compensation convexity and realized idiosyncratic firm stock-price crash risk.

1.5.1. Exogenous Variation in Executive Compensation Convexity

Next, I assess the robustness of my inferences within a natural experiment setting by exploiting the exogenous variation in compensation convexity surrounding a change in the expensing treatment of executive stock options. Prior to FAS 123R, firms were given a choice to expense executive options at either their intrinsic or fair values. Most firms elected the intrinsic valuation methodology and issued options at-the-money so as to set their option related expenses to zero when reporting earnings. FAS 123R mandated the expensing of options at their fair value through the use of either a closed form option pricing model, such as the Black and Scholes (1973) model as modified to account for dividend payouts, or a binomial option pricing model. Using a comprehensive sample of firms, Hayes, Lemmon, and Qiu (2012) demonstrate that firms attenuate their use of options as a component of executive remuneration portfolios following the implementation of FAS 123R in December of 2005.

As option value is a convex function of a firm's stock price, Hayes, Lemmon, and Qiu (2012) find that this reduction in options issuance to executives precipitated an exogenous decline in compensation convexity. In contrast, Hayes, Lemmon, and Qiu (2012) show that firms largely offset the decline in price increasing incentives (delta) stemming from a decrease in options by increasing their use of restricted stock grants. Accordingly, Hayes, Lemmon, and Qiu (2012) argue that FAS 123R largely represents an exogenous shock to compensation convexity (vega) and not to price increasing incentives (delta). Consistent with Hayes, Lemmon, and Qiu (2012), I find that the average executive team's compensation convexity decreases by \$11,705 per percentage point change in the standard deviation of a firm's equity returns (significant at the 1% level). This represents a 11.42% decline in average compensation convexity from the pre- to post-FAS 123R period. In contrast, the change in the average price increasing incentives (total equity portfolio delta) of the executive team surrounding FAS 123R is not statistically significant at the 10% level.

In addressing potential endogeneity concerns, I utilize the cross-sectional difference-in-means identification strategy of Hayes, Lemmon, and Qiu (2012) in buttressing my previous interpretations. Specifically, I transform all of my independent and dependent variables by first determining the averages of the respective variables, for each firm, pre- and post-FAS 123R. I then calculate a post- minus pre-period difference for each variable and regress changes in my crash outcome variables on changes in my independent variables. I define the pre-FAS 123R period as spanning fiscal years 2002-2004 while setting the post-FAS 123R period to fiscal years 2005-2007. Table 1.12 presents the results of these cross-sectional difference-in-means tests surrounding the exogenous variation in compensation convexity stemming from FAS 123R. On average, I find that firms experiencing greater pre- to post-FAS 123R declines in compensation convexity experience greater reductions in the occurrence, frequency, and magnitude of realized (ex-post) idiosyncratic firm stock-price crashes. In contrast, I find no evidence indicating that the aforementioned exogenous negative shock to compensation convexity had any significant effect on the option market's perception of firms' ex-ante idiosyncratic crash risk. As a robustness test, I reconstruct the idiosyncratic firm put smirk using longer maturity 182-day options in Table 1.13 and find that my inferences from Table 1.12 are unchanged.

Another point to consider is whether compensation convexity is also symmetrically positively related to a firm's idiosyncratic positive jump risk. If the observed relation between compensation convexity and idiosyncratic crash risk is entirely mediated by the risky investments of a firm's executives, I would expect to also observe a positive relation between convexity and positive stock-price jump risk as these risky bets should, in certain states, also yield highly positive idiosyncratic returns. I examine this question by constructing the positive jump risk equivalents of the four crash risk measures used in this paper. Specifically, JIFP Smirk is the positive jump risk idiosyncratic firm put smirk and captures the option market's perception of a firm's ex-ante positive stock price jump risk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year and Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. Table 1.14 presents no evidence of a symmetric positive relation between compensation convexity and a firm's idiosyncratic positive stock-price jump risk. These results suggest that executives' concealing of negative firm performance information plays a crucial role in catalyzing the observed empirical relation between compensation convexity and idiosyncratic firm crash risk.

Finally, I employ a difference-in-differences identification strategy featuring a continuous magnitude of convexity treatment variable in further examining the robustness of the convexity-idiosyncratic crash risk relation. As an ex-ante proxy for the magnitude of convexity treatment under FAS 123R, I use the level of Executive Vega in fiscal year 2002. I select this fiscal year as it is prior to when most firms began adjusting compensation contracts in anticipation of FAS 123R. All else equal, firms with higher vega in 2002 are expected to be more affected by FAS 123R from a risk-taking incentives standpoint than their lower vega counterparts. In interacting the magnitude of convexity treatment variable (Executive Vega 2002) with the post-FAS 123R period dummy in Table 1.15, I find that firms that were, ex-ante, more likely to be affected by FAS 123R decrease their idiosyncratic crash risk by a greater amount than those firms who were less likely to be affected by FAS 123R. These results are largely consistent with my previous inferences.

1.6. Summary and Conclusion

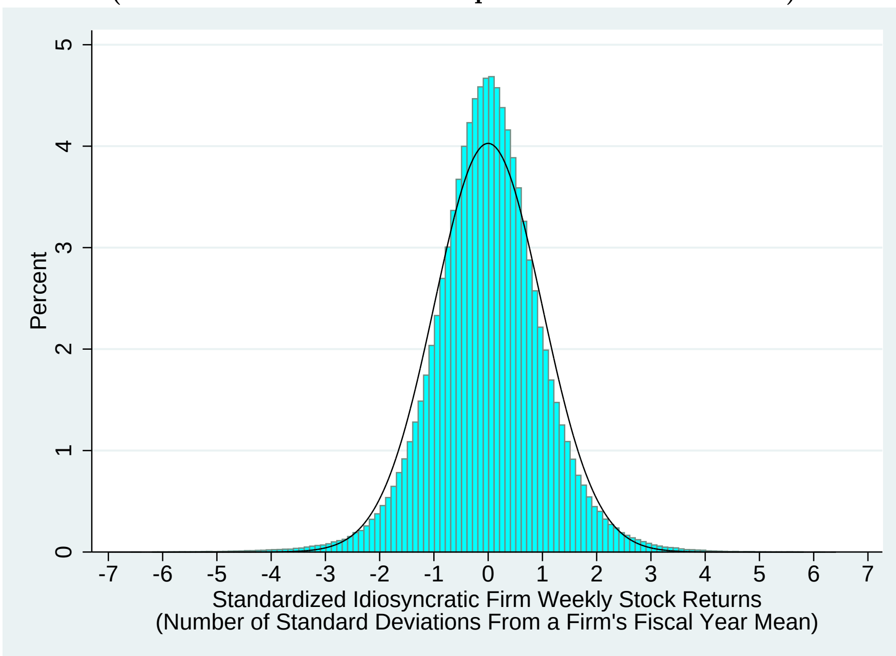
Within this paper, I examine whether executive compensation convexity, measured as the average sensitivity of the top executives' equity compensation portfolios to stock volatility, predicts idiosyncratic firm crashes. Using four measures of idiosyncratic firm crash risk, one ex-ante and three ex-post, I provide new evidence demonstrating an economically significant positive predictive link between compensation convexity (risk-taking incentives) and idiosyncratic firm crashes. First, I identify a positive relation between compensation convexity and the slope of the idiosyncratic firm put smirk, a measure of the option market's perception of a firm's future expected (ex-ante) idiosyncratic crash risk. Next, I find that compensation convexity is positively related to the realized (ex-post) occurrence, frequency, and magnitude of idiosyncratic firm stock-price crashes even after controlling for the put smirk and other established predictive measures of idiosyncratic crashes. This evidence suggests that option prices may not fully reflect the impact of compensation convexity on future idiosyncratic firm crash risk.

All else equal, I find that a bottom-to-top decile change in compensation convexity results in a 21% increase in a firm's unconditional ex-post idiosyncratic crash risk. I also present evidence that is consistent with the notion that the effects of compensation convexity on idiosyncratic crash risk are more pronounced in firms in which the limits to arbitrage are more stringent. In contrast, I do not find robust evidence of a significant link between compensation convexity and a firm's idiosyncratic positive jump risk. This result suggests that executives' concealing of negative firm performance information plays a crucial role in propagating the observed empirical relation between compensation convexity and idiosyncratic firm crash risk. Finally, I exploit exogenous variation in compensation convexity, stemming from a change in the expensing treatment of executive stock options, in buttressing my interpretations within a natural experiment setting. As a whole, the evidence within this paper elucidates the potentially negative implications of compensation convexity, within managerial equity remuneration contracts, on extreme corporate outcomes.

1.7. Figures and Tables

Figure 1.1: Distributions of Standardized Idiosyncratic Firm Returns During Crash and Non-Crash Weeks

Panel A: Distribution of Standardized Idiosyncratic Firm Returns (Normal Distribution is Depicted as a Solid Curve)



Panel B: Distribution of Standardized Idiosyncratic Firm Returns During Crash Weeks

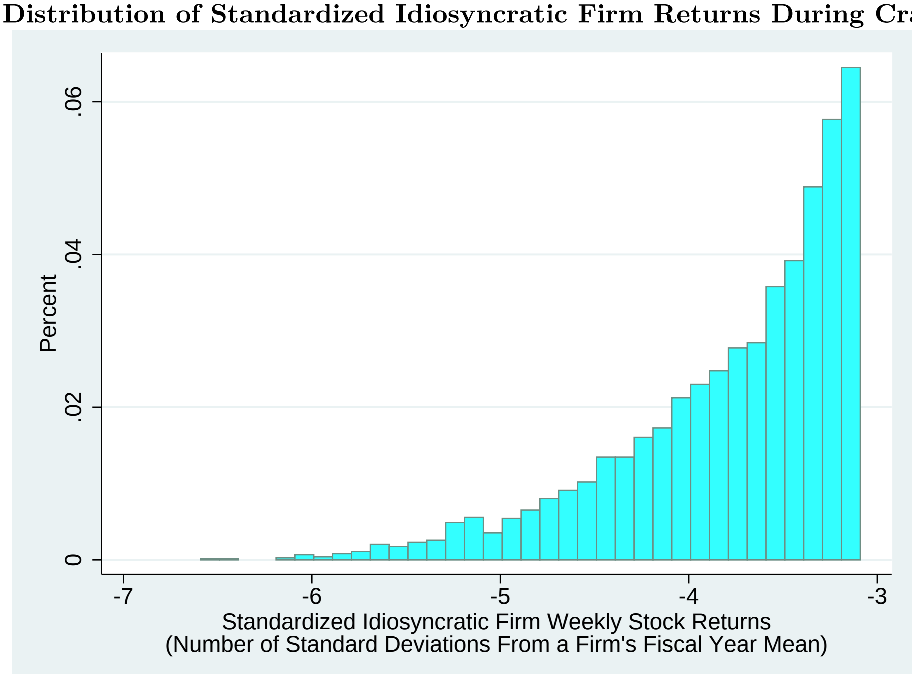
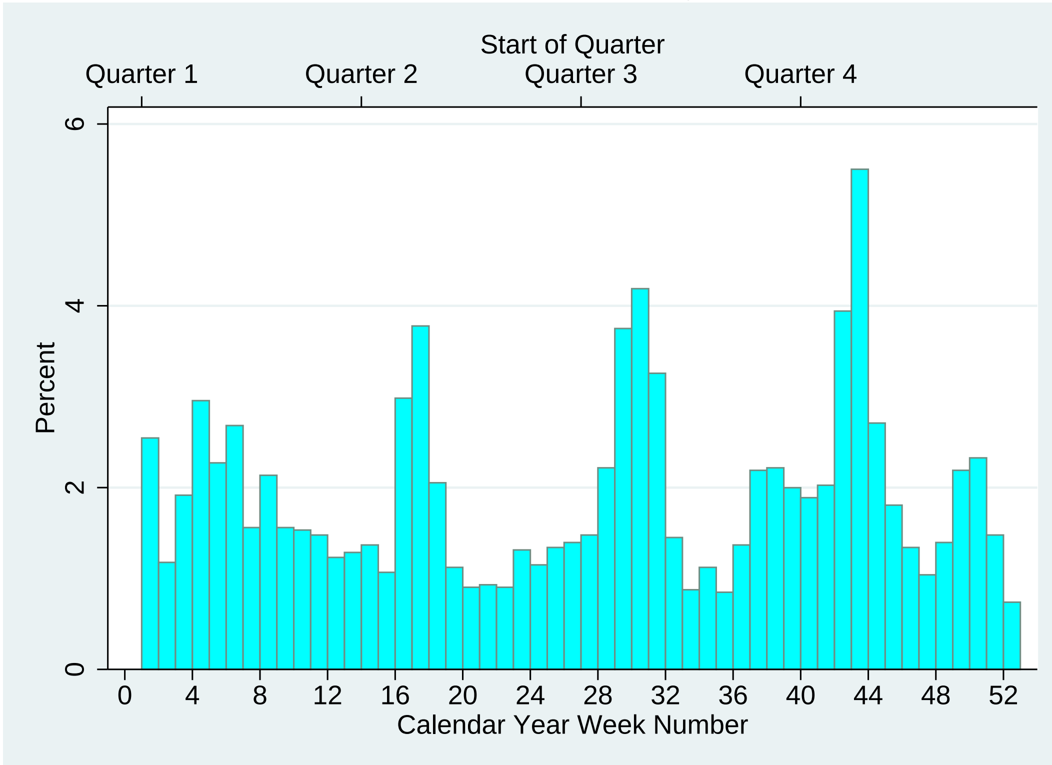


Figure 1.2: Temporal Distribution of Idiosyncratic Firm Crashes

Panel A: Calendar Year Distribution of Idiosyncratic Firm Crashes



Panel B: Fiscal Year Distribution of Idiosyncratic Firm Crashes

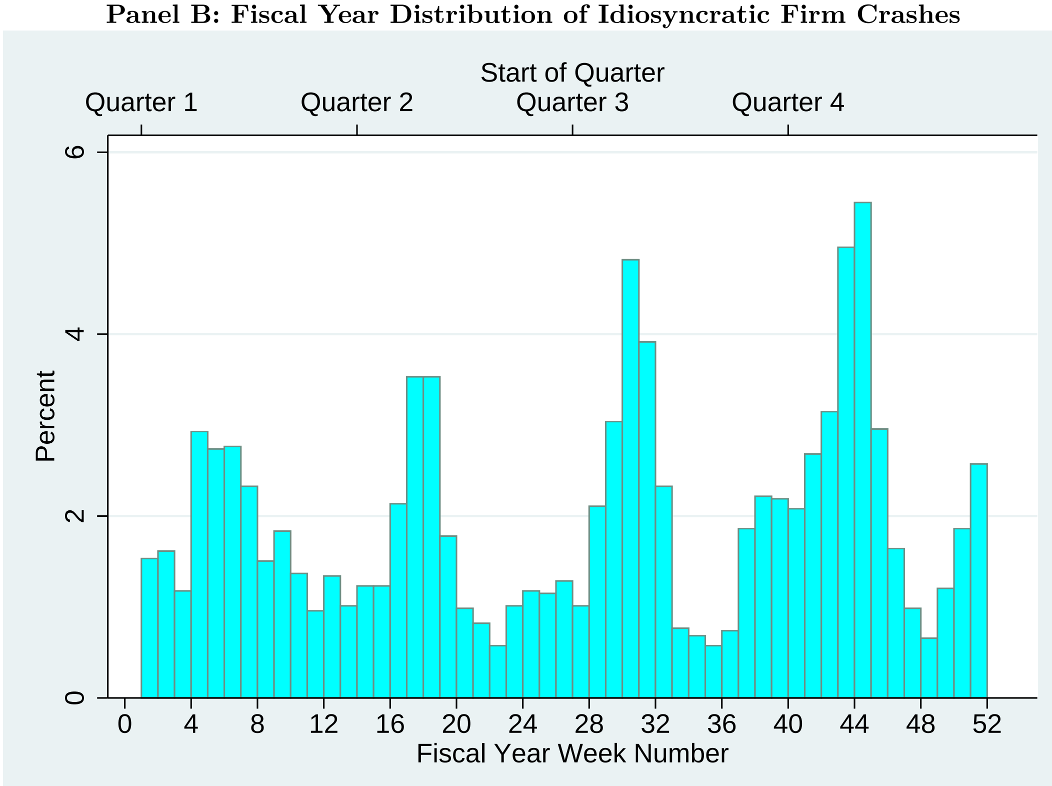


Table 1.1: Summary Statistics

This table presents summary statistics for variables related to executive compensation incentives, idiosyncratic firm crash risk, idiosyncratic positive jump risk, and firm properties. My primary sample consists of 14,115 firm fiscal year observations spanning fiscal years 1997 through 2011. I winsorize the variables Size, Opaque, ROE, M/B, Leverage, IFP Smirk, IFP Smirk_182, JIFP Smirk, Executive CashComp, Executive Delta, and Executive Vega at the first and 99th percentiles. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Scaled Delta is the ratio of Executive Delta to Executive CashComp. Scaled Vega is the ratio of Executive Vega to Executive CashComp. IFP smirk is the idiosyncratic firm put smirk constructed using 91-day maturity options. IFP smirk_182 is the idiosyncratic firm put smirk constructed using 182-day maturity options. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. JIFP Smirk is the jump risk related idiosyncratic firm put smirk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. All remaining variables are defined in Appendix B.

Full Sample of Firm Fiscal Years with Non-Missing Variables							
Variable	Mean	Std	5%	25%	50%	75%	95%
Executive Incentives:							
Executive CashComp (in $000s)	740.08	529.77	264.64	407.50	579.33	870.72	1815.18
Executive Delta (in $000s)	314.93	609.67	16.13	52.13	121.02	292.47	1220.30
Executive Vega (in $000s)	68.78	99.63	2.28	13.34	32.63	79.22	268.80
Scaled Delta	0.44	0.88	0.03	0.10	0.19	0.41	1.64
Scaled Vega	0.09	0.10	0.00	0.03	0.06	0.11	0.28
ln(1+Executive CashComp)	6.42	0.58	5.58	6.01	6.36	6.77	7.50
ln(1+Executive Delta)	4.86	1.29	2.84	3.97	4.80	5.68	7.11
ln(1+Executive Vega)	3.48	1.32	1.19	2.66	3.52	4.38	5.60
Idiosyncratic Firm Crash Risk:							
IFP Smirk	1.03	0.47	0.39	0.91	1.05	1.19	1.55
IFP Smirk_182	0.95	0.57	0.17	0.85	1.01	1.15	1.45
Crash	0.25	0.43	0.00	0.00	0.00	0.00	1.00
Crash Frequency	0.26	0.46	0.00	0.00	0.00	0.00	1.00
Sigma	2.69	0.78	1.73	2.13	2.52	3.09	4.27
Idiosyncratic Firm Jump Risk:							
JIFP Smirk	1.09	0.31	0.80	0.94	1.02	1.14	1.62
Jump	0.19	0.40	0.00	0.00	0.00	0.00	1.00
Jump Frequency	0.20	0.41	0.00	0.00	0.00	0.00	1.00
Jump Sigma	2.59	0.65	1.73	2.12	2.48	2.94	3.83
Firm Properties:							
ROE	0.10	0.28	-0.28	0.05	0.12	0.19	0.38
Size	7.70	1.48	5.53	6.62	7.54	8.62	10.45
M/B	3.28	3.36	0.78	1.57	2.43	3.94	9.20
Leverage	0.52	0.22	0.15	0.36	0.53	0.67	0.90
Opaque	1.59	3.62	0.06	0.16	0.37	1.11	7.52
Idiosyncratic Volatility	0.05	0.03	0.02	0.03	0.04	0.06	0.09

Table 1.2: Weekly Returns During Idiosyncratic Firm Stock-Price Crash Weeks

This table presents summary statistics pertaining to firm, industry, and market weekly returns during idiosyncratic firm stock-price crash weeks. A week is classified as a crash week if a firm experiences an idiosyncratic weekly stock return decline falling 3.09 or more standard deviations below its mean idiosyncratic weekly return for a particular fiscal year. The notation $*, **, * * *$ indicates statistical significance at the $10\%, 5\%,$ and 1% levels, respectively. The aforementioned significance levels pertain to difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests for mean and median returns during crash and non-crash weeks.

Panel A: Firm Weekly Returns During Crash vs. Non-Crash Weeks

Variable	N(Weeks)	Mean	Median	Variance
Crash Weeks	3,653	-0.1940***	-0.1683***	0.0135
Non-Crash Weeks	731,321	0.0034	0.0018	0.0046
Total	734,974			

Panel B: Industry Weekly Returns During Crash vs. Non-Crash Weeks

Variable	N(Weeks)	Mean	Median	Variance
Crash Weeks	3,653	0.0036***	0.0041**	0.0014
Non-Crash Weeks	731,321	0.0015	0.0033	0.0013
Total	734,974			

Panel C: Market Weekly Returns During Crash vs. Non-Crash Weeks

Variable	N(Weeks)	Mean	Median	Variance
Crash Weeks	3,653	0.0044***	0.0054***	0.0007
Non-Crash Weeks	731,321	0.0013	0.0030	0.0007
Total	734,974			

Panel D: Crash Week Frequencies Within Firm Fiscal Year Sample

Number of Crashes	N(Years)	Percentage of Sample	Cumulative Percentage
0	10,621	75.04	75.04
1	3,411	24.10	99.14
2	121	0.85	100
Total	14,153	100	

Table 1.3: Effect of Executive Compensation Convexity on Idiosyncratic Firm Put Smirks

The dependent variable, IFP Smirk, is the idiosyncratic firm put smirk. The idiosyncratic firm put smirk is a measure of the option market's perception of the firm's future expected (ex-ante) idiosyncratic crash and negative jump risk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a binary dummy variable for the tenure of a given CEO at a particular firm. All variables are measured at time t. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) IFP Smirk	(2) IFP Smirk	(3) IFP Smirk	(4) IFP Smirk	(5) IFP Smirk
ln(1+Executive Vega)	**0.0419***** **(8.10)**	**0.0765***** **(8.12)**	**0.0250***** **(5.15)**	**0.0731***** **(6.50)**	**0.0716***** **(6.23)**
ln(1+Executive Delta)	-0.0129*** (-2.59)	-0.0486*** (-4.86)	-0.0009 (-0.18)	-0.0265* (-1.93)	-0.0281* (-1.89)
ln(1+Executive CashComp)	-0.0044 (-0.44)	0.0349** (2.38)	-0.0183* (-1.83)	0.0530*** (3.23)	0.0533*** (3.20)
ROE	0.0081 (0.58)	-0.0055 (-0.30)	0.0096 (0.70)	-0.0034 (-0.16)	0.0006 (0.03)
Size	-0.0222*** (-4.12)	0.0124 (1.00)	-0.0224*** (-4.23)	-0.0093 (-0.61)	-0.0084 (-0.51)
M/B	-0.0011 (-0.88)	-0.0030* (-1.71)	0.0024** (2.01)	-0.0026 (-1.41)	-0.0032* (-1.70)
Leverage	0.0452** (2.11)	0.1576*** (3.26)	0.0745*** (3.62)	0.1172** (2.16)	0.1259** (2.21)
Opaque	0.0084*** (9.15)	0.0073*** (5.15)	0.0033*** (3.57)	0.0060*** (3.76)	0.0059*** (3.67)
Idiosyncratic Volatility	-0.7453*** (-4.28)	-0.6983*** (-2.87)	-0.6715*** (-3.72)	-0.5351* (-1.90)	-0.5475* (-1.94)
Observations	14153	14153	14153	14153	14153
Adjusted R^2	0.014	0.059	0.079	0.098	0.101
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.4: Effect of Executive Compensation Convexity on the Occurrence of Idiosyncratic Firm Crashes: Logistic and Conditional Logistic Analysis

The dependent variable, Crash, is a binary indicator specifying the occurrence of an idiosyncratic firm crash within a given firm fiscal year. Specifically, crash is set to one if within its fiscal year a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Column (1) is a logistic regression whereas columns (2)-(5) are conditional logistic regressions. IFP smirk is the idiosyncratic firm put smirk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses in column (1) are clustered at the firm level. t-statistics in columns (2)-(5) are clustered within the respective conditioning variables of the conditional logistic regressions. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Crash	(2) Crash	(3) Crash	(4) Crash	(5) Crash
ln(1+Executive Vega)	**0.0632*****	**0.0965*****	**0.0557****	**0.1396*****	**0.1421*****
	(2.72)	**(2.78)**	**(2.36)**	**(3.13)**	**(3.17)**
ln(1+Executive Delta)	0.0026	-0.0464	0.0072	-0.0778	-0.1257**
	(0.11)	(-1.12)	(0.38)	(-1.28)	(-1.99)
ln(1+Executive CashComp)	-0.0541	0.0317	-0.0388	-0.0126	-0.0311
	(-1.04)	(0.43)	(-0.78)	(-0.15)	(-0.37)
IFP Smirk	0.1342***	0.0646	0.0787**	0.0706	0.0676
	(3.11)	(1.30)	(2.31)	(1.28)	(1.21)
ROE	0.0940	0.0074	0.0932*	0.0508	0.0403
	(1.23)	(0.08)	(1.96)	(0.48)	(0.38)
Size	-0.0675***	0.4376***	-0.0716**	0.4977***	0.5958***
	(-2.69)	(7.79)	(-2.42)	(6.55)	(7.66)
M/B	0.0205***	0.0109	0.0234***	0.0192**	0.0193**
	(3.27)	(1.40)	(3.29)	(1.98)	(1.97)
Leverage	-0.2878***	0.1323	-0.2550***	-0.0590	0.0407
	(-2.75)	(0.61)	(-2.84)	(-0.21)	(0.14)
Opaque	0.0188***	-0.0012	0.0122**	-0.0090	-0.0099
	(3.42)	(-0.17)	(2.04)	(-1.11)	(-1.19)
Idiosyncratic Volatility	1.4797*	-1.2251	2.9980***	-2.9845**	-2.8928**
	(1.66)	(-0.97)	(2.84)	(-2.13)	(-2.03)
Observations	14153	11986	14153	9963	9896
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.5: Effect of Executive Compensation Convexity on the Occurrence of Idiosyncratic Firm Crashes: Linear Probability Model Analysis

The dependent variable, Crash, is a binary indicator specifying the occurrence of an idiosyncratic firm crash within a given firm fiscal year. Specifically, crash is set to one if within its fiscal year a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. IFP smirk is the idiosyncratic firm put smirk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in \$000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Crash	(2) Crash	(3) Crash	(4) Crash	(5) Crash
ln(1+Executive Vega)	**0.0113*****	**0.0145****	**0.0100****	**0.0213*****	**0.0215*****
	(2.77)	**(2.35)**	**(2.40)**	**(2.64)**	**(2.63)**
ln(1+Executive Delta)	0.0006	-0.0059	0.0013	-0.0103	-0.0182
	(0.14)	(-0.75)	(0.30)	(-0.93)	(-1.51)
ln(1+Executive CashComp)	-0.0101	0.0039	-0.0071	-0.0055	-0.0078
	(-1.06)	(0.29)	(-0.70)	(-0.33)	(-0.46)
IFP Smirk	0.0240***	0.0101	0.0135*	0.0100	0.0096
	(3.16)	(1.16)	(1.70)	(1.01)	(0.96)
ROE	0.0165	0.0007	0.0164	0.0098	0.0077
	(1.18)	(0.04)	(1.17)	(0.49)	(0.37)
Size	-0.0122***	0.0716***	-0.0128***	0.0808***	0.0963***
	(-2.66)	(7.10)	(-2.70)	(5.99)	(6.57)
M/B	0.0038***	0.0026	0.0044***	0.0042**	0.0042**
	(3.14)	(1.63)	(3.53)	(2.18)	(2.16)
Leverage	-0.0524***	0.0262	-0.0462**	-0.0016	0.0177
	(-2.68)	(0.61)	(-2.34)	(-0.03)	(0.30)
Opaque	0.0038***	-0.0000	0.0025**	-0.0016	-0.0018
	(3.24)	(-0.02)	(2.06)	(-0.82)	(-0.89)
Idiosyncratic Volatility	0.2836*	-0.2564	0.5702***	-0.6026**	-0.5911**
	(1.65)	(-1.05)	(2.98)	(-2.11)	(-2.02)
Observations	14153	14153	14153	14153	14153
Adjusted R^2	0.005	0.050	0.010	0.059	0.058
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.6: Effect of Executive Compensation Convexity on the Number of Idiosyncratic Firm Crashes: Poisson and Conditional Poisson Analysis

The dependent variable, Crash Frequency, is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. A firm experiences an idiosyncratic crash within a fiscal year if its idiosyncratic weekly returns drop by 3.09 or more standard deviations below their firm fiscal year mean. Column (1) is a Poisson regression whereas columns (2)-(5) are conditional Poisson regressions. IFP smirk is the idiosyncratic firm put smirk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses in column (1) are clustered at the firm level. t-statistics in columns (2)-(5) are clustered within the respective conditioning variables of the conditional Poisson regressions. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Crash Freq	(2) Crash Freq	(3) Crash Freq	(4) Crash Freq	(5) Crash Freq
ln(1+Executive Vega)	**0.0483*****	**0.0680*****	**0.0419****	**0.0961*****	**0.0973*****
	(2.69)	**(2.65)**	**(2.17)**	**(2.89)**	**(2.93)**
ln(1+Executive Delta)	0.0067	-0.0337	0.0116	-0.0540	-0.0912**
	(0.37)	(-1.12)	(0.91)	(-1.20)	(-1.99)
ln(1+Executive CashComp)	-0.0384	0.0246	-0.0270	-0.0118	-0.0252
	(-0.96)	(0.46)	(-0.78)	(-0.19)	(-0.41)
IFP Smirk	0.1106***	0.0646*	0.0672***	0.0682	0.0656
	(3.39)	(1.74)	(2.73)	(1.62)	(1.55)
ROE	0.0774	-0.0082	0.0770**	0.0362	0.0275
	(1.34)	(-0.12)	(2.47)	(0.46)	(0.35)
Size	-0.0533***	0.3347***	-0.0564***	0.3947***	0.4670***
	(-2.76)	(8.08)	(-2.60)	(6.98)	(8.24)
M/B	0.0160***	0.0078	0.0182***	0.0125*	0.0126*
	(3.37)	(1.44)	(3.36)	(1.88)	(1.88)
Leverage	-0.2243***	0.0856	-0.1984***	-0.0505	0.0248
	(-2.81)	(0.55)	(-2.85)	(-0.25)	(0.12)
Opaque	0.0128***	-0.0015	0.0076*	-0.0078	-0.0080
	(3.38)	(-0.31)	(1.95)	(-1.47)	(-1.48)
Idiosyncratic Volatility	1.1586*	-0.9423	2.3590***	-2.0551**	-1.9290*
	(1.76)	(-1.05)	(3.05)	(-2.10)	(-1.96)
Observations	14153	12056	14153	10111	10044
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.7: Effect of Executive Compensation Convexity on the Number of Idiosyncratic Firm Crashes: Linear Model Analysis

The dependent variable, Crash Freq, is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. A firm experiences an idiosyncratic crash within a fiscal year if its idiosyncratic weekly returns drop by 3.09 or more standard deviations below their firm fiscal year mean. IFP smirk is the idiosyncratic firm put smirk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Crash Freq	(2) Crash Freq	(3) Crash Freq	(4) Crash Freq	(5) Crash Freq
ln(1+Executive Vega)	**0.0118*****	**0.0142****	**0.0103****	**0.0198****	**0.0200****
	(2.74)	**(2.17)**	**(2.37)**	**(2.29)**	**(2.29)**
ln(1+Executive Delta)	0.0019	-0.0053	0.0029	-0.0084	-0.0179
	(0.41)	(-0.63)	(0.63)	(-0.72)	(-1.40)
ln(1+Executive CashComp)	-0.0100	0.0045	-0.0068	-0.0084	-0.0108
	(-0.99)	(0.31)	(-0.64)	(-0.48)	(-0.60)
IFP Smirk	0.0270***	0.0135	0.0156*	0.0136	0.0133
	(3.43)	(1.49)	(1.91)	(1.32)	(1.27)
ROE	0.0184	-0.0009	0.0188	0.0132	0.0105
	(1.27)	(-0.05)	(1.29)	(0.64)	(0.50)
Size	-0.0131***	0.0773***	-0.0138***	0.0877***	0.1057***
	(-2.71)	(7.23)	(-2.76)	(6.12)	(6.81)
M/B	0.0042***	0.0030*	0.0048***	0.0047**	0.0048**
	(3.16)	(1.77)	(3.57)	(2.27)	(2.26)
Leverage	-0.0558***	0.0276	-0.0490**	-0.0044	0.0203
	(-2.70)	(0.62)	(-2.35)	(-0.07)	(0.32)
Opaque	0.0038***	-0.0002	0.0023*	-0.0021	-0.0022
	(3.08)	(-0.10)	(1.82)	(-1.01)	(-1.06)
Idiosyncratic Volatility	0.3130*	-0.2795	0.6364***	-0.6527**	-0.6191**
	(1.72)	(-1.11)	(3.12)	(-2.20)	(-2.06)
Observations	14153	14153	14153	14153	14153
Adjusted R^2	0.006	0.052	0.010	0.062	0.062
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.8: Effect of Executive Compensation Convexity on the Magnitude of Idiosyncratic Firm Crashes

The dependent variable, Sigma, is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. IFP smirk is the idiosyncratic firm put smirk. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Sigma	(2) Sigma	(3) Sigma	(4) Sigma	(5) Sigma
ln(1+Executive Vega)	**0.0194*****	**0.0255****	**0.0138***	**0.0375****	**0.0378****
	(2.71)	**(2.29)**	**(1.92)**	**(2.51)**	**(2.50)**
ln(1+Executive Delta)	0.0042	-0.0070	0.0038	-0.0151	-0.0250
	(0.53)	(-0.49)	(0.47)	(-0.72)	(-1.10)
ln(1+Executive CashComp)	-0.0244	0.0118	-0.0231	-0.0085	-0.0107
	(-1.40)	(0.49)	(-1.25)	(-0.29)	(-0.36)
IFP Smirk	0.0407***	0.0094	0.0212	0.0092	0.0083
	(3.06)	(0.61)	(1.54)	(0.53)	(0.47)
ROE	0.0287	-0.0115	0.0285	0.0014	-0.0016
	(1.04)	(-0.34)	(1.03)	(0.03)	(-0.04)
Size	-0.0210**	0.1585***	-0.0201**	0.1823***	0.2080***
	(-2.55)	(8.50)	(-2.36)	(7.19)	(7.45)
M/B	0.0074***	0.0040	0.0081***	0.0061	0.0064
	(3.18)	(1.19)	(3.43)	(1.56)	(1.61)
Leverage	-0.0893**	0.0684	-0.0757**	0.0984	0.1476
	(-2.53)	(0.89)	(-2.11)	(0.98)	(1.38)
Opaque	0.0073***	-0.0018	0.0052**	-0.0060*	-0.0067*
	(3.18)	(-0.58)	(2.23)	(-1.70)	(-1.84)
Idiosyncratic Volatility	0.6373**	-0.7873*	0.9436***	-1.6372***	-1.6510***
	(2.14)	(-1.92)	(2.83)	(-3.35)	(-3.33)
Observations	14153	14153	14153	14153	14153
Adjusted R^2	0.006	0.059	0.011	0.067	0.068
Firm-FE	No	Yes	No	No	No
Year-FE	No	No	Yes	No	No
CEO-FE	No	No	No	Yes	No
Spell-FE	No	No	No	No	Yes

Table 1.9: Effect of Executive Compensation Convexity on Idiosyncratic Firm Crashes: Scaled Decile Rank Linear Model Analysis

The dependent variables are IFP Smirk, Crash, Crash Frequency, and Sigma, respectively. All independent variables are transformed by first calculating their decile rank each fiscal year, subtracting one, and then dividing by nine. The coefficient on the respective scaled decile rank variable is the change in the corresponding dependent variable stemming from a bottom-to-top decile transition in the independent variable. IFP smirk is the idiosyncratic firm put smirk. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. Intercept term is included but not reported. All *t*-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) IFP Smirk	(2) Crash	(3) Crash Frequency	(4) Crash Magnitude
Rank(Managerial Vega)	**0.1091*****	**0.0514*****	**0.0506*****	**0.0698****
	(5.08)	**(2.97)**	**(2.77)**	**(2.25)**
Rank(Managerial Delta)	0.0093	-0.0149	-0.0077	-0.0365
	(0.46)	(-0.82)	(-0.41)	(-1.11)
Rank(Managerial CashComp)	-0.0338*	0.0029	0.0051	-0.0132
	(-1.79)	(0.16)	(0.27)	(-0.41)
Rank(IFP Smirk)		0.0185	0.0211*	0.0427**
		(1.62)	(1.73)	(2.04)
Rank(ROE)	-0.0064	0.0016	0.0058	0.0123
	(-0.41)	(0.11)	(0.38)	(0.46)
Rank(Size)	-0.1249***	-0.0351	-0.0386	-0.0226
	(-5.01)	(-1.52)	(-1.60)	(-0.54)
Rank(M/B)	0.0210	0.0617***	0.0636***	0.1189***
	(1.21)	(3.86)	(3.75)	(4.01)
Rank(Leverage)	0.0425***	-0.0368***	-0.0402***	-0.0614**
	(2.79)	(-2.67)	(-2.77)	(-2.47)
Rank(Opaque)	-0.0225	-0.0183	-0.0206	-0.0275
	(-1.59)	(-1.39)	(-1.48)	(-1.18)
Rank(Idiosyncratic Volatility)	-0.0387**	0.0910***	0.0981***	0.1807***
	(-2.09)	(5.70)	(5.76)	(6.39)
Observations	14153	14153	14153	14153
Adjusted R^2	0.004	0.007	0.007	0.008

Table 1.10: Effect of Executive Compensation Convexity on Idiosyncratic Firm Crashes: Alternate Compensation Incentive Measures

The dependent variables are IFP Smirk, Crash, Crash Frequency, and Sigma, respectively. IFP smirk is the idiosyncratic firm put smirk. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Scaled Delta is the ratio of Executive Delta to Executive CashComp. Scaled Vega is the ratio of Executive Vega to Executive CashComp. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. A spell is defined as a unique CEO-firm combination. Columns (2) and (3) are logistic and Poisson regressions, respectively. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) IFP Smirk	(2) Crash	(3) Crash Frequency	(4) Sigma
Scaled Vega	**0.4426*****	**0.6441*****	**0.5199*****	**0.2566*****
	(9.08)	**(2.97)**	**(3.38)**	**(3.22)**
Scaled Delta	-0.0124***	-0.0506*	-0.0362	-0.0120
	(-2.74)	(-1.78)	(-1.63)	(-1.36)
ln(1+Executive CashComp)	0.0285***	-0.0103	-0.0003	-0.0053
	(2.75)	(-0.19)	(-0.01)	(-0.30)
IFP Smirk		0.1345***	0.1102***	0.0401***
		(3.14)	(3.41)	(3.02)
ROE	0.0051	0.0919	0.0767	0.0289
	(0.37)	(1.20)	(1.34)	(1.05)
Size	-0.0268***	-0.0545**	-0.0434**	-0.0191**
	(-5.19)	(-2.23)	(-2.35)	(-2.29)
M/B	-0.0011	0.0229***	0.0180***	0.0081***
	(-0.90)	(3.64)	(3.80)	(3.53)
Leverage	0.0495**	-0.3170***	-0.2496***	-0.0985***
	(2.39)	(-3.08)	(-3.18)	(-2.86)
Opaque	0.0084***	0.0184***	0.0124***	0.0071***
	(9.05)	(3.35)	(3.30)	(3.11)
Idiosyncratic Volatility	-0.8101***	1.5103*	1.1734*	0.6297**
	(-4.67)	(1.70)	(1.78)	(2.11)
Observations	14153	14153	14153	14153
Adjusted R^2	0.013			0.006

Table 1.11: Effect of Executive Compensation Convexity on Idiosyncratic Firm Crashes: Idiosyncratic Volatility Quartile Dummy Stratification

The dependent variables are IFP Smirk, Crash, Crash Frequency, and Sigma, respectively. IFP smirk is the idiosyncratic firm put smirk. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Q4(Idio. Vol.) is the highest idiosyncratic volatility quartile stratification dummy. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) IFP Smirk	(2) Crash	(3) Crash Frequency	(4) Sigma
ln(1+Managerial Vega)	**0.0656*****	**-0.0036**	**-0.0036**	**-0.0050**
	(6.66)	**(-0.61)**	**(-0.56)**	**(-0.49)**
ln(1+Managerial Vega)×Q2(Idio. Vol.)	**-0.0283*****	**0.0152***	**0.0153***	**0.0229***
	(-2.65)	**(1.94)**	**(1.79)**	**(1.65)**
ln(1+Managerial Vega)×Q3(Idio. Vol.)	**-0.0412*****	**0.0243*****	**0.0255*****	**0.0438*****
	(-3.70)	**(2.95)**	**(2.89)**	**(3.05)**
ln(1+Managerial Vega)×Q4(Idio. Vol.)	**-0.0262****	**0.0265*****	**0.0275*****	**0.0417*****
	(-2.31)	**(3.04)**	**(2.94)**	**(2.68)**
ln(1+Managerial Delta)	-0.0112**	-0.0022	-0.0011	-0.0013
	(-2.23)	(-0.50)	(-0.25)	(-0.16)
ln(1+Managerial CashComp)	-0.0051	-0.0073	-0.0070	-0.0191
	(-0.51)	(-0.77)	(-0.69)	(-1.11)
IFP Smirk		0.0246***	0.0276***	0.0417***
		(3.24)	(3.51)	(3.15)
ROE	0.0201	0.0237*	0.0259*	0.0391
	(1.45)	(1.70)	(1.79)	(1.43)
Size	-0.0175***	-0.0036	-0.0040	-0.0048
	(-3.25)	(-0.79)	(-0.84)	(-0.58)
M/B	-0.0020	0.0033***	0.0037***	0.0065***
	(-1.59)	(2.73)	(2.77)	(2.87)
Leverage	0.0504**	-0.0417**	-0.0441**	-0.0669*
	(2.30)	(-2.14)	(-2.14)	(-1.91)
Opaque	0.0085***	0.0034***	0.0033***	0.0064***
	(9.29)	(2.86)	(2.69)	(2.82)
Q2(Idio. Vol.)	0.1032**	-0.0232	-0.0219	-0.0201
	(2.20)	(-0.73)	(-0.64)	(-0.36)
Q3(Idio. Vol.)	0.1494***	-0.0411	-0.0399	-0.0409
	(3.15)	(-1.28)	(-1.17)	(-0.75)
Q4(Idio. Vol.)	0.1012**	-0.0183	-0.0169	-0.0078
	(2.17)	(-0.56)	(-0.49)	(-0.14)
Observations	14153	14153	14153	14153
Adjusted R^2	0.014	0.008	0.009	0.009

Table 1.12: Exogenous Variation in Compensation Convexity: Cross-Sectional Difference-in-Means Analysis

The dependent variables are Δ(IFP Smirk), Δ(Crash), Δ(Crash Frequency), and Δ(Sigma), respectively. All variables are transformed by first determining the average of the respective variable for each firm pre- and post-FAS123R, and then calculating a post- minus pre-period difference. The pre-FAS 123R period spans fiscal years 2002-2004 while the post-FAS 123R period spans fiscal years 2005-2007. IFP smirk is the idiosyncratic firm put smirk constructed using 91-day maturity options. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Δ(Executive CashComp) is the change in mean executive cash compensation, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Delta) is the change in mean executive delta, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Vega) is the change in mean executive vega, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Intercept term is included but not reported. All *t*-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Δ(IFP Smirk)	(2) Δ(Crash)	(3) Δ(Crash Frequency)	(4) Δ(Sigma)
Δ(Managerial Vega)	**-0.0000**	**0.0003****	**0.0004****	**0.0007****
	(-0.14)	**(2.41)**	**(2.42)**	**(2.35)**
Δ(Managerial Delta)	-0.0000	-0.0000	-0.0000	-0.0001*
	(-0.01)	(-1.16)	(-1.01)	(-1.89)
Δ(Managerial CashComp)	-0.0000	-0.0000	-0.0000	0.0000
	(-0.21)	(-0.96)	(-0.87)	(0.37)
Δ(IFP Smirk)		0.0814	0.1041*	0.0302
		(1.49)	(1.84)	(0.29)
Δ(ROE)	0.0136	0.1468**	0.1484**	0.2381**
	(0.31)	(2.39)	(2.20)	(2.13)
Δ(Size)	-0.1229***	0.0719**	0.1008***	0.1594**
	(-5.65)	(2.18)	(2.83)	(2.56)
Δ(M/B)	0.0069*	0.0094*	0.0069	0.0241**
	(1.67)	(1.67)	(1.09)	(2.41)
Δ(Leverage)	0.0269	0.1636	0.1783	0.5215**
	(0.36)	(1.24)	(1.29)	(2.27)
Δ(Opaque)	0.0009	0.0000	-0.0010	0.0070
	(0.42)	(0.00)	(-0.28)	(1.12)
Δ(Idiosyncratic Vol.)	-2.2250***	0.5327	0.6413	-1.2262
	(-3.23)	(0.44)	(0.50)	(-0.59)
Observations	929	929	929	929
Adjusted R^2	0.036	0.015	0.017	0.030

Table 1.13: Exogenous Variation in Compensation Convexity: Cross-Sectional Difference-in-Means Analysis

The dependent variables are Δ(IFP Smirk_182), Δ(Crash), Δ(Crash Frequency), and Δ(Sigma), respectively. All variables are transformed by first determining the average of the respective variable for each firm pre- and post-FAS123R, and then calculating a post- minus pre-period difference. The pre-FAS 123R period spans fiscal years 2002-2004 while the post-FAS 123R period spans fiscal years 2005-2007. IFP smirk_182 is the idiosyncratic firm put smirk constructed using 182-day maturity options. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Δ(Executive CashComp) is the change in mean executive cash compensation, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Delta) is the change in mean executive delta, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Vega) is the change in mean executive vega, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in \$000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Δ(IFP Smirk_182)	(2) Δ(Crash)	(3) Δ(Crash Frequency)	(4) Δ(Sigma)
Δ(Managerial Vega)	**0.0001**	**0.0003****	**0.0004****	**0.0007****
	(0.40)	**(2.38)**	**(2.36)**	**(2.34)**
Δ(Managerial Delta)	-0.0000	-0.0000	-0.0000	-0.0001*
	(-0.21)	(-1.18)	(-1.02)	(-1.90)
Δ(Managerial CashComp)	0.0000	-0.0000	-0.0000	0.0000
	(0.04)	(-0.97)	(-0.89)	(0.37)
Δ(IFP Smirk_182)		0.0409	0.0647	0.0108
		(0.84)	(1.25)	(0.12)
Δ(ROE)	0.0165	0.1472**	0.1488**	0.2383**
	(0.37)	(2.39)	(2.20)	(2.13)
Δ(Size)	-0.1078***	0.0663**	0.0950***	0.1569**
	(-4.61)	(2.01)	(2.67)	(2.52)
Δ(M/B)	0.0024	0.0099*	0.0075	0.0243**
	(0.60)	(1.76)	(1.18)	(2.44)
Δ(Leverage)	0.0606	0.1633	0.1772	0.5217**
	(0.79)	(1.24)	(1.28)	(2.27)
Δ(Opaque)	-0.0014	0.0001	-0.0008	0.0070
	(-0.60)	(0.04)	(-0.23)	(1.13)
Δ(Idiosyncratic Vol.)	-0.5002	0.3719	0.4419	-1.2880
	(-0.74)	(0.31)	(0.35)	(-0.63)
Observations	929	929	929	929
Adjusted R^2	0.024	0.013	0.015	0.030

Table 1.14: Effect of Compensation Convexity on Idiosyncratic Positive Jump Risk: Cross-Sectional Difference-in-Means Analysis

The dependent variables are Δ(JIFP Smirk), Δ(Jump), Δ(Jump Frequency), and Δ(Jump Sigma), respectively. All variables are transformed by first determining the average of the respective variable for each firm pre- and post-FAS123R, and then calculating a post- minus pre-period difference. The pre-FAS 123R period spans fiscal years 2002-2004 while the post-FAS 123R period spans fiscal years 2005-2007. JIFP Smirk is the jump risk related idiosyncratic firm put smirk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. Δ(Executive CashComp) is the change in mean executive cash compensation, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Delta) is the change in mean executive delta, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Δ(Executive Vega) is the change in mean executive vega, by firm, surrounding the exogenous FAS 123R compensation convexity shock. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Δ(JIFP Smirk)	(2) Δ(Jump)	(3) Δ(Jump Frequency)	(4) Δ(Jump Sigma)
Δ(Managerial Vega)	**-0.0000**	**-0.0002**	**-0.0002**	**-0.0002**
	(-0.84)	**(-1.07)**	**(-0.99)**	**(-0.78)**
Δ(Managerial Delta)	0.0000	0.0000	0.0000	0.0000
	(0.30)	(0.32)	(0.32)	(0.14)
Δ(Managerial CashComp)	-0.0000**	0.0001**	0.0001*	0.0001*
	(-2.17)	(2.01)	(1.94)	(1.91)
Δ(JIFP Smirk)		-0.0435	-0.0380	-0.0298
		(-0.57)	(-0.48)	(-0.21)
Δ(ROE)	0.0512*	-0.1334**	-0.1436**	-0.3209***
	(1.92)	(-2.02)	(-2.11)	(-2.98)
Δ(Size)	-0.0271*	-0.0457	-0.0500	-0.1567***
	(-1.91)	(-1.35)	(-1.42)	(-3.04)
Δ(M/B)	-0.0021	0.0077	0.0076	0.0156
	(-0.81)	(1.19)	(1.10)	(1.42)
Δ(Leverage)	-0.0222	-0.0159	-0.0388	-0.0126
	(-0.43)	(-0.14)	(-0.33)	(-0.07)
Δ(Opaque)	0.0001	-0.0032	-0.0050	-0.0026
	(0.04)	(-0.97)	(-1.43)	(-0.51)
Δ(Idiosyncratic Vol.)	-0.2057	3.2716***	3.3366***	4.7873***
	(-0.52)	(3.21)	(3.22)	(3.14)
Observations	929	929	929	929
Adjusted R^2	0.004	0.024	0.025	0.043

Table 1.15: Exogenous Variation in Compensation Convexity: Difference-in-Differences Analysis

The dependent variables are IFP Smirk, Crash, Crash Frequency, and Sigma, respectively. IFP smirk is the idiosyncratic firm put smirk. Crash is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return. Crash Frequency is the number of idiosyncratic firm stock-price crashes within a given firm fiscal year. Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Executive CashComp is the executive team's average total cash remuneration within a given firm fiscal year. Executive Delta is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price. Executive Vega is the average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Executive Vega 2002 is the continuous treatment variable. Post×ln(1+Executive Vega 2002) is the difference-in-differences interaction term. All specifications feature industry and year fixed effects. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) IFP Smirk	(2) Crash	(3) Crash Frequency	(4) Sigma
Post×ln(1+Managerial Vega 2002)	**-0.0294*****	**-0.0275*****	**-0.0280*****	**-0.0684*****
	(-3.74)	**(-2.71)**	**(-2.59)**	**(-3.83)**
Post-123R	0.2023***	0.1541***	0.1357**	0.3707***
	(5.17)	(2.60)	(2.05)	(3.42)
ln(1+Managerial Vega 2002)	0.0260***	0.0013	0.0028	0.0004
	(3.40)	(0.13)	(0.26)	(0.02)
ln(1+Managerial Delta)	-0.0052	0.0087	0.0099	0.0073
	(-0.84)	(1.02)	(1.10)	(0.48)
ln(1+Managerial CashComp)	-0.0121	-0.0076	-0.0079	0.0153
	(-0.92)	(-0.41)	(-0.39)	(0.47)
IFP Smirk		-0.0114	-0.0099	-0.0181
		(-0.51)	(-0.44)	(-0.45)
ROE	0.0068	0.0770***	0.0818***	0.1233**
	(0.32)	(2.71)	(2.70)	(2.11)
Size	-0.0040	-0.0288***	-0.0309***	-0.0498***
	(-0.59)	(-3.19)	(-3.24)	(-3.11)
M/B	0.0013	-0.0033	-0.0034	-0.0068
	(0.68)	(-1.14)	(-1.09)	(-1.27)
Leverage	0.0827***	0.0529	0.0672	0.0093
	(2.67)	(1.29)	(1.51)	(0.11)
Opaque	0.0039***	0.0030*	0.0028	0.0066**
	(3.73)	(1.81)	(1.63)	(2.02)
SD(lnres)	-0.2804	-0.4955	-0.4861	-0.2499
	(-0.83)	(-1.10)	(-1.01)	(-0.30)
Observations	4370	4370	4370	4370
Adjusted R^2	0.090	0.023	0.022	0.024

Appendices

A. Estimation of Compensation Incentives

Delta is the dollar change in the value of the executive's equity portfolio (in \$000s) associated with a 1% increase in the firm's stock price. Similarly, vega is the dollar change in the value of the executive's equity portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The closed form expressions for the delta and vega of a call option on an underlying security with dividends are provided by the Black and Scholes (1973) option pricing model as modified to account for dividend payouts:

$$\text{Option Value} = Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma\sqrt{T}\right) \tag{15}$$

$$\Delta = \frac{\partial\,(\text{Option Value})}{\partial S} \tag{16}$$

$$= e^{-dT}N(Z)$$

$$\nu = \frac{\partial\,(\text{Option Value})}{\partial \sigma} \tag{17}$$

$$= e^{-dT}N'(Z)\,S\sqrt{T}$$

$$Z = \frac{\ln\left(\frac{S}{X}\right) + T\left[r - d + \frac{\sigma^2}{2}\right]}{\sigma\sqrt{T}} \tag{18}$$

where N is the cumulative density function for the normal distribution, N' is the probability density function for the normal distribution, d is the natural logarithm of the expected dividend yield, T is the time to maturity of the option in years, S is the price of the underlying stock, X is the exercise price of the option, r is the natural logarithm of the risk-free interest rate, and σ is the expected stock return volatility. Accordingly, the dollar change in the value of an option associated with a 1% increase in the firm's stock price is $.01 \times \Delta \times S$. The dollar change in the value of an option associated with a one percentage-point increase in the standard deviation of the firm's equity returns is $.01 \times \nu$.

The methodology in Core and Guay (2002) is used to aggregate the delta and vega of individual option grants so as to arrive at the total delta and total vega of the executive's option portfolio. The total delta of the executive's portfolio of stocks is then added to the total option portfolio delta in calculating the total delta of the executive's equity portfolio. The total vega of the executive's equity portfolio is approximated as the total vega of the option portfolio as Guay (1999) finds that stock options, but not common stock, substantially increase the sensitivity of the executive's wealth to firm equity risk.

B. Variable Definitions

1. **Cash Compensation**: Total current compensation (Salary+Bonus) of the executive—`TOTAL_CURR`.

2. **Crash**: A binary indicator specifying the occurrence of an idiosyncratic firm crash within a given firm fiscal year. Specifically, crash is set to one if within its fiscal year a firm experiences one or more idiosyncratic firm weekly returns falling 3.09 or more standard deviations below the mean idiosyncratic firm weekly return.

3. **Crash Frequency**: The number of idiosyncratic firm stock-price crashes within a given firm fiscal year. A firm experiences an idiosyncratic crash within a fiscal year if its idiosyncratic firm weekly returns drop by 3.09 or more standard deviations below their firm fiscal year mean.

4. **Delta**: Dollar change in the value of the executive's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price.

5. **Discretionary Accruals**: Discretionary accruals are calculated by estimating the modified Jones model. For all firms within each Fama-French industry in a given fiscal year, I estimate the following cross-sectional regression:

$$\frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} = \alpha_0 \left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] + \beta_1 \left[\frac{\Delta\mathbf{Sales}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \beta_2 \left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \varepsilon_{i,t}$$

Discretionary accruals, for each firm fiscal year, are then calculated as follows:

$$\mathbf{DiscAcc}_{i,t} = \frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} - \widehat{\alpha}_0 \left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] - \widehat{\beta}_1 \left[\frac{\Delta\mathbf{Sales}_{i,t} - \Delta\mathbf{Receivables}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right]$$

$$-\widehat{\beta}_2\left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right]$$

where $\mathbf{TA}_{i,t}$ is the total accruals, $\mathbf{Assets}_{i,t}$ is the total assets, $\Delta\mathbf{Sales}_{i,t}$ is the change in sales, $\Delta\mathbf{Receivables}_{i,t}$ is the change in receivables, and $\mathbf{PPE}_{i,t}$ is the property, plant, and equipment of firm i in fiscal year t, respectively.

6. **Executive CashComp**: The executive team's average total cash remuneration within a given firm fiscal year.

7. **Executive Delta**: Average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a 1% increase in the firm's stock price.

8. **Executive Vega**: Average dollar change in the value of the executive team's total equity compensation portfolios (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns.

9. **Idiosyncratic Firm Put Smirk**: The ratio of the idiosyncratic implied volatility (variance) of out-of-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. Specifically, I define IFP Smirk for a given firm i in fiscal year t as follows:

$$\textbf{IFP Smirk}_{i,t} = \frac{\hat{\boldsymbol{\sigma}}^2_{i,t-1,OTM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,OTM}\right]}{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}\right]}$$

$$\hat{\boldsymbol{\beta}}_{\text{i,t-1,Vasicek}} = \boldsymbol{w}_{i,t-1}\hat{\boldsymbol{\beta}}^{TS}_{i,t-1} + \left[(1-\boldsymbol{w}_{i,t-1}) \times \mathbf{1}\right]$$

$$\boldsymbol{w}_{i,t-1} = \frac{\text{XSVar}(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})}{\text{XSVar}(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1}) + \text{SE}^2(\hat{\boldsymbol{\beta}}^{TS}_{i,t-1})}$$

$$r_{i,t-1} = \alpha_i + \beta^{TS}_{i,t-1} r_{m,t-1} + \varepsilon_{i,t-1}$$

where the deltas of the out-of-the-money (OTM) put options and at-the-money (ATM) put options are -.2 and -.5, respectively. $\hat{\sigma}^2_{i,t-1,OTM}$ is the average implied volatility (variance) of out-of-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\sigma}^2_{S\&P500,t-1,OTM}$ is the average implied volatility (variance) of out-of-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\sigma}^2_{i,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\sigma}^2_{S\&P500,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\beta}_{\text{i,t-1,Vasicek}}$ is the Vasicek shrinkage estimator of firm i's beta on the market during fiscal year $t-1$ as estimated using weekly returns. $\hat{\beta}^{TS}_{i,t-1}$ is the time-series estimate of firm i's fiscal year beta on the market during fiscal year $t-1$ using weekly returns. $w_{i,t-1}$ is the Vasicek shrinkage weight on the time-series estimate of firm i's fiscal year beta on the market during fiscal year $t-1$. $\text{XSVar}(\hat{\beta}^{TS}_{i,t-1})$ is the cross-sectional variance of the time-series estimates of firm betas on the market during fiscal year $t-1$. $\text{SE}^2(\hat{\beta}^{TS}_{i,t-1})$ is the square of the standard error on the time-series estimate of firm i's beta on the market portfolio during fiscal year $t-1$ using using weekly returns. $r_{i,t-1}$ denotes firm i's weekly returns during fiscal year $t-1$ and $r_{m,t-1}$ represents the weekly returns for the CRSP value-weighted market index during fiscal year $t-1$.

10. **Idiosyncratic Firm Weekly Returns**: I estimate the below model for each

stock fiscal year and I define idiosyncratic firm weekly returns as $\mathbf{ln(1+\varepsilon)}$:

$$\boldsymbol{r}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_{1,i}\boldsymbol{r}_{m,t-1} + \boldsymbol{\beta}_{2,i}\boldsymbol{r}_{j,t-1} + \boldsymbol{\beta}_{3,i}\boldsymbol{r}_{m,t} + \boldsymbol{\beta}_{4,i}\boldsymbol{r}_{j,t} + \boldsymbol{\beta}_{5,i}\boldsymbol{r}_{m,t+1} + \boldsymbol{\beta}_{6,i}\boldsymbol{r}_{j,t+1} + \boldsymbol{\varepsilon}_{it}$$

where $\boldsymbol{r}_{i,t}$ is the weekly return for stock i in week t, $\boldsymbol{r}_{m,t}$ is the weekly return for the CRSP value-weighted market index in week t, and $\boldsymbol{r}_{j,t}$ is the weekly return for stock i's value-weighted Fama-French industry index j during week t. I include leads and lags to account for non-synchronous trading (Dimson, 1979).

11. **Idiosyncratic Volatility**: The standard deviation of idiosyncratic firm weekly returns for a given firm fiscal year.

12. **IFP smirk_182**: The idiosyncratic firm put smirk constructed using 182-day maturity options.

13. **Jump**: Set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return.

14. **Jump Frequency**: The number of idiosyncratic firm stock-price jumps within a given firm fiscal year.

15. **Jump Idiosyncratic Firm Put Smirk**: The ratio of the idiosyncratic implied volatility (variance) of in-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. Specifically, I define JIFP Smirk for a given firm i in fiscal year t as follows:

$$\textbf{JIFP Smirk}_{i,t} = \frac{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ITM} - \left[\hat{\beta}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ITM}\right]}{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM} - \left[\hat{\beta}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}\right]}$$

where the deltas of the in-the-money (ITM) put options and at-the-money

(ATM) put options are -.8 and -.5, respectively. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,ITM}$ is the average implied volatility (variance) of in-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ITM}$ is the average implied volatility (variance) of in-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t.

16. **Jump Sigma**: The largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean.

17. **Leverage**: Total assets minus the book value of common equity scaled by total assets —`(AT-CEQ)/AT`.

18. **MTB**: Market value of common equity scaled by the book value of common equity—`(PRCC_F*CSHO)/CEQ`.

19. **Opaque**: Three year moving sum of the absolute value of discretionary accruals:

$$\mathbf{Opaque}_t = \sum_{i=t-3}^{t-1} |\mathbf{DiscAcc}_i|$$

20. **Post-123R**: Dummy variable equal to 0 for fiscal years 2002-2004 and equal to 1 for fiscal years 2005-2007.

21. **ROE**: Income before extraordinary items scaled by the book value of common equity—`IBC/CEQ`.

22. **Scaled Delta**: Scaled Delta is the ratio of Executive Delta to Executive Cash-Comp.

23. **Scaled Vega**: Scaled Vega is the ratio of Executive Vega to Executive Cash-Comp.

24. **Sigma**: Sigma is the largest standard deviation decline in idiosyncratic firm weekly returns below their firm fiscal year mean. Specifically, I define sigma for a given firm fiscal year as follows:

$$\textbf{Sigma} = -\min\left[\frac{\mathbf{ln(1+\varepsilon)} - \text{Mean}\left(\mathbf{ln(1+\varepsilon)}\right)}{\text{Standard Deviation}\left(\mathbf{ln(1+\varepsilon)}\right)}\right]$$

25. **Size**: Natural logarithm of the market value of common equity—`ln(PRCC_F*CSHO)`.

26. **Total Accruals**: Income before extraordinary items and discontinued operations minus the cash flow from operating activities—`(IBC_t-OANCF_t)`.

27. **Vega**: Dollar change in the value of the executive's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns.

CHAPTER 2

The Differential Ramifications of Risk-Taking Incentives on Systematic and Idiosyncratic Volatility: Evidence from a Natural Experiment

2.1. Introduction

CEO compensation contracts have attained heightened scrutiny in the wake of the Financial Crisis of 2008. Academics and regulators have highlighted the recent explosion in executive pay, as well as the role of misaligned remuneration incentives in the recent crisis, in calling for reform. For instance, Bebchuk (2009) posits that the risk-taking incentives arising from option-based pay may have fueled the exorbitant risk-taking activities that precipitated the crisis. One factor that contributed to the proliferation of options, as components of executive pay, is their generous expensing treatment. Until recently, firms were given a choice to either expense options at their intrinsic value or at their fair value through some variant of a closed-form option pricing model, such as the Black and Scholes (1973) model as modified to account for dividends, or a binomial option pricing model. Consequently, most firms elected to use the intrinsic valuation methodology and granted options at-the-money so as to set the intrinsic value of grants at zero. This, in turn, allowed firms to artificially inflate their earnings by avoiding the recognition of option-grant expenses.

Under the terms of FAS 123R, firms were mandated to adopt the fair value expensing of options. Hayes, Lemmon, and Qiu (2012) show that following the adoption of FAS 123R in December of 2005, firms drastically decrease their use of option-based pay and, consequently, also reduce the convexity of compensation contracts. However, they do not find any evidence of the expected decrease in proxies for managerial risk-taking behavior associated with a decrease in the risk-taking incentives stemming from option pay.[1] They state that "it remains a challenge to understand the conditions under which convexity in compensation contracts affects managerial behavior and the role that options play relative to other forms of compensation as an efficient

[1] Anderson and Core (2013) present one potential solution to the puzzle in Hayes, Lemmon, and Qiu (2012) by accounting for the full risk-taking incentives of executives stemming from option-, stock-, and debt-like remuneration structures.

mechanism for paying managers."

In discerning the relationship between option remuneration and managerial risk-taking behavior, it is paramount to consider the role of CEO risk-aversion. Namely, not all risk is equally risky in the perspective of a risk-averse CEO who is overexposed to the risk of the firm. If a manager wants to increase the value of options within their option compensation portfolio by increasing the volatility of the firm, an increase in hedgeable risk is preferable to an increase in non-hedgeable risk. Armstrong and Vashishtha (2012) reason that as CEOs are precluded from shorting their firm's equity and are able to freely trade the market portfolio, it is easier for them to hedge a given undesirable increase in systematic risk than a similar unwanted increase in idiosyncratic risk. CEOs can also hedge their potentially suboptimal over-exposure to systematic risk through the use of derivatives contracts. Ceteris paribus, the certainty equivalent of an increase in the value of the risk-averse manager's option portfolio stemming from a fixed increase in systematic risk is greater than that from an identical increase in idiosyncratic risk as the cash flow is subjectively deemed less risky.

Kulatilaka and Marcus (1994) show that while the value of tradable options is increasing in the volatility of the underlying stock, the value of restricted employee options can actually fall as volatility increases. They argue that the early exercise of employee stock options leads to an option pricing anomaly. As volatility increases, a risk-averse CEO is more likely to sub-optimally exercise early so as to decrease non-hedgeable over-exposure to firm risk which, in turn, reduces the option's expected value. For reasonable risk-aversion parameters, this mechanism can offset the otherwise value-increasing effects of volatility on option prices. The intuition in Lambert, Larcker, and Verrecchia (1991), Carpenter (2000), and Ross (2004) implies that unlike increases in total risk stemming from idiosyncratic volatility, increases in total risk linked to systematic volatility unambiguously increase the CEO's valuation of their option portfolio.

In this paper, I exploit the exogenous negative shock to compensation convexity stemming from FAS 123R in examining the differential ramifications of option pay and risk-taking incentives on the systematic and idiosyncratic volatility of the firm. If option convexity in the pre-FAS 123R period incentivized CEOs to primarily increase the value of their option portfolios by increasing their firms' systematic volatility, the post-FAS 123R period should feature a differential decrease in systematic volatility as compensation convexity and option use decrease. In isolating the aforementioned effect, I use a difference-in-differences identification strategy featuring two control groups of firms that are relatively unaffected by FAS 123R. My ideal control group is composed of firms in which the CEO's compensation portfolio is entirely devoid of stock options over the sample period. These CEOs are not affected by FAS 123R, from a risk-taking incentives standpoint, as their remuneration package does not feature any current or prior outstanding stock option grants surrounding the adoption of FAS 123R.

Gormley, Matsa, and Milbourn (2013) argue that when analyzing the implications of FAS 123R on firms, it is crucial to account for the fact these new accounting rules were known in advance of the passage and adoption of FAS 123R. If firms recognized the forthcoming regulatory changes and voluntarily adopted the terms of FAS 123R early, the true ramifications of FAS 123R as measured at the time of mandatory adoption may be biased downward.[2] With this in mind, my second control contains, both, firms in the first control group as well as early full-adopters of FAS 123R. To the extent that early-full adopting firms voluntarily enact the fair-value methodology prior to the adoption of FAS 123R, they are expected to be relatively less affected by FAS 123R, at its later time of mandated adoption, than their counterpart firms who

[2] I would like to thank Carter, Lynch, and Tuna (2007) for giving me access to a list of early adopters of FAS 123R.

delay adoption until the mandatory enforcement deadline.[3]

By combining the first control group of firms with early-full adopters of FAS 123R, I increase the power of my tests. With both of the above control groups, I show that firms subjected to a negative convexity shock (treatment firms) differentially decrease their systematic volatility by a greater magnitude than those firms whose executive compensation convexity profile is relatively unaffected by FAS 123R (control firms) at its time of mandatory adoption. In contrast, I do not find a similar differential trend in idiosyncratic volatility between the aforementioned treatment and control groups. This evidence is largely consistent with the notion that compensation convexity, stemming from option convexity, predominantly incentivizes under-diversified risk-averse CEOs to increase the value of their option portfolios by increasing the systematic volatility of the firms they manage as it is readily more hedgeable than idiosyncratic volatility.

This study contributes to the literature in several ways. First, this paper presents a novel approach to resolving the convexity puzzle within Hayes, Lemmon, and Qiu (2012) as I present new evidence indicating that convexity in the remuneration package incentivizes CEOs to primarily augment the systematic volatility, as opposed to the idiosyncratic volatility, of the firms they manage. If managers use options as a conduit through which they can gamble with shareholder wealth by exposing them to suboptimal systematic volatility, options are not serving their intended contracting function. Instead of decreasing the agency costs of risk by encouraging CEOs to adopt positive NPV projects that may be characterized by idiosyncratic risk, option pay may have instead contributed to the very frictions it was intended to reduce. To my knowledge, this is the first paper to examine the differential ramifications of compensation convexity on systematic and idiosyncratic volatility within a natural experiment setting featuring an exogenous negative option convexity shock to CEO

[3]Specifically, I use the subset of early FAS 123R adopters who chose the modified prospective adoption methodology.

firm-specific equity portfolios.

In addition, this study also presents evidence in accordance with the framework and predictions developed by Armstrong and Vashishtha (2012). Specifically, they utilize an instrumental variables approach in attempting to control for the endogeneity inherent in the risk-compensation incentives setting mechanism. A potential concern with instrumental variables approaches is the requirement for untestable exclusion restrictions to hold. Namely, Gormley, Matsa, and Milbourn (2013) reference this concern in noting that Armstrong and Vashishtha (2012) “assume that cash balances, marginal tax rates, past stock returns, and past profitability are unrelated to the proportion of firms’ overall risk that is systematic.” The evidence presented within my paper, from a natural experiment setting, is largely in agreement with the intuition from Armstrong and Vashishtha (2012) and hence helps to allay the aforementioned concerns regarding invalid instruments driving the results in their paper.

The remainder of this study proceeds as follows. Section 2.2 conducts a review of the related literature and institutional background. Section 2.3 develops the testable hypotheses and specifies the identification strategy. Section 2.4 describes the data selection process as well as the measurement of important variables. Section 2.5 presents the empirical analysis and Section 2.6 concludes the paper.

2.2. Related Literature and Institutional Background

2.2.1. Option Pay, Risk-Taking Incentives, and CEO Behavior

A number of papers explicitly examine the link between between option pay, risk-taking incentives, and the risk-taking behavior of managers. For instance, Guay (1999) finds that stock options, but not common stock, substantially increase the sensitivity of the manager's wealth to firm risk. He also examines the cross-section of firms and identifies a positive relationship between a firm's investment opportunities and compensation convexity. This finding is in accordance with the notion that firms in which the agency costs of risk are greatest from potential managerial underinvestment in risky positive-NPV projects have the highest impetus to increase managerial risk-taking incentives. He also identifies a positive relation between a firm's stock-return volatility and the convexity provided by managerial option grants.

Coles, Daniel, and Naveen (2006) attempt to control for the endogeneity inherent in the risk and compensation incentives setting mechanism by implementing a simultaneous equations framework designed to capture plausible reverse causality. They find that a higher sensitivity of CEO wealth to stock volatility results in the manager's implementation of riskier policy choices. They also identify a positive feedback relation between riskier policy choices and compensation convexity. Low (2009) also identifies a positive causal relation between compensation convexity and managerial risk-taking behavior. Namely, she finds that in response to an exogenous positive shock to takeover protection in Delaware in the 1990s, CEOs decrease the risk of the firms they manage. This reduction primarily occurs in firms featuring low managerial wealth sensitivity to stock return volatility. In response to the increase in takeover protection, firms increase compensation convexity so as provide augmented risk-taking incentives to CEOs.

Chava and Purnanandam (2010) find a positive relationship between the risk-taking incentives of CEOs and CFOs and financial policy. They show that CEOs' risk increasing incentives are linked to greater leverage as well as lower cash balances while CFOs' risk-increasing incentives are associated with riskier debt-maturity decisions and lower earnings-smoothing. Bakke, Mahmudi, Fernando, and Salas (2013) show that compensation convexity is negatively associated with the use of oil and gas derivative contracts within the oil and gas industry. Specifically, they find that firms increase their use of derivatives contracts meant to guard against shocks in oil and gas prices following the decrease in compensation convexity associated with FAS 123R. Gormley, Matsa, and Milbourn (2013) identify an exogenous increase in left-tail risk and show that boards reduce managerial exposure to stock price movements as a consequence. They also find greater risk reducing activities after a decrease in option-based pay.

While the aforementioned evidence portrays a positive association between option convexity and managerial risk-taking activities, several papers highlight the need for caution in depicting the full nature of this connection. For example, Lambert, Larcker, and Verrecchia (1991) demonstrate that the managerial incentives stemming from restricted option pay do not necessarily follow the same dynamics as those provided by unrestricted options. They show that if the probability of an option vesting in the money is substantially high, managerial stock options can actually increase aversion to risk-taking behavior. Carpenter (2000) examines the impact of option compensation on the manager's appetite for risk when the option position is not hedgeable. She finds that the ramifications of option compensation on the manager's risk-taking behavior is more complicated than simple option pricing intuition may imply. While the convexity in option pay incentivizes the manager to seek payoffs that are "away from the money" and thus may lead to an augmentation of firm volatility, DARA utility shows that the manager may dynamically adjust volatility as asset values fluctuate. As asset values increase, the CEO may attenuate the risk of their equity portfolio.

Hall and Murphy (2002) argue that the interaction of risk aversion with non-diversification leads to a divergence between the company's cost of granting options and the CEO's valuation of options granted. As risk averse CEOs are overexposed to the risk of the firms they manage, their valuation of options within their equity portfolio is less than that of the firm. Hall and Murphy (2002) explain that this friction can justify the large premiums that managers demand when accepting option pay in lieu of cash compensation. Ross (2004) contends that convexity within an agent's fee schedule does not automatically imply lower risk aversion. Specifically, convexity within the pay contract is a necessary but insufficient condition for inducing risk-taking behavior. Increasing the CEO's wealth, by means of option grants, may not necessarily lead to greater risk-taking behavior if the wealth effect of the options perturbs the manager's utility function into a more risk-averse portion of its domain.

2.3. Hypotheses Development and Research Design

2.3.1. Hypotheses Development

Armstrong and Vashishtha (2012) conjecture that for a fixed level of compensation convexity (vega), an increase in systematic risk, for all combinations of risk and risk-aversion, unambiguously yields an increase in the manager's certainty equivalent of their firm-specific equity portfolio. This is a direct result of the CEO's ability to hedge any potentially deleterious increases in systematic risk by trading the market portfolio. CEOs can also hedge their potentially suboptimal overexposure to systematic risk through the use of derivatives contracts. I utilize this intuition in approaching the convexity puzzle within Hayes, Lemmon, and Qiu (2012). My first hypothesis is specified below:

Hypothesis 1. *Compensation convexity, stemming from option pay, incentivizes CEOs to increase the systematic risk of the firms they manage.*

I exploit the exogenous negative shock to compensation convexity associated with FAS 123R in testing the empirical predictions of the aforementioned hypothesis. If option convexity in the pre-FAS 123R period incentivized CEOs to increase the value of their option portfolios by increasing their firms' systematic risk, the post-FAS 123R period should feature a decrease in systematic risk as compensation convexity, risk-taking incentives, and option use exogenously decrease. Specifically, firms subjected to a negative convexity shock (treatment firms) should differentially decrease their systematic risk by a greater magnitude than those firms whose executive compensation convexity profiles are relatively unaffected by FAS 123R (control firms) at its time of mandatory adoption.

Ceteris paribus, the certainty equivalent of an increase in the value of the risk-averse manager's option portfolio stemming from a fixed increase in systematic risk is greater than that from an identical increase in idiosyncratic risk as the cash flow is subjectively deemed less risky. If option convexity in the pre-FAS 123R period incentivized CEOs to increase the value of their option portfolios by primarily increasing the systematic as opposed to the idiosyncratic risk of the firm, there should not be an equally observable differential trend in idiosyncratic risk between the aforementioned treatment and control groups. This leads to my second hypothesis:

Hypothesis 2. *Compensation convexity, stemming from option pay, incentivizes CEOs to increase risk by* ***primarily*** *increasing the systematic as opposed to the idiosyncratic risk of the firms they manage.*

2.3.2. Research Design

In examining the testable empirical implications of my hypotheses, I use a difference-in-differences identification strategy featuring two control groups of firms that are relatively unaffected by FAS 123R. My ideal control group is composed of firms in which the CEO's compensation portfolio is entirely devoid of stock options over the sample period. These CEOs are not affected by FAS 123R, from a risk-taking incentives standpoint, as their remuneration package does not feature any current or prior outstanding stock option grants surrounding the adoption of FAS 123R. Gormley, Matsa, and Milbourn (2013) argue that when analyzing the implications of FAS 123R on firms, it is crucial to account for the fact these new accounting rules were known in advance of the passage and adoption of FAS 123R. If firms recognized the forthcoming regulatory changes and voluntarily adopted the terms of FAS 123R early, the true ramifications of FAS 123R as measured at the time of mandatory adoption may be biased downward. With this in mind, my second control group also includes early full-adopters of FAS 123R. To the extent that early-full adopting firms voluntarily enact the fair-value methodology prior to the adoption of FAS 123R, they are expected to be relatively less affected by FAS 123R, at its later time of mandated adoption, than their counterpart firms who delay adoption until the mandatory enforcement deadline. I first test the empirical predictions of my hypotheses using my ideal control group. I then combine the first control group of firms with full-early adopters of FAS 123R, so as to increase the power of my tests, and re-examine the empirical validity of my hypotheses.

I employ the following equations in analyzing the differential ramifications of an exogenous negative shock to compensation convexity on the total, systematic, and idiosyncratic risk of the firm:

$$\ln(TR_{i,t+1}) = \lambda_0 + \lambda_1 Post + \lambda_2 Treatment + \lambda_3 Post{\times}Treatment + \sum_{j=1}^{m} \beta_j Control_{j,i,t} + \epsilon_{i,t+1} \tag{2.1}$$

$$\ln(SR_{i,t+1}) = \phi_0 + \phi_1 Post + \phi_2 Treatment + \phi_3 Post{\times}Treatment + \sum_{j=1}^{m} \delta_j Control_{j,i,t} + \eta_{i,t+1} \tag{2.2}$$

$$\ln(IR_{i,t+1}) = \psi_0 + \psi_1 Post + \psi_2 Treatment + \psi_3 Post{\times}Treatment + \sum_{j=1}^{m} \omega_j Control_{j,i,t} + \xi_{i,t+1} \tag{2.3}$$

where *Post-123R* (abbreviated as *Post*) is a dummy variable equal to 0 for fiscal years 2002-2004 and equal to 1 for fiscal years 2005-2007, and *Treatment* is a dummy variable equal to 0 for firms assigned to the control group and equal to 1 for firms assigned to the treatment group. *TR*, *SR*, and *IR* are acronyms for total risk, systematic risk, and idiosyncratic risk, respectively. All control variables are defined in Appendix B.

If the testable implication of Hypothesis 1 holds, I should find that firms subjected to a negative convexity shock (treatment firms) differentially decrease their systematic risk by a greater magnitude than those firms whose executive compensation convexity profiles are relatively unaffected by FAS 123R (control firms) at its time of mandatory adoption. This translates to a negative and statistically significant coefficient on the difference-in differences interaction term within Equation 2.2 ($\phi_3 < 0$). Similarly, one potential empirical manifestation of Hypothesis 2 is for ϕ_3 to be negative and statistically significant within Equation 2.2 and for ψ_3 to be negative but statistically insignificant within Equation 2.3. As total risk is composed of systematic and idiosyncratic risk, the ramification of an exogenous shock to compensation convexity on the total risk of the firm will be an interaction of the individual effects of the shock on the systematic and idiosyncratic components of risk. To the extent that the relationship between compensation convexity and the total risk of the firm may be attenuated by the weaker relation between compensation convexity and the idiosyncratic risk of the firm, the finding within Hayes, Lemmon, and Qiu (2012) demonstrating that an exogenous drop in convexity is not associated with the expected drop in total volatility can be further rationalized. While the expected sign on λ_3 within Equation 2.1 is negative, it is difficult to make a prediction regarding its statistical significance.

2.4. Data Selection and Variable Measurement

For my primary empirical analysis, I begin by obtaining all relevant variables from the ExecuComp database pertaining to the annual compensation of CEOs between fiscal years 2002-2007. The CEO's equity incentives to increase the stock price of the firm, delta, is calculated as the dollar change in the value of the CEO's equity portfolio (in \$000s) associated with a 1% increase in the firm's stock price. Compensation convexity, vega, is defined as the CEO's equity incentives to increase the risk of the firm. Specifically, vega is the dollar change in the value of the CEO's equity portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The closed form expressions for the delta and vega of a call option on an underlying security with dividends are provided by the Black and Scholes (1973) option pricing model as modified to account for dividend payouts. The methodology in Core and Guay (2002) is used to aggregate the delta and vega of individual option grants so as to arrive at the total delta and total vega of the CEO's option portfolio. The total delta of the CEO's portfolio of stocks is then added to the total option portfolio delta in calculating the total delta of the CEO's equity portfolio. The total vega of CEO's equity portfolio is approximated as the total vega of the option portfolio as Guay (1999) finds that stock options, but not common stock, substantially increase the sensitivity of the manager's wealth to firm risk.

After collecting the necessary Execucomp measures, I merge this data with the required Compustat control variables. All volatility measures are based on stock return data obtained from the Center for Research in Security Prices (CRSP). I follow Execucomp in calculating volatility as the standard deviation of firm stock returns over rolling 60-month windows. In order to estimate volatility accurately, I mandate a minimum requirement of 20 monthly observations over the aforementioned rolling windows for a given volatility estimate to be retained. The Fama-French three-factor asset pricing model is employed in decomposing total volatility into its systematic and idiosyncratic components. All information regarding the monthly risk-free rate as well as the Fama-French market, value-growth, and size factors is obtained from Wharton Research Data Services (WRDS). Next, I annualize all volatility measures by multiplying the monthly volatility measures by the square root of 12.

I merge the data constructed from Execucomp and Compustat with the CRSP volatility data. I retain a given firm-year if all required variables are available for that observation. In addition, I keep data for a given firm if it has a minimum of one year of data within both the pre- and post-FAS 123R periods. I also remove utility firms (firms whose SIC code is between 4900 and 4999) and financial firms (firms with SIC codes between 6000 and 6999) from my sample. The Fama-French 49 industry definitions are obtained from Kenneth French's online data library. Finally, I winsorize market-to-book-ratio, cash compensation, delta, leverage, pp&e, total pay, as well as vega at the 1st and 99th percentiles. All control variables are defined in Appendix B.

2.5. Empirical Analysis

Table 2.1 presents the descriptive statistics for all variables used within my primary tests. The mean total annual pay for a CEO in my sample is roughly \$5.09 million, with roughly \$1.39 million stemming from cash-based compensation. The average grant-date value of the option portfolio accounts for 31% of the manager's annual pay, which translates to approximately \$1.6 million. The two primary incentives derived from the CEO's equity compensation portfolio are incentives to increase the firm's stock price, delta, and incentives to increase the firm's volatility, vega. Table 2.1 indicates that for a typical CEO, the value of the equity remuneration portfolio increases by \$761,940 for a 1% increase in their firm's stock price. In contrast, the value of the total option remuneration portfolio increases by \$178,450 for a one percentage-point increase in the standard deviation of the firm's return. On average, systematic volatility constitutes roughly 26% of the total volatility of the firm.

Panel B of Figure 2.1, illustrates the importance of the firm's annual issuance of new option grants to the CEO's compensation portfolio in maintaining a desired optimal level of risk-taking incentives. Ceteris paribus, the total vega of previously granted options decreases as the aggregate time-to-maturity of the option portfolio decreases (vega time-decay). In addition, Panel B of Figure 2.1 demonstrates graphically that the risk-taking incentives derived from option grants are maximized when the options are at-the-money. Until recently, firms were given a choice to either expense options at their intrinsic value or at their fair value through some variant of a closed-form option pricing model, such as the Black and Scholes (1973) model as modified to account for dividends, or a binomial option pricing model. Consequently, most firms elected to use the intrinsic valuation methodology and granted options at-the-money so as to set the intrinsic value of grants at zero. This, in turn, allowed firms to artificially inflate their earnings by avoiding the recognition of option-grant expenses. As options were perceived as a relatively less-costly form of pay, they constituted an average of roughly 41% of the CEOs' annual pay in 2002 (Figure 2.2). As firms started to recognize the forthcoming mandatory fair-value regulatory changes associated with FAS 123R, they began decreasing their utilization of option-based pay within the remuneration package. Namely, option pay decreased to 31% of total annual CEO compensation by fiscal year 2005 and to only 23% of total pay in 2007.

As the earning advantages of options declined, option pay decreased, and the risk-taking incentives stemming from options fell. Figure 2.3 documents the temporal trend in mean CEO equity portfolio vega over my sample period. As the total vega of the CEO's equity portfolio is an aggregation of the risk taking incentives derived from unexercised vested options, unexercised unvested options, and current option grants, total average CEO option portfolio vega continued to increase through fiscal year 2003, reaching a maximum value of approximately \$191,253. Firms recognized the forthcoming regulatory changes and began adjusting their compensation policies so as to comply with the terms of FAS 123R. As a result, vega began to decline in fiscal year 2004 and entered a period of steep attenuation as the post-FAS 123R period set in. By fiscal year 2007, vega had declined to roughly \$160,796. This decrease constitutes a 16% negative shock to the compensation convexity stemming from options in the period surrounding the adoption of FAS 123R. I exploit this exogenous negative shock to compensation convexity in examining the differential ramifications of option pay and risk-taking incentives on the systematic and idiosyncratic risk of the firm.

My ideal control group consists of firms in which the CEO's compensation portfolio is entirely devoid of stock options over my sample period. These CEOs are not affected by FAS 123R, from a risk-taking incentives standpoint, as their remuneration package does not feature any current or prior outstanding stock option grants surrounding the adoption of FAS 123R. If firms recognized the forthcoming regulatory changes and voluntarily adopted the terms of FAS 123R early, the true ramifications of FAS 123R as measured at the time of mandatory adoption may be biased downward. With this in mind, my second control group also includes early full-adopters of FAS 123R. To the extent that early-full adopting firms voluntarily enact the fair-value methodology prior to the adoption of FAS 123R, they are expected to be relatively less affected by FAS 123R, at its later time of mandated adoption, than their counterpart firms who delay adoption until the mandatory enforcement deadline. I first test the empirical predictions of my hypotheses using my ideal control group. I then combine the first control group of firms with full-early adopters of FAS 123R, so as to increase the power of my tests, and re-examine the empirical validity of my hypotheses. This merged control group, featuring both the ideal control sample as well as early-full adopters of FAS 123R, is henceforth referred to as the full control group.

Table 2.2 presents the summary statistics for my treatment and full control group over the entire sample period. Similarly, Table 2.3 provides the descriptive statistics for my treatment and ideal control group over the duration of my sample. For my analysis to yield unbiased estimates, the respective treatment and control groups should feature similar firm properties in the pre-FAS 123R period. Table 2.4 features the results of difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests between my treatment and full control samples in the pre-FAS 123R window. The treatment and full control groups are similar in size, leverage, market-to-book ratio, investment growth, return on equity, cash holdings, as well as in total plant, property, and equipment. The primary divergence in firm properties appears to be in the percentage of firms paying dividends as well as in research and development expenses, sales growth, and capital expenditures. By construction, firms within the full control sample have lower option pay and lower vega than their counterpart firms in the treatment sample. These firms also have lower volatility.[4] I control for all differences in the observable characteristics of my treatment and control firms within my primary volatility tests. It is certainly comforting that the treatment and control sample are similar along many of the firm properties demonstrated to impact volatility.

Table 2.5 features the results of difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests between my treatment and ideal control samples in the pre-FAS 123R period. The ideal control group appears to be more similar to the treatment sample. Namely, firms in the ideal control group are similar to treatment firms in size, leverage, market-to-book ratio, investment growth,

[4]It is paramount to account for the endogeneity inherent in the volatility and compensation incentives setting mechanism by exploiting exogenous variation in vega. Ceteris paribus, managers with greater wealth-stock volatility sensitivities are more incentivized to increase the volatility of the firms they manage. However, it is also the case that firms operating in economic settings characterized by greater volatility may render the compensation contract more convex. This is done so as to reward the CEO for bearing the greater risks associated with their position and to also decrease the net risk aversion of the executive.

sales growth, return on equity, cash holdings, capital expenditures, as well as in total plant, property, and equipment. In terms of firm properties, they are only statistically different from treatment firms in research and development expenses and dividend payer status. Ideal control firms, by construction, have zero vega as their CEO's remuneration package does not feature any current or prior outstanding stock option grants surrounding the adoption of FAS 123R. Figure 2.4 illustrates the temporal trend in mean option grant value as a proportion of total CEO compensation in my treatment and ideal control group, respectively. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007. Similarly, Figure 2.5 presents the time trend in mean CEO equity portfolio vega in the treatment and ideal control group, respectively. For my analysis to yield unbiased estimates, the treatment and ideal control sample should follow parallel trends in the primary volatility outcome variables of interest prior to the convexity shock. Over fiscal years 2002-2004, Figures 2.6, 2.7, and 2.8 show that there are, indeed, parallel trends in total volatility, systematic volatility, and idiosyncratic volatility between my treatment and ideal control group. The use of a control group is essential within my research design as I am able to filter secular declines in volatility that are unrelated to the convexity shock stemming from FAS 123R. This is one of the benefits of a difference-in-differences identification strategy. I also use year fixed-effects in further controlling for this aforementioned decrease in volatility.

I begin my primary analysis by demonstrating that, within my ideal control and treatment sample, the shock to CEO remuneration packages surrounding the passage of FAS 123R is primarily a shock to risk-taking incentives.[5] Table 2.6 demonstrates that FAS 123R does not consistently constitute a differential shock to the price-increasing incentives of CEOs across my five empirical specifications. With delta as

[5]As the compensation incentives and volatility measures are skewed, I take the natural logarithmic transformation of the relevant variables in normalizing the transformed empirical data distributions.

the dependent variable, the difference-in-differences interaction term is statistically insignificant in columns 1-4 of Table 2.6. In contrast, Table 2.7 shows that firms in my ideal control group decrease their portion of total pay stemming from option pay by roughly 14 percentage points more than their counterparts in the control group. As expected, this translates to a substantial decline in the risk-taking incentives of CEOs. I find that the dollar change in the value of the average treatment-sample CEO's equity portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's return declines by $49,985 more than for similar CEOs in my control group. This effect is statistically significant for all specifications within Table 2.8. Firms appear to have largely stabilized delta incentives over the pre- and post-FAS 123R by increasing the portion of CEO pay stemming from restricted stock grants so as to offset decreases in delta associated with decreases in option pay.[6] Having demonstrated empirically that FAS 123R is primarily a differential exogenous shock to the compensation convexity of CEOs within my treatment and ideal control sample, I next examine the testable empirical implications of my two hypotheses.

If the testable implication of Hypothesis 1 holds, I should find that firms subjected to a negative convexity shock (treatment firms) differentially decrease their systematic risk by a greater magnitude than those firms whose executive compensation convexity profiles are unaffected by FAS 123R (control firms) at its time of mandatory adoption. This translates to a negative and statistically significant coefficient on the difference-in differences interaction term within Equation 2.2 ($\phi_3 < 0$). Table 2.9 presents evidence that is largely consistent with my first hypothesis. With systematic volatility as the dependent variable, the difference-in-differences interaction term (*Post×Treatment*) is negative and statistically significant at the 5% level. The economic magnitude of this result is also significant as firms subjected to the negative convexity shock (treatment firms) decrease their systematic risk by roughly 3.84 percentage points more than

[6] I further control for the relatively minor changes in delta surrounding FAS 123R by including CEO delta as a control variable within all of my primary volatility empirical specifications.

those firms whose executive compensation convexity profiles are unaffected by FAS 123R (control firms). This decrease represents 15.05% of the average volatility of treatment firms within the pre-FAS 123R period.

As my sample features firms from a wide array of industries, it is important to control for the unobservable time-invariant heterogeneity in volatility stemming from industry membership. Accordingly, Table 2.10 implements industry fixed-effects in addressing this concern. As before, the difference-in-differences interaction term is negative and becomes statistically significant at the 1% level. It is also crucial to account for year-specific heterogeneity in volatility in controlling for secular declines in volatility that are unrelated to the compensation convexity shock. Accordingly, Table 2.11 repeats the analysis with year fixed-effects and the results remain largely unchanged. Next, I include both industry fixed-effects and year fixed-effects within Equation 2.2 and show, in Table 2.12, that the interaction term in Equation 2.2 remains negative and statistically significant at the 1% level. Finally, I account for the role of unobservable time-invariant, firm-effects in volatility by incorporating firm fixed-effects into my framework. Table 2.13 demonstrates that the interaction term in Equation 2.2 remains negative and is statistically significant at the 5% level after accounting for firm and year fixed-effects. All of these results support my first hypothesis.

One potential empirical manifestation of Hypothesis 2 is for ϕ_3 to be negative and statistically significant within Equation 2.2 and for ψ_3 to be negative but statistically insignificant within Equation 2.3. As I have already demonstrated that ϕ_3 is negative and statistically significant across my empirical specifications, I now examine the sign and statistical significance of ψ_3 within Equation 2.3. Table 2.9 presents evidence that is largely consistent with my second hypothesis. With idiosyncratic volatility as the dependent variable, the difference-in-differences interaction term is highly insignificant. While firms subjected to a negative convexity shock (treatment firms) differentially decrease their systematic risk by a greater magnitude than those firms whose executive compensation convexity profile is unaffected by FAS 123R (control firms) at its time of mandatory adoption, I do not find a similar differential trend in idiosyncratic risk between the aforementioned treatment and control groups. I account for the role of industry, year, and firm fixed-effects within my framework in Tables 2.10, 2.11, 2.12, and 2.13. Across these specifications, ψ_3 remains highly insignificant. The interaction term within Equation 2.1 is statistically insignificant across all of my empirical specifications as the relationship between compensation convexity and the total risk of the firm is attenuated by the weaker relation between compensation convexity and the idiosyncratic risk of the firm. These results demonstrate, within a natural experiment setting, that the relation between risk-taking incentives and the firm's total volatility is primarily driven by the more robust relation between risk-taking incentives and the systematic volatility of the firm.

In further testing the robustness of my results, I extend my sample period by one year so as to include fiscal years 2002-2008. This is the sample period analyzed in Hayes, Lemmon, and Qiu (2012). Table 2.14 demonstrates that all of my results continue to hold in this extended sample. Namely, ϕ_3 is negative and statistically significant at the 5% level within Equation 2.2 and ψ_3 is negative but statistically insignificant within Equation 2.3. Gormley, Matsa, and Milbourn (2013) argue that when analyzing the implications of FAS 123R on firms, it is crucial to account for the fact these new accounting rules were known in advance of the passage and adoption of FAS 123R. If firms recognized the forthcoming regulatory changes and voluntarily adopted the terms of FAS 123R early, the true ramifications of FAS 123R as measured at the time of mandatory adoption may be biased downward. With this in mind, I re-examine the robustness of my results to the inclusion of early full-adopters of FAS 123R within my control group (full control group). Table 2.15 presents results that are in accordance with both of my hypotheses as the interaction term in

Equation 2.2 is negative and significant at the 1% level. In contrast, the interaction term is statistically insignificant in Equation 2.3.

What are the hedging mechanisms through which CEOs decrease the systematic risk of the firms they manage? Knopf, Nam, and Thornton Jr (2002) use derivatives data from the Swaps Monitor private database to analyze the relation between managerial equity incentives and the use of interest rate and currency derivatives by CEOs. Specifically, they examine the association between equity incentives and the notional amounts of interest rate and currency derivatives, including swaps, forwards, options, and futures. They present evidence suggesting that as vega increases, firms tend to decrease their use of hedging instruments. As FAS 123R features an exogenous negative shock to the convexity of the CEO's compensation portfolio, the intuition from Knopf, Nam, and Thornton Jr (2002) implies that CEOs should increase their hedging activities in the post-FAS 123R period. This augmentation of hedging behavior can be utilized to decrease the suboptimal overexposure of the firm to systematic risk and can drive the differential decrease of systematic risk within firms subjected to a negative compensation convexity shock (treatment firms) in the post-FAS 123R period. Bakke, Mahmudi, Fernando, and Salas (2013) identify evidence that is consistent with this logic by showing that compensation convexity is negatively associated with the use of oil and gas derivative contracts within the oil and gas industry. Specifically, they use a hand-collected sample of firms, with the requisite hedging data, in demonstrating that oil and gas companies increase their use of derivatives contracts, meant to guard against systematic shocks in oil and gas prices, following the decrease in compensation convexity associated with FAS 123R.

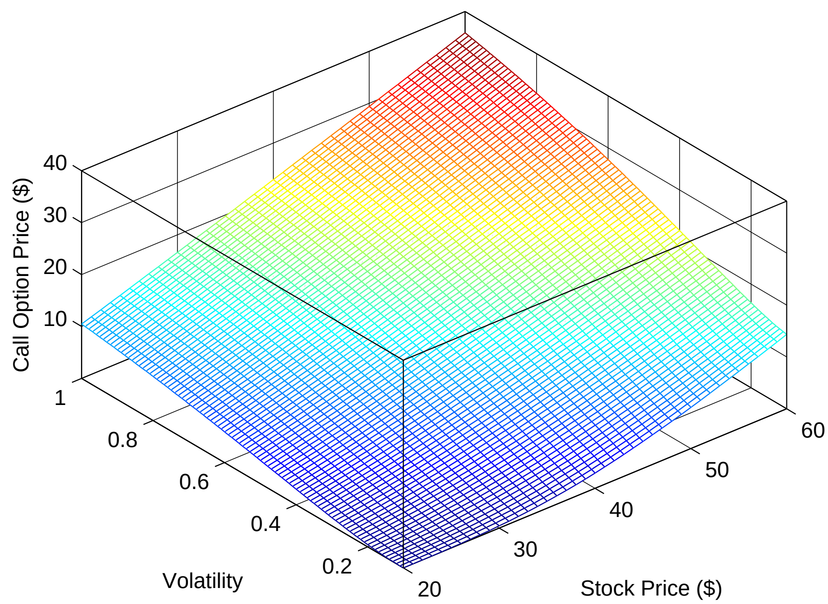
2.6. Summary and Conclusion

Within this paper, I exploit an exogenous negative shock to CEO compensation convexity in examining the differential ramifications of option pay and risk-taking incentives on the systematic and idiosyncratic volatility of the firm. In isolating this mechanism, I use a difference-in-differences identification strategy featuring two control groups of firms that are relatively unaffected by the aforementioned shock. By examining this question in this setting, I identify a novel approach towards resolving a puzzle within the compensation literature. In addition, I present new evidence that is largely consistent with the notion that compensation convexity, stemming from option convexity, predominantly incentivizes under-diversified risk-averse CEOs to increase the value of their option portfolios by increasing the systematic volatility of the firms they manage as it is readily more hedgeable than idiosyncratic volatility. If managers use options as a conduit through which they can gamble with shareholder wealth by overexposing them to suboptimal systematic volatility, options are not serving their intended contracting function. Instead of decreasing agency costs of risk, by encouraging CEOs to adopt innovative positive NPV projects that may be primarily characterized by idiosyncratic risk, option pay may have contributed to the very frictions it was intended to reduce. To my knowledge, this is the first paper to examine the heterogeneous implications of compensation convexity on systematic and idiosyncratic firm volatility within a natural experiment setting featuring an exogenous negative option convexity shock to CEO firm-specific equity portfolios.

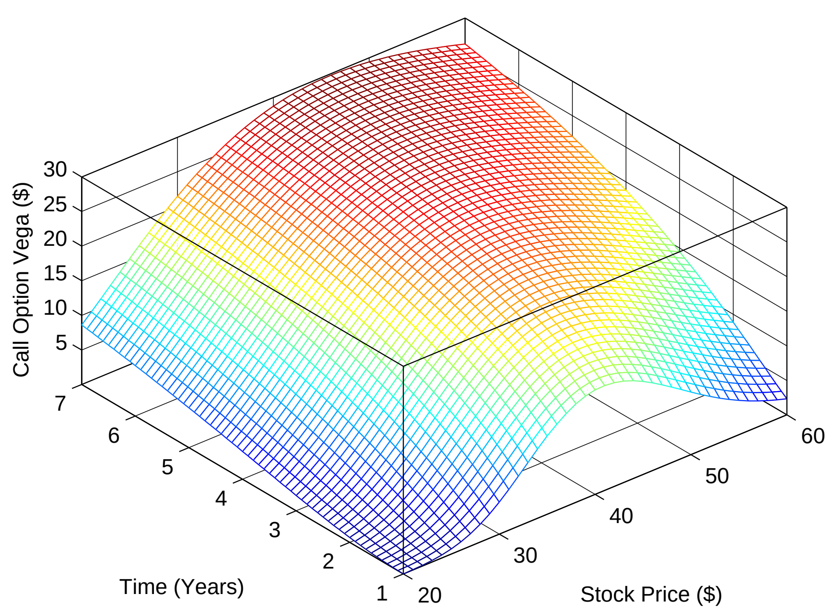
2.7. Figures and Tables

Figure 2.1: Black-Scholes-Merton Call Option Price & Vega

Panel A: Call Option Price—Stock Price & Volatility Sensitivity, X=$40



Panel B: Call Option Vega—Stock Price & Time Sensitivity, X=$40



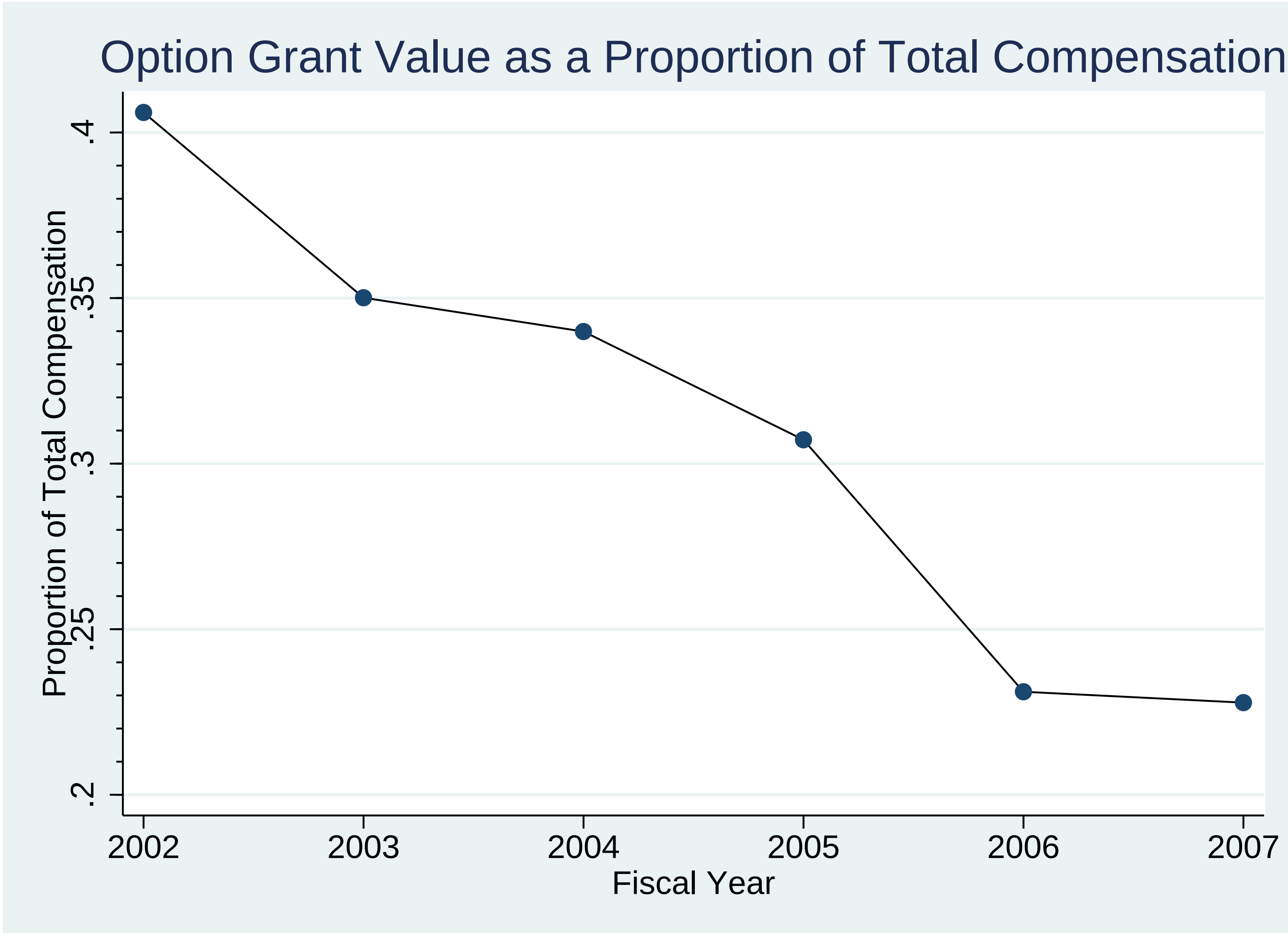


Figure 2.2: Temporal trend in mean option grant value as a proportion of total CEO compensation. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

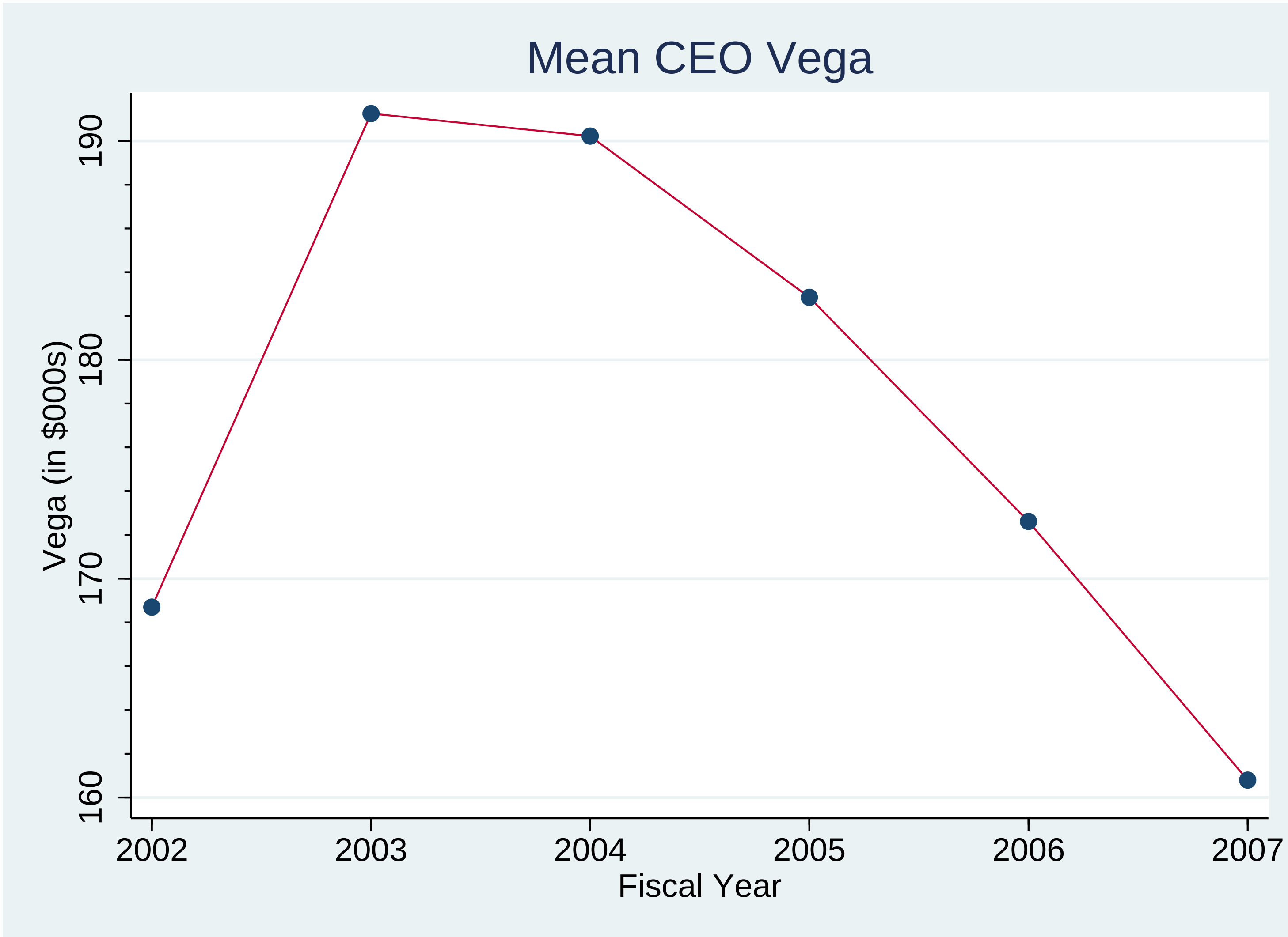


Figure 2.3: Temporal trend in mean CEO equity portfolio vega. Vega is the dollar change in the value of the CEO's equity portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

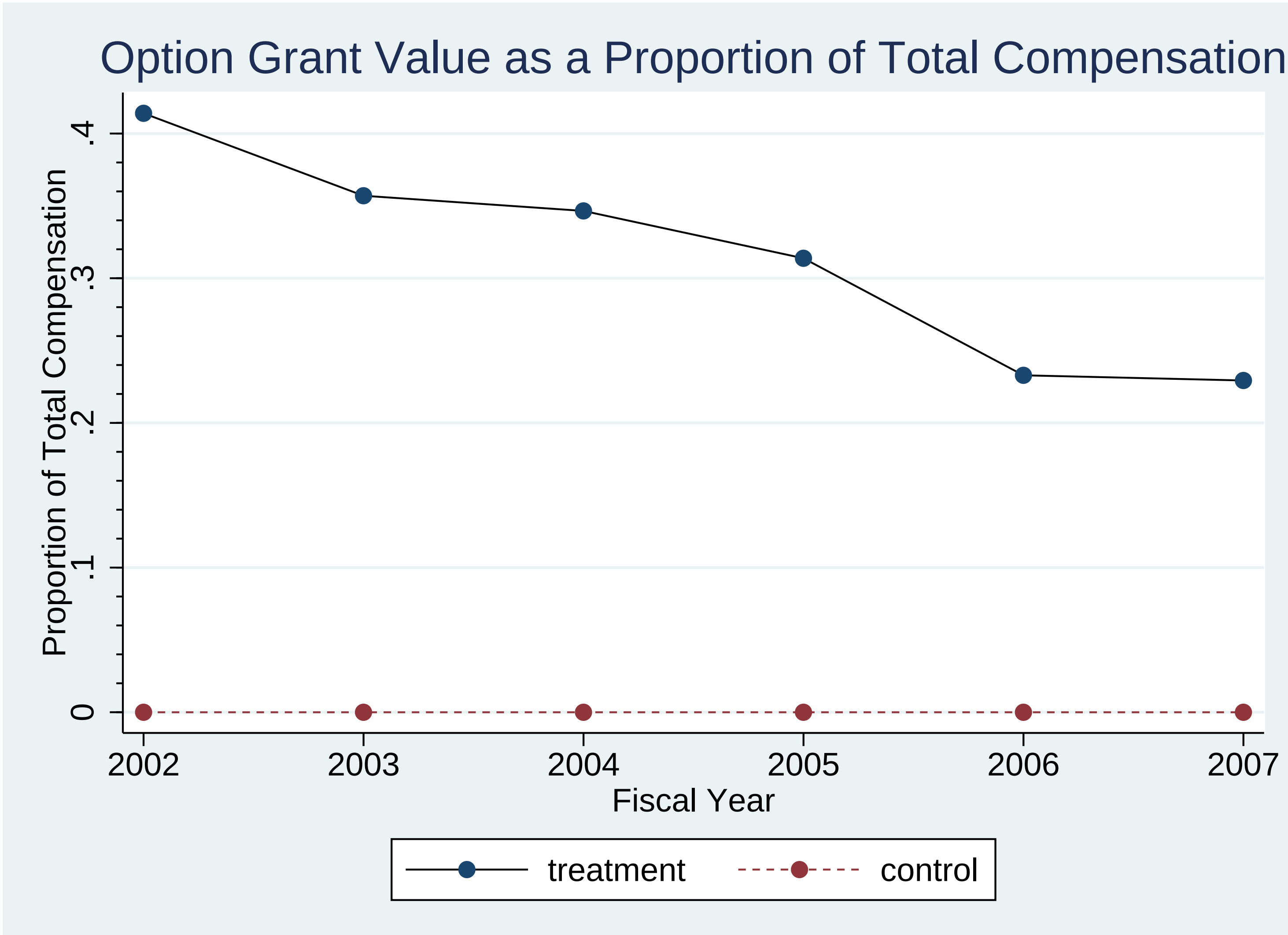


Figure 2.4: Differential temporal trend in mean option grant value as a proportion of total CEO compensation in the treatment and ideal control group, respectively. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

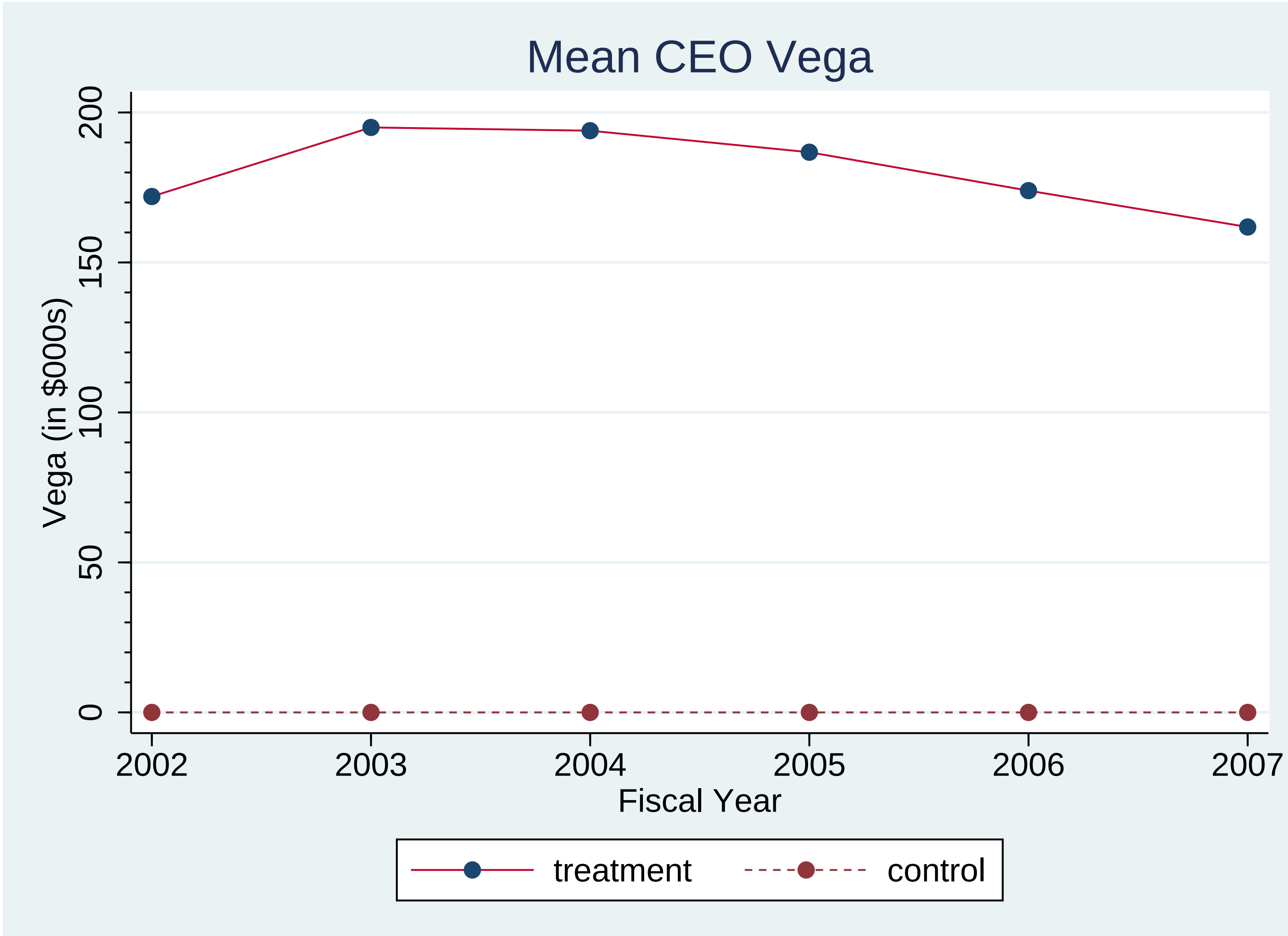


Figure 2.5: Differential temporal trend in mean CEO equity portfolio vega in the treatment and ideal control group, respectively. Vega is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

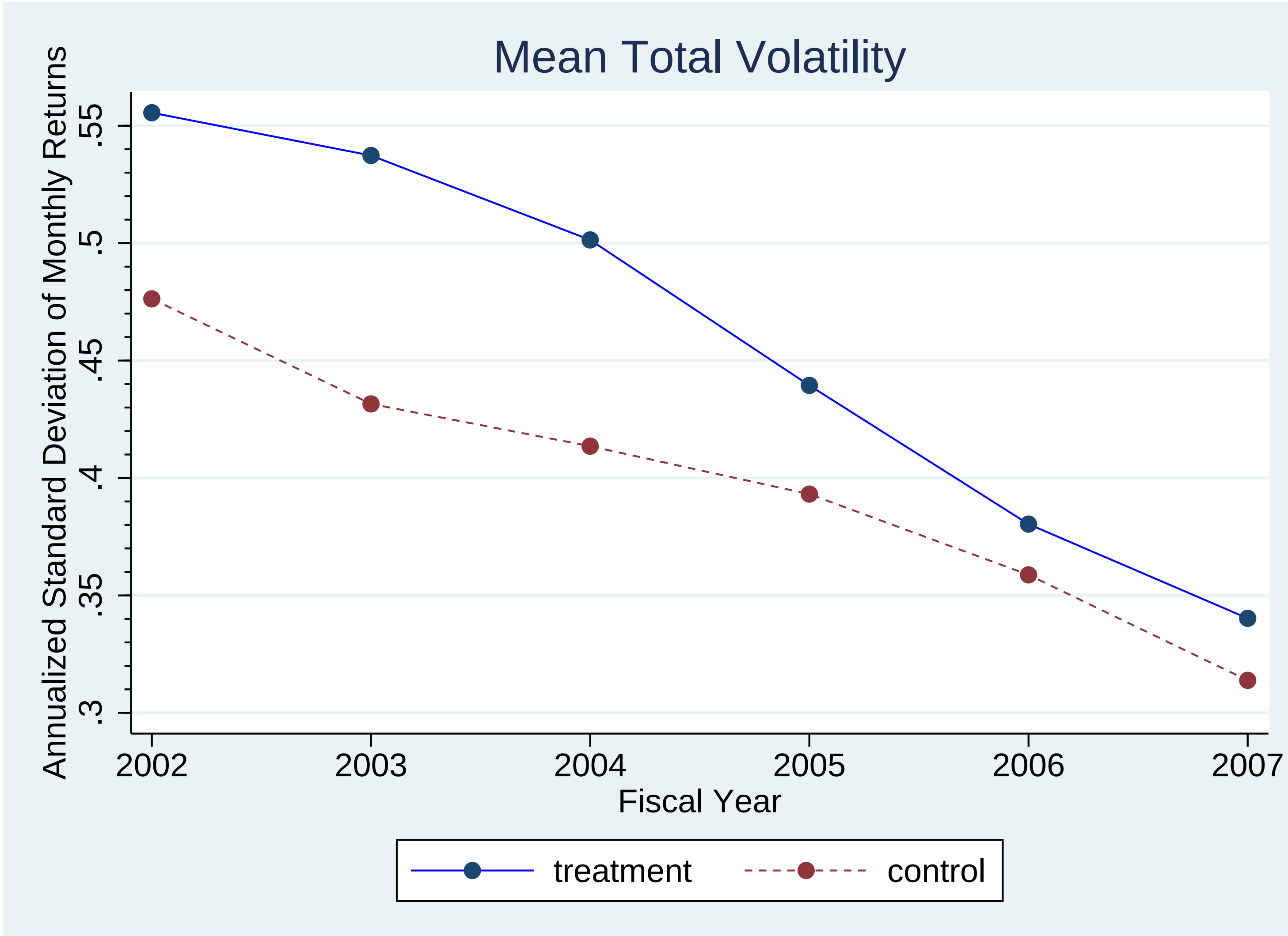


Figure 2.6: Differential temporal trend in mean annualized total firm volatility in the treatment and ideal control group, respectively. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

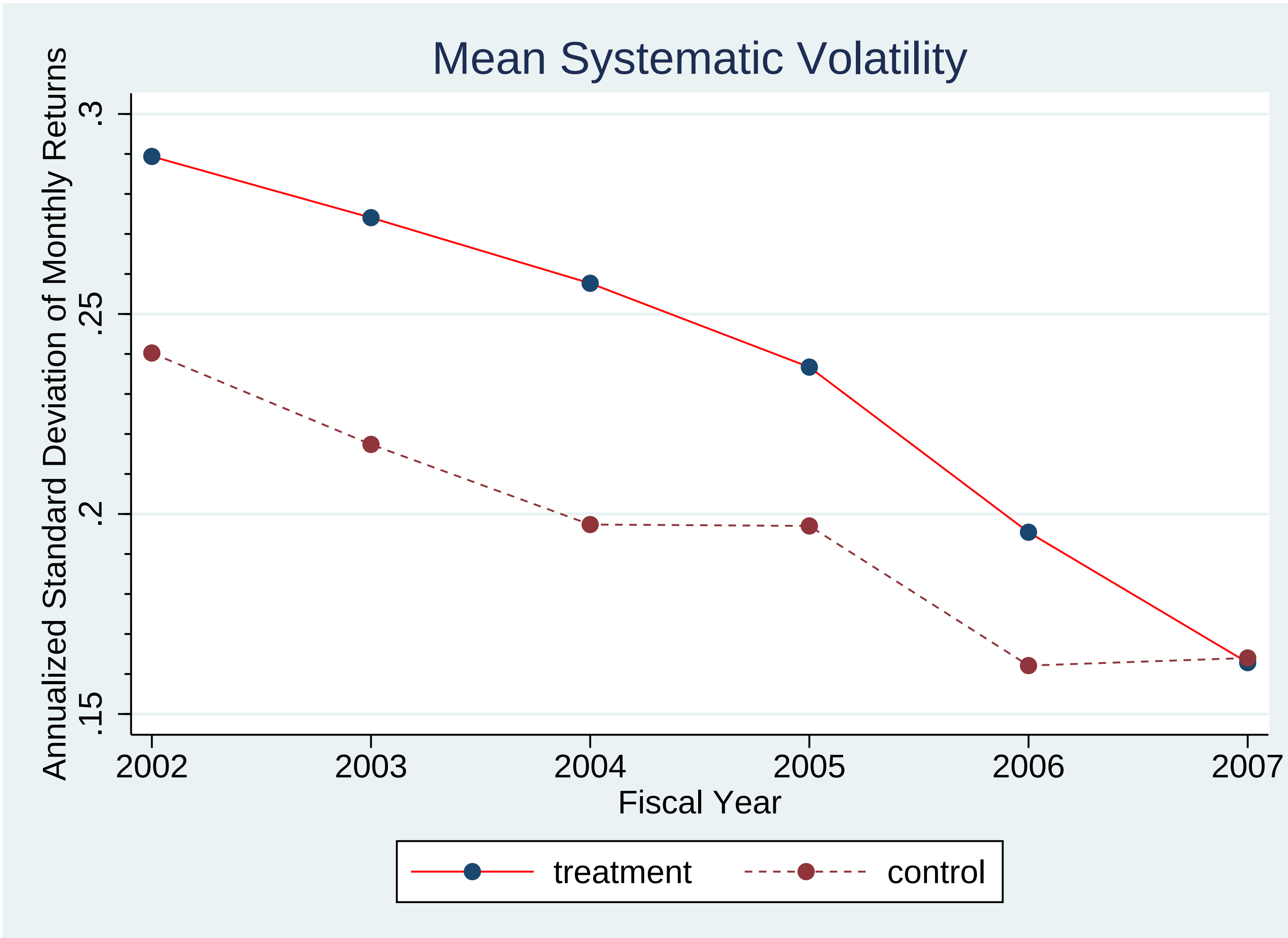


Figure 2.7: Differential temporal trend in mean annualized systematic firm volatility in the treatment and ideal control group, respectively. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

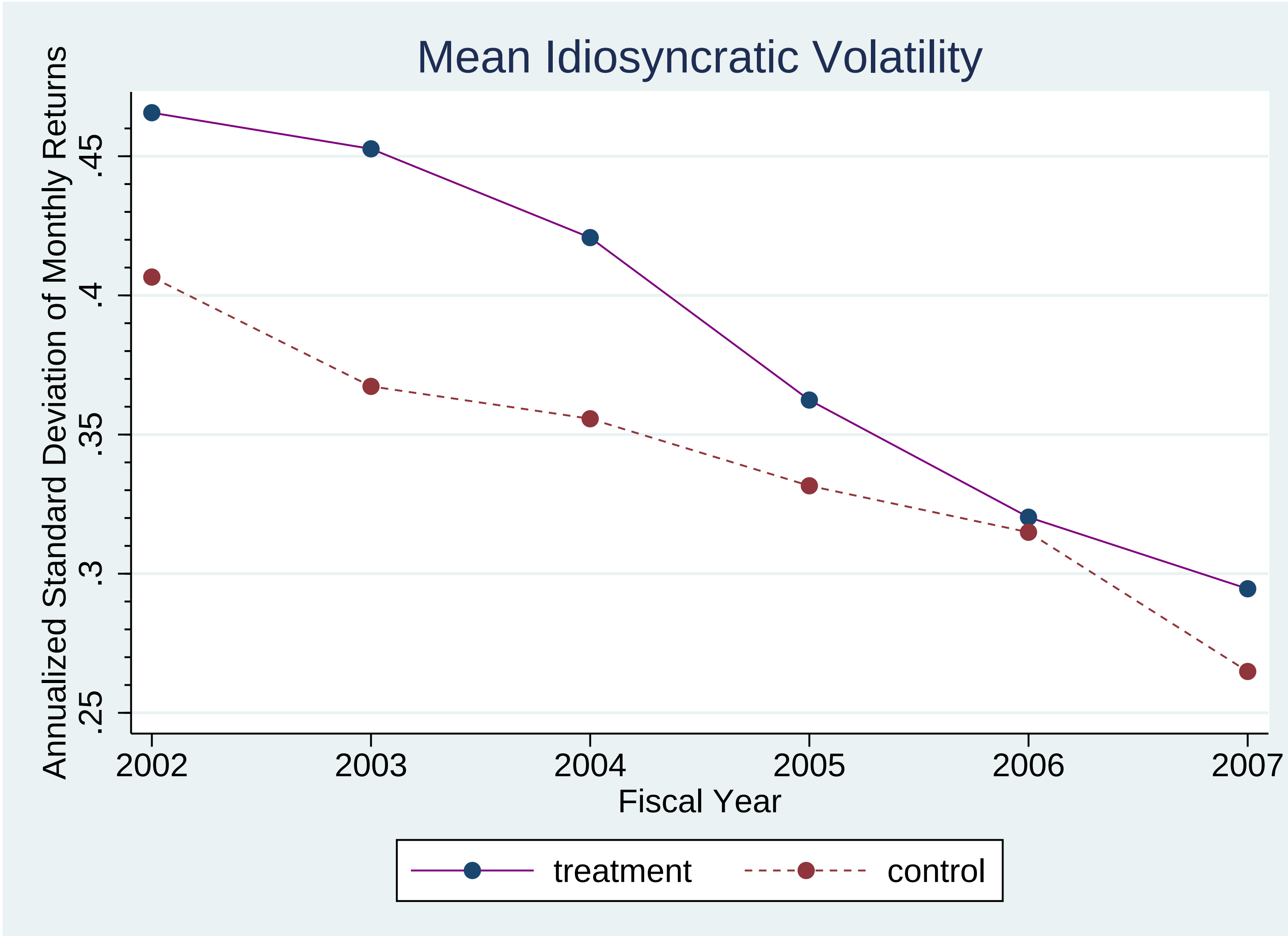


Figure 2.8: Differential temporal trend in mean annualized idiosyncratic firm volatility in the treatment and ideal control group, respectively. The pre-FAS 123R period spans fiscal years 2002-2004 and the post-FAS 123R period spans fiscal years 2005-2007.

Table 2.1: Descriptive Statistics

This table presents descriptive statistics for variables related to CEO compensation, CEO incentives, volatility, and firm properties. The sample contains firms in Execucomp from fiscal years 2002-2007 with non-missing values for all required variables. All variables are defined in Appendix B.

Full sample of firm-years with all required variables								
Variable	N	Mean	Std	5%	25%	50%	75%	95%
CEO Compensation:								
Total Pay (in $000s)	5781	5088.42	5748.28	551.88	1515.49	3125.98	6225.44	16893.21
Cash Compensation (in $000s)	5781	1385.06	1231.46	350.00	641.15	1000.00	1667.50	3800.00
Option Proportion	5781	0.31	0.28	0.00	0.00	0.29	0.52	0.81
Tenure	5781	7.78	7.35	0.95	2.75	5.41	10.07	22.48
CEO Incentives:								
Delta (in $000s)	5781	761.94	1533.87	26.32	107.63	273.95	698.16	3013.53
Vega (in $000s)	5781	178.45	287.34	1.92	27.30	74.64	198.39	732.10
Annualized Volatility:								
Total Volatility	5781	0.43	0.21	0.20	0.29	0.37	0.52	0.83
Systematic Volatility	5781	0.22	0.14	0.07	0.13	0.19	0.27	0.50
Idiosyncratic Volatility	5781	0.36	0.17	0.17	0.24	0.32	0.44	0.69
Firm Properties:								
Size	5781	7.40	1.54	5.09	6.33	7.26	8.32	10.18
Leverage	5781	0.20	0.17	0.00	0.04	0.19	0.31	0.52
MTB	5781	1.99	1.08	0.97	1.28	1.66	2.31	4.16
Investment Growth	5781	0.20	0.77	-0.56	-0.16	0.08	0.36	1.22
Sales Growth	5781	0.12	0.25	-0.16	0.02	0.09	0.18	0.47
ROE	5781	-0.03	10.54	-0.40	0.04	0.11	0.18	0.39
Cash	5781	0.16	0.18	0.01	0.03	0.10	0.24	0.55
Dividend Payer	5781	0.49	0.50	0.00	0.00	0.00	1.00	1.00
PP&E	5781	0.26	0.21	0.03	0.10	0.20	0.36	0.72
R&D	5781	0.03	0.06	0.00	0.00	0.01	0.05	0.15
Capex	5781	0.05	0.05	0.01	0.02	0.03	0.06	0.14

Table 2.2: Descriptive Statistics—Treatment vs. Full Control Sample

This table presents descriptive statistics for variables related to CEO compensation, CEO incentives, volatility, and firm properties. The sample contains firms in Execucomp from fiscal years 2002-2007 with non-missing values for all required variables. All variables are defined in Appendix B.

	Treatment Firms			Control Firms		
Variable	N	Mean	Median	N	Mean	Median
CEO Compensation:						
Total Pay (in $000s)	5613	5136.72	3170.87	168	3474.92	1848.72
Cash Compensation (in $000s)	5613	1392.52	1000.00	168	1135.83	850.67
Option Proportion	5613	0.32	0.30	168	0.14	0.00
Tenure	5613	7.67	5.41	168	11.50	7.58
CEO Incentives:						
Delta (in $000s)	5613	736.72	273.61	168	1604.43	309.60
Vega (in $000s)	5613	181.40	76.82	168	80.02	0.00
Annualized Volatility:						
Total Volatility	5613	0.43	0.38	168	0.39	0.34
Systematic Volatility	5613	0.22	0.19	168	0.19	0.17
Idiosyncratic Volatility	5613	0.36	0.32	168	0.33	0.29
Firm Properties:						
Size	5613	7.39	7.27	168	7.61	7.20
Leverage	5613	0.20	0.19	168	0.24	0.19
MTB	5613	2.00	1.67	168	1.90	1.50
Investment Growth	5613	0.20	0.08	168	0.22	0.11
Sales Growth	5613	0.12	0.09	168	0.09	0.08
ROE	5613	-0.03	0.11	168	0.07	0.11
Cash	5613	0.17	0.10	168	0.15	0.10
Dividend Payer	5613	0.48	0.00	168	0.67	1.00
PP&E	5613	0.26	0.19	168	0.28	0.24
R&D	5613	0.03	0.01	168	0.01	0.00
Capex	5613	0.05	0.03	168	0.05	0.04

Table 2.3: Descriptive Statistics—Treatment vs. Ideal Control Sample

This table presents descriptive statistics for variables related to CEO compensation, CEO incentives, volatility, and firm properties. The sample contains firms in Execucomp from fiscal years 2002-2007 with non-missing values for all required variables. All variables are defined in Appendix B.

	Treatment Firms			Control Firms		
Variable	N	Mean	Median	N	Mean	Median
CEO Compensation:						
Total Pay (in $000s)	5689	5145.54	3180.77	92	1556.41	1104.44
Cash Compensation (in $000s)	5689	1394.40	1000.00	92	807.68	658.43
Option Proportion	5689	0.32	0.30	92	0.00	0.00
Tenure	5689	7.67	5.36	92	14.59	12.49
CEO Incentives:						
Delta (in $000s)	5689	733.45	273.61	92	2523.56	533.76
Vega (in $000s)	5689	181.34	77.30	92	0.00	0.00
Annualized Volatility:						
Total Volatility	5689	0.43	0.37	92	0.39	0.36
Systematic Volatility	5689	0.22	0.19	92	0.20	0.18
Idiosyncratic Volatility	5689	0.36	0.32	92	0.33	0.31
Firm Properties:						
Size	5689	7.40	7.27	92	7.15	7.14
Leverage	5689	0.20	0.19	92	0.21	0.18
MTB	5689	2.00	1.66	92	1.88	1.55
Investment Growth	5689	0.20	0.08	92	0.16	0.08
Sales Growth	5689	0.12	0.09	92	0.11	0.10
ROE	5689	-0.03	0.11	92	0.04	0.10
Cash	5689	0.16	0.10	92	0.16	0.11
Dividend Payer	5689	0.49	0.00	92	0.65	1.00
PP&E	5689	0.26	0.20	92	0.29	0.23
R&D	5689	0.03	0.01	92	0.01	0.00
Capex	5689	0.05	0.03	92	0.04	0.04

Table 2.4: Pre-FAS 123R Period—Treatment vs. Full Control Sample

This table presents descriptive statistics for variables related to CEO compensation, CEO incentives, volatility, and firm properties within the pre-FAS 123R period. The pre-FAS 123R sample contains firms in Execucomp from fiscal years 2002-2004 with non-missing values for all required variables. The notation $*, **, * * *$ indicates statistical significance at the $10\%, 5\%,$ and 1% levels, respectively. The aforementioned significance levels pertain to difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests between the treatment and full control sample in the pre-FAS 123R period. All variables are defined in Appendix B.

	Treatment Firms		Control Firms	
Variable	Mean	Median	Mean	Median
CEO Compensation:				
Total Pay (in $000s)	4712.94	2812.11	2712.36***	1320.80***
Cash Compensation (in $000s)	1486.74	1100.00	1103.44***	841.91***
Option Proportion	0.37	0.37	0.14***	0.00***
Tenure	7.71	5.08	11.91***	8.83***
CEO Incentives:				
Delta (in $000s)	710.25	271.51	1770.64***	366.01*
Vega (in $000s)	187.52	78.51	75.43***	0.00***
Annualized Volatility:				
Total Volatility	0.49	0.43	0.42***	0.35***
Systematic Volatility	0.26	0.21	0.21***	0.18***
Idiosyncratic Volatility	0.41	0.36	0.36***	0.31***
Firm Properties:				
Size	7.25	7.06	7.43	7.14
Leverage	0.20	0.19	0.23	0.19
MTB	1.99	1.63	1.97	1.47
Investment Growth	0.16	0.03	0.13	-0.00
Sales Growth	0.12	0.09	0.09*	0.07
ROE	-0.21	0.10	0.02	0.09
Cash	0.17	0.10	0.16	0.11
Dividend Payer	0.46	0.00	0.64***	1.00***
PP&E	0.27	0.20	0.27	0.24
R&D	0.04	0.01	0.01***	0.00***
Capex	0.05	0.03	0.04**	0.03

Table 2.5: Pre-FAS 123R Period—Treatment vs. Ideal Control Sample

This table presents descriptive statistics for variables related to CEO compensation, CEO incentives, volatility, and firm properties within the pre-FAS 123R period. The pre-FAS 123R sample contains firms in Execucomp from fiscal years 2002-2004 with non-missing values for all required variables. The notation $*, **, ***$ indicates statistical significance at the $10\%, 5\%,$ and 1% levels, respectively. The aforementioned significance levels pertain to difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests between the treatment and ideal control sample in the pre-FAS 123R period. All variables are defined in Appendix B.

	Treatment Firms		Control Firms	
Variable	Mean	Median	Mean	Median
CEO Compensation:				
Total Pay (in $000s)	4716.95	2813.92	1128.33***	957.10***
Cash Compensation (in $000s)	1488.57	1101.03	745.66***	547.04***
Option Proportion	0.37	0.36	0.00***	0.00***
Tenure	7.71	5.07	14.82***	12.20***
CEO Incentives:				
Delta (in $000s)	707.63	271.51	2635.59***	512.65**
Vega (in $000s)	187.48	78.72	0.00***	0.00***
Annualized Volatility:				
Total Volatility	0.49	0.42	0.42***	0.39**
Systematic Volatility	0.26	0.21	0.21***	0.18**
Idiosyncratic Volatility	0.41	0.36	0.36***	0.33*
Firm Properties:				
Size	7.26	7.07	7.09	7.09
Leverage	0.20	0.19	0.20	0.15
MTB	1.99	1.63	1.95	1.57
Investment Growth	0.16	0.03	0.13	0.01
Sales Growth	0.12	0.08	0.11	0.11
ROE	-0.20	0.10	0.02	0.10
Cash	0.17	0.10	0.18	0.13
Dividend Payer	0.46	0.00	0.59*	1.00*
PP&E	0.27	0.20	0.28	0.24
R&D	0.03	0.01	0.01***	0.00***
Capex	0.05	0.03	0.04	0.04

Table 2.6: Differential Change in CEO Delta Surrounding Convexity Shock

The dependent variable is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All *p*-values in parentheses are clustered at the industry level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(CEO Delta)	(2) ln(CEO Delta)	(3) ln(CEO Delta)	(4) ln(CEO Delta)	(5) ln(CEO Delta)
Post-123R	0.057	0.019	-0.025	-0.004	0.373
	(0.812)	(0.933)	(0.925)	(0.986)	(0.153)
Treatment	-0.577	-0.550	-0.581	-0.554	3.725***
	(0.227)	(0.270)	(0.226)	(0.267)	(0.000)
Post×Treatment	**-0.232**	**-0.196**	**-0.178**	**-0.143**	**-0.510****
	(0.332)	**(0.379)**	**(0.465)**	**(0.533)**	**(0.052)**
Size	0.578***	0.587***	0.578***	0.587***	0.812***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-1.021***	-0.965***	-1.016***	-0.954***	-0.793***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MTB	0.476***	0.454***	0.474***	0.452***	0.495***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Investment Growth	0.023	0.031	0.018	0.027	0.002
	(0.225)	(0.112)	(0.338)	(0.160)	(0.863)
Sales Growth	0.293***	0.314***	0.265***	0.289***	0.033
	(0.006)	(0.004)	(0.010)	(0.005)	(0.465)
ROE	-0.001*	-0.001**	-0.001*	-0.001**	-0.000**
	(0.072)	(0.029)	(0.083)	(0.034)	(0.026)
Cash	-0.087	0.039	-0.098	0.024	-0.173
	(0.645)	(0.877)	(0.601)	(0.926)	(0.351)
Dividend Payer	-0.141**	-0.084	-0.144**	-0.085	-0.150*
	(0.045)	(0.200)	(0.045)	(0.212)	(0.097)
Observations	5781	5781	5781	5781	5781
Adjusted R^2	0.453	0.480	0.455	0.482	0.826
Industry-FE	No	Yes	No	Yes	No
Year-FE	No	No	Yes	Yes	Yes
Firm-FE	No	No	No	No	Yes

Table 2.7: Differential Change in CEO Option Pay Surrounding Convexity Shock

The dependent variable is the value of current options granted scaled by total pay. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Option Pay	(2) Option Pay	(3) Option Pay	(4) Option Pay	(5) Option Pay
Post-123R	0.029*	0.011	0.062*	0.049	0.094***
	(0.071)	(0.346)	(0.096)	(0.124)	(0.001)
Treatment	0.355***	0.338***	0.355***	0.339***	0.148**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)
Post×Treatment	**-0.141*****	**-0.125*****	**-0.126*****	**-0.108*****	**-0.090*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Size	0.037***	0.037***	0.038***	0.037***	0.050***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Leverage	-0.070*	-0.040	-0.075**	-0.044	-0.095
	(0.064)	(0.238)	(0.044)	(0.192)	(0.150)
MTB	0.038***	0.034***	0.040***	0.035***	0.008
	(0.000)	(0.000)	(0.000)	(0.000)	(0.454)
Investment Growth	-0.005	-0.003	-0.003	-0.001	-0.001
	(0.391)	(0.628)	(0.584)	(0.879)	(0.927)
Sales Growth	-0.027	-0.036**	-0.020	-0.028*	-0.048**
	(0.165)	(0.033)	(0.322)	(0.094)	(0.049)
ROE	-0.000	0.000	-0.000	-0.000	0.000***
	(0.845)	(0.931)	(0.698)	(0.836)	(0.000)
Cash	0.218***	0.104***	0.218***	0.106***	-0.047
	(0.000)	(0.009)	(0.000)	(0.008)	(0.410)
Dividend Payer	-0.087***	-0.068***	-0.085***	-0.066***	-0.018
	(0.000)	(0.000)	(0.000)	(0.000)	(0.236)
Observations	5781	5781	5781	5781	5781
Adjusted R^2	0.148	0.185	0.162	0.199	0.413
Industry-FE	No	Yes	No	Yes	No
Year-FE	No	No	Yes	Yes	Yes
Firm-FE	No	No	No	No	Yes

Table 2.8: Differential Change in CEO Vega Surrounding Convexity Shock

The dependent variable is the natural logarithm of one plus the total vega of the CEO's equity portfolio. Vega is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All *p*-values in parentheses are clustered at the industry level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(CEO Vega)	(2) ln(CEO Vega)	(3) ln(CEO Vega)	(4) ln(CEO Vega)	(5) ln(CEO Vega)
Post-123R	0.002	-0.089	-0.159	-0.214*	-0.037
	(0.981)	(0.168)	(0.218)	(0.079)	(0.633)
Treatment	4.195***	4.125***	4.189***	4.119***	2.326***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Post×Treatment	**-0.299*****	**-0.213****	**-0.241****	**-0.152***	**-0.094***
	(0.005)	**(0.017)**	**(0.026)**	**(0.072)**	**(0.075)**
Size	0.659***	0.676***	0.660***	0.677***	0.381***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.468*	-0.458*	-0.460*	-0.453*	-0.446**
	(0.063)	(0.055)	(0.065)	(0.057)	(0.013)
MTB	0.293***	0.237***	0.294***	0.238***	0.067
	(0.000)	(0.000)	(0.000)	(0.000)	(0.122)
Investment Growth	-0.051**	-0.033*	-0.055***	-0.037**	-0.005
	(0.013)	(0.066)	(0.010)	(0.048)	(0.675)
Sales Growth	-0.086	-0.041	-0.100	-0.055	-0.019
	(0.218)	(0.459)	(0.171)	(0.312)	(0.697)
ROE	-0.000	-0.001	-0.000	-0.000	-0.000**
	(0.163)	(0.112)	(0.201)	(0.143)	(0.026)
Cash	0.356	0.129	0.343	0.108	-0.268
	(0.118)	(0.601)	(0.133)	(0.661)	(0.343)
Dividend Payer	-0.098	-0.027	-0.099	-0.028	-0.158*
	(0.240)	(0.746)	(0.240)	(0.744)	(0.086)
Observations	5781	5781	5781	5781	5781
Adjusted R^2	0.490	0.528	0.493	0.530	0.805
Industry-FE	No	Yes	No	Yes	No
Year-FE	No	No	Yes	Yes	Yes
Firm-FE	No	No	No	No	Yes

Table 2.9: Differential Change in Volatility Surrounding Convexity Shock

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	-0.162*	-0.096	-0.175*
	(0.077)	(0.317)	(0.060)
Treatment	0.119	0.186	0.102
	(0.126)	(0.167)	(0.122)
Post×Treatment	**-0.086**	**-0.159****	**-0.063**
	(0.242)	**(0.013)**	**(0.416)**
ln(CEO Delta)	-0.032**	-0.039**	-0.031**
	(0.015)	(0.045)	(0.012)
Size	-0.085***	-0.035	-0.102***
	(0.000)	(0.141)	(0.000)
Leverage	0.127**	-0.063	0.179***
	(0.026)	(0.595)	(0.001)
MTB	-0.046***	-0.083***	-0.037***
	(0.002)	(0.001)	(0.004)
Investment Growth	0.002	0.014	-0.001
	(0.852)	(0.424)	(0.905)
Sales Growth	0.033	-0.017	0.052
	(0.503)	(0.853)	(0.144)
CEO Cash Compensation	-0.000	-0.000	-0.000
	(0.278)	(0.218)	(0.320)
CEO Tenure	0.004***	0.004**	0.004***
	(0.005)	(0.026)	(0.008)
PP&E	-0.235***	-0.297***	-0.196**
	(0.007)	(0.007)	(0.030)
R&D	1.888***	2.647***	1.541***
	(0.000)	(0.000)	(0.000)
Capex	0.733***	0.294	0.860***
	(0.002)	(0.303)	(0.001)
ROE	-0.001***	-0.001***	-0.000
	(0.005)	(0.000)	(0.110)
Observations	5781	5781	5781
Adjusted R^2	0.382	0.228	0.394
Industry-FE	No	No	No
Year-FE	No	No	No
Firm-FE	No	No	No

Table 2.10: Differential Change in Volatility Surrounding Convexity Shock

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	-0.170*	-0.088	-0.185**
	(0.054)	(0.293)	(0.048)
Treatment	0.160**	0.249*	0.139*
	(0.050)	(0.060)	(0.056)
Post×Treatment	**-0.074**	**-0.154*****	**-0.052**
	(0.205)	**(0.000)**	**(0.456)**
ln(CEO Delta)	-0.030***	-0.029**	-0.032***
	(0.009)	(0.048)	(0.005)
Size	-0.092***	-0.050***	-0.108***
	(0.000)	(0.007)	(0.000)
Leverage	0.304***	0.240***	0.315***
	(0.000)	(0.005)	(0.000)
MTB	-0.032**	-0.050**	-0.030**
	(0.041)	(0.040)	(0.034)
Investment Growth	0.003	0.013	0.001
	(0.701)	(0.163)	(0.946)
Sales Growth	0.008	-0.041	0.029
	(0.830)	(0.568)	(0.310)
CEO Cash Compensation	-0.000	-0.000	-0.000
	(0.383)	(0.343)	(0.374)
CEO Tenure	0.003***	0.003***	0.003***
	(0.003)	(0.002)	(0.007)
PP&E	-0.170***	-0.133	-0.163**
	(0.008)	(0.154)	(0.020)
R&D	1.187***	1.591***	0.981***
	(0.000)	(0.003)	(0.000)
Capex	0.391**	0.030	0.464***
	(0.025)	(0.917)	(0.007)
ROE	-0.001***	-0.001***	-0.000*
	(0.004)	(0.000)	(0.052)
Observations	5781	5781	5781
Adjusted R^2	0.495	0.381	0.493
Industry-FE	Yes	Yes	Yes
Year-FE	No	No	No
Firm-FE	No	No	No

Table 2.11: Differential Change in Volatility Surrounding Convexity Shock

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	-0.039	0.032	-0.056
	(0.624)	(0.786)	(0.469)
Treatment	0.123	0.191	0.105
	(0.115)	(0.157)	(0.111)
Post×Treatment	**-0.079**	**-0.149*****	**-0.058**
	(0.236)	**(0.007)**	**(0.437)**
ln(CEO Delta)	-0.031**	-0.038*	-0.030**
	(0.021)	(0.060)	(0.016)
Size	-0.083***	-0.032	-0.100***
	(0.000)	(0.211)	(0.000)
Leverage	0.114*	-0.072	0.165***
	(0.054)	(0.555)	(0.002)
MTB	-0.044***	-0.082***	-0.035***
	(0.002)	(0.001)	(0.006)
Investment Growth	0.006	0.016	0.004
	(0.559)	(0.347)	(0.699)
Sales Growth	0.054	-0.003	0.076**
	(0.302)	(0.972)	(0.040)
CEO Cash Compensation	-0.000	-0.000	-0.000
	(0.246)	(0.169)	(0.316)
CEO Tenure	0.004***	0.004**	0.004***
	(0.007)	(0.035)	(0.009)
PP&E	-0.239***	-0.301***	-0.199**
	(0.006)	(0.006)	(0.029)
R&D	1.851***	2.616***	1.502***
	(0.000)	(0.000)	(0.000)
Capex	0.721***	0.301	0.839***
	(0.003)	(0.276)	(0.001)
ROE	-0.001***	-0.001***	-0.000
	(0.003)	(0.000)	(0.101)
Observations	5781	5781	5781
Adjusted R^2	0.396	0.238	0.408
Industry-FE	No	No	No
Year-FE	Yes	Yes	Yes
Firm-FE	No	No	No

Table 2.12: Differential Change in Volatility Surrounding Convexity Shock

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	-0.019	0.059	-0.033
	(0.711)	(0.445)	(0.583)
Treatment	0.166**	0.258*	0.144**
	(0.039)	(0.051)	(0.043)
Post×Treatment	**-0.065**	**-0.143*** **	**-0.044**
	(0.239)	**(0.000)**	**(0.524)**
ln(CEO Delta)	-0.030**	-0.028*	-0.032***
	(0.010)	(0.060)	(0.005)
Size	-0.090***	-0.047**	-0.106***
	(0.000)	(0.017)	(0.000)
Leverage	0.290***	0.230***	0.301***
	(0.000)	(0.008)	(0.000)
MTB	-0.030**	-0.049**	-0.027**
	(0.049)	(0.044)	(0.041)
Investment Growth	0.008	0.016*	0.006
	(0.281)	(0.076)	(0.422)
Sales Growth	0.031	-0.026	0.054*
	(0.459)	(0.722)	(0.066)
CEO Cash Compensation	-0.000	-0.000	-0.000
	(0.286)	(0.209)	(0.314)
CEO Tenure	0.003***	0.003***	0.003***
	(0.003)	(0.005)	(0.005)
PP&E	-0.182***	-0.146*	-0.173**
	(0.003)	(0.089)	(0.012)
R&D	1.173***	1.584***	0.965***
	(0.000)	(0.004)	(0.000)
Capex	0.363**	0.023	0.427**
	(0.050)	(0.931)	(0.024)
ROE	-0.001***	-0.001***	-0.000**
	(0.002)	(0.000)	(0.040)
Observations	5781	5781	5781
Adjusted R^2	0.510	0.391	0.509
Industry-FE	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes
Firm-FE	No	No	No

Table 2.13: Differential Change in Volatility Surrounding Convexity Shock

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	0.036	0.077	0.036
	(0.652)	(0.365)	(0.679)
Treatment	0.383***	0.751**	0.279***
	(0.000)	(0.014)	(0.005)
Post×Treatment	**-0.079**	**-0.167****	**-0.061**
	(0.279)	**(0.022)**	**(0.450)**
ln(CEO Delta)	-0.021***	-0.016	-0.020***
	(0.001)	(0.140)	(0.006)
Size	-0.017	0.038	-0.034
	(0.557)	(0.343)	(0.177)
Leverage	0.142***	0.160*	0.132***
	(0.009)	(0.083)	(0.008)
MTB	0.015	0.019	0.012
	(0.167)	(0.340)	(0.151)
Investment Growth	0.003	0.003	0.004
	(0.334)	(0.806)	(0.253)
Sales Growth	-0.022	-0.020	-0.022
	(0.289)	(0.258)	(0.355)
CEO Cash Compensation	-0.000	0.000	-0.000
	(0.993)	(0.917)	(0.755)
CEO Tenure	0.002**	0.003**	0.002
	(0.032)	(0.021)	(0.142)
PP&E	-0.122	0.045	-0.203
	(0.400)	(0.811)	(0.160)
R&D	-0.014	-0.200	0.010
	(0.939)	(0.353)	(0.951)
Capex	0.155	0.499*	0.051
	(0.447)	(0.099)	(0.788)
ROE	-0.000	-0.000	-0.000
	(0.394)	(0.375)	(0.326)
Observations	5781	5781	5781
Adjusted R^2	0.859	0.761	0.861
Industry-FE	No	No	No
Year-FE	Yes	Yes	Yes
Firm-FE	Yes	Yes	Yes

Table 2.14: Differential Change in Volatility Surrounding Convexity Shock: Alternate Sample Period (2002-2008)

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2008. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	0.023	0.077	0.016
	(0.776)	(0.459)	(0.859)
Treatment	0.622***	0.995***	0.509***
	(0.000)	(0.000)	(0.001)
Post×Treatment	**-0.100**	**-0.206****	**-0.071**
	(0.246)	**(0.045)**	**(0.431)**
ln(CEO Delta)	-0.049***	-0.046**	-0.047**
	(0.007)	(0.018)	(0.010)
Size	-0.025	0.034	-0.045*
	(0.376)	(0.427)	(0.067)
Leverage	0.244**	0.301**	0.222***
	(0.012)	(0.037)	(0.010)
MTB	0.033**	0.030	0.031**
	(0.042)	(0.190)	(0.029)
Investment Growth	-0.002	-0.000	-0.001
	(0.654)	(0.950)	(0.870)
Sales Growth	-0.015	-0.018	-0.012
	(0.501)	(0.306)	(0.638)
CEO Cash Compensation	-0.000	-0.000	-0.000
	(0.850)	(0.744)	(0.886)
CEO Tenure	0.004***	0.004***	0.004**
	(0.006)	(0.005)	(0.020)
PP&E	0.026	0.199	-0.039
	(0.875)	(0.344)	(0.817)
R&D	-0.299*	-0.497	-0.241
	(0.096)	(0.179)	(0.182)
Capex	0.233	0.556**	0.106
	(0.252)	(0.015)	(0.593)
ROE	-0.000	-0.000	-0.000
	(0.424)	(0.377)	(0.432)
Observations	6689	6689	6689
Adjusted R^2	0.801	0.695	0.814
Industry-FE	No	No	No
Year-FE	Yes	Yes	Yes
Firm-FE	Yes	Yes	Yes

Table 2.15: Differential Change in Volatility Surrounding Convexity Shock: Control Group Including Full-Early Adopters

The dependent variable is the natural logarithm of annualized total firm volatility, annualized systematic firm volatility, and annualized idiosyncratic firm volatility, respectively. ln(CEO Delta) is the natural logarithm of one plus the total delta of the CEO's equity portfolio. Delta is the dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price. Post-123R is a dummy variable equal to zero for fiscal years 2002-2004 and equal to one for fiscal years 2005-2007. Treatment is a dummy variable equal to zero for firms assigned to the control group and equal to one for firms assigned to the treatment group. Post×Treatment is the difference-in-differences interaction term. Intercept term is included but not reported. All p-values in parentheses are clustered at the industry level and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) ln(Total Volatility)	(2) ln(Systematic Volatility)	(3) ln(Idiosyncratic Volatility)
Post-123R	0.038	0.069	0.043
	(0.495)	(0.305)	(0.476)
Treatment	0.385***	0.749***	0.283***
	(0.000)	(0.000)	(0.000)
Post×Treatment	**-0.082**	**-0.161*****	**-0.069**
	(0.137)	**(0.003)**	**(0.249)**
ln(CEO Delta)	-0.021***	-0.016	-0.020***
	(0.001)	(0.149)	(0.006)
Size	-0.018	0.038	-0.035
	(0.548)	(0.346)	(0.171)
Leverage	0.145***	0.165*	0.134***
	(0.008)	(0.078)	(0.007)
MTB	0.015	0.019	0.013
	(0.155)	(0.322)	(0.138)
Investment Growth	0.003	0.002	0.004
	(0.354)	(0.818)	(0.265)
Sales Growth	-0.022	-0.020	-0.022
	(0.285)	(0.252)	(0.350)
CEO Cash Compensation	-0.000	0.000	-0.000
	(0.999)	(0.912)	(0.762)
CEO Tenure	0.002**	0.002**	0.002
	(0.033)	(0.022)	(0.142)
PP&E	-0.125	0.039	-0.205
	(0.384)	(0.835)	(0.152)
R&D	-0.013	-0.198	0.011
	(0.943)	(0.359)	(0.948)
Capex	0.149	0.487	0.046
	(0.466)	(0.111)	(0.809)
ROE	-0.000	-0.000	-0.000
	(0.399)	(0.384)	(0.330)
Observations	5781	5781	5781
Adjusted R^2	0.859	0.761	0.861
Industry-FE	No	No	No
Year-FE	Yes	Yes	Yes
Firm-FE	Yes	Yes	Yes

Appendices

A. Estimation of Compensation Incentives

Delta is the dollar change in the value of the CEO's equity portfolio (in \$000s) associated with a 1% increase in the firm's stock price. Similarly, vega is the dollar change in the value of the CEO's equity portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The closed form expressions for the delta and vega of a call option on an underlying security with dividends are provided by the Black and Scholes (1973) option pricing model as modified to account for dividend payouts:

$$\text{Option Value} = Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma\sqrt{T}\right) \tag{4}$$

$$\Delta = \frac{\partial(\text{Option Value})}{\partial S} = e^{-dT}N(Z) \tag{5}$$

$$\nu = \frac{\partial(\text{Option Value})}{\partial \sigma} = e^{-dT}N'(Z)S\sqrt{T} \tag{6}$$

$$Z = \frac{\ln\left[\frac{S}{X}\right] + T\left[r - d + \frac{\sigma^2}{2}\right]}{\sigma\sqrt{T}} \tag{7}$$

where N is the cumulative density function for the normal distribution, N' is the probability density function for the normal distribution, d is the natural logarithm of the expected dividend yield, T is the time to maturity of the option in years, S is the price of the underlying stock, X is the exercise price of the option, r is the natural logarithm of the risk-free interest rate, and σ is the expected stock return volatility. Accordingly, the dollar change in the value of an option associated with a 1% increase in the firm's stock price is $.01 \times \Delta \times S$. The dollar change in the value of an option associated with a one percentage-point increase in the standard deviation of the firm's return is $.01 \times \nu$.

The methodology in Core and Guay (2002) is used to aggregate the delta and vega of individual option grants so as to arrive at the total delta and total vega of the CEO's option portfolio. The total delta of the CEO's portfolio of stocks is then added to the total option portfolio delta in calculating the total delta of the CEO's equity portfolio. The total vega of the CEO's equity portfolio is approximated as the total vega of the option portfolio as Guay (1999) finds that stock options, but not common stock, substantially increase the sensitivity of the manager's wealth to firm equity risk.

B. Variable Definitions

1. **CAPEX**: Capital expenditures scaled by total assets—`CAPX/AT`.
2. **Cash**: Cash and short-term investments scaled by total assets—`CHE/AT`.
3. **CEO Cash Compensation**: Total current compensation (Salary+Bonus)—`TOTAL_CURR`.
4. **CEO Tenure**: Number of years elapsed between the date on which the executive became CEO (`BECAMECEO`) and the end a given fiscal year (`DATADATE`).
5. **Delta**: Dollar change in the value of the CEO's equity portfolio (in $000s) associated with a 1% increase in the firm's stock price.
6. **Dividend Payer**: Dummy variable equal to 1 if the firm paid dividends to its common/ordinary equity shareholders (`DVC>0`) .
7. **Idiosyncratic Volatility**: Annualized standard deviation of the idiosyncratic component of the firm's 60-month stock return as calculated by the fama-french three-factor asset pricing model.
8. **Investment Growth**: Growth in capital expenditures—$(\mathtt{CAPX}_t - \mathtt{CAPX}_{t-1})/\mathtt{CAPX}_{t-1}$.
9. **Leverage**: Total debt in current liabilities plus total long-term debt scaled by total assets —`(DLC+DLTT)/AT`.
10. **MTB**: Market-to-book ratio—`((PRCC_F*CSHO)+LT)/AT`.
11. **Option Proportion**: Value of options granted scaled by total pay. Prior to 2006, this ratio is `OPTION_AWARDS_BLK_VALUE/TDC1`. Beginning in 2006, this ratio is `OPTION_AWARDS_FV/TDC1`.
12. **Post-123R**:Dummy variable equal to 0 for fiscal years 2002-2004 and equal to 1 for fiscal years 2005-2007.

13. **PP&E**: Total plant, property, and equipment scaled by total assets—`PPENT/AT`.

14. **R&D**: Research and development expense scaled by total assets—`max(0,XRD)/AT`.

15. **ROE**: Net income scaled by the book value of common equity—`NI/CEQ`.

16. **Sales Growth**: Growth in sales—$(\texttt{SALE}_t\texttt{-SALE}_{t-1})/\texttt{SALE}_{t-1}$.

17. **Size**: Natural logarithm of total assets—`ln(AT)`.

18. **Systematic Volatility**: Annualized standard deviation of the systematic component of the firm's 60-month stock return as calculated by the fama-french three-factor asset pricing model.

19. **Total Pay**:Total Compensation (salary+bonus+other annual+restricted stock grants+ltip payouts+all other+value of option grants)—`TDC1`.

20. **Total Volatility**: Annualized standard deviation of the firm's 60-month stock return.

21. **Treatment**: Dummy variable equal to 0 for firms assigned to the control group and equal to 1 for firms assigned to the treatment group.

22. **Vega**: Dollar change in the value of the CEO's equity portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns.

CHAPTER 3

Managerial Inside-Debt and Firm Jump Risk

3.1. Introduction

Within the framework of Jensen and Meckling (1976), the separation of ownership and control inherent in the managerial control of a firm owned by shareholders leads to a number of inefficiencies. As an executive's actions and the firm's access to investment opportunities cannot be perfectly observed by shareholders, the firm can design the incentive contract so as to align managerial objectives with those of the firm. Jensen and Murphy (1990b) argue that this, in theory, can be accomplished by linking executive wealth to that of shareholders, thus providing incentives for an executive to engage in optimal behavior that maximizes shareholder value.

While the dependence of managerial compensation on the value of the firm can induce effort and potentially attenuate monitoring costs, equity-based remuneration can lead to excessive risk-taking behavior. Firms can attenuate the negative consequences of equity compensation by compensating executives with debt-like remuneration mechanisms. Recent developments in the managerial inside-debt literature suggest that pension benefits and deferred compensation can align the incentives of executives with those of bond holders. For example, Sundaram and Yermack (2007) as well as Edmans and Liu (2011) argue that since pensions and deferred compensation are unsecured firm liabilities, inside-debt holdings expose managers to firm default risk. This debt-like exposure to risk can incentivize managers to attenuate suboptimal overexposure to risk.

In this paper, I explore the ramifications of managerial inside-debt holdings on stock-price jump risk. I present evidence that suggests that not all debt-like compensation mechanisms decrease managerial risk-taking equally. First, I find that CEO pension pay significantly reduces the likelihood of positive stock-price jumps. Specifically, I find that a bottom-to-top decile increase in the present value of CEO pension pay leads to a roughly 25% decrease in a firm's unconditional ex-post jump probability. Second, I find that CEO deferred compensation does not reduce jump risk. Finally, I show that an ex-ante measure of the option market's perception of future stock-price jumps, the option-implied volatility smirk, does not appear to capture these aforementioned relations.

The remainder of this paper proceeds as follows. Section 3.2 surveys the related literature and institutional background. Section 3.3 summarizes the data construction procedure. Section 3.4 presents my hypotheses and formulates my identification strategy. Section 3.5 presents my empirical analysis and Section 3.6 concludes the paper.

3.2. Related Literature and Institutional Background

Sundaram and Yermack (2007) argue that debt-like managerial compensation can help to alleviate the agency costs of debt within a firm. For instance, CEOs with greater pension holdings are naturally expected to prefer less risky firm policies. This can manifest with increases in the average maturity of firm debt, a reduction of payouts from the firm to shareholders, as well as through the undertaking of less risky firm investments. They find that as CEOs age, their compensation holdings gradually shift from equity towards debt-based compensation. In addition, CEOs with vested pensions that are immediately payable are found to be more likely to voluntarily retire for a given age. Finally, firms managed by CEOs with greater inside-debt holdings are found to feature lower default risk.

Cassell, Huang, Sanchez, and Stuart (2012) examine the implications of managerial inside-debt holdings on the investment and financial policies of firms. Namely, they find that CEOs with greater inside-debt compensation elect investment and financial policies that are safer. For instance, they show that larger inside-debt compensation levels incentivize CEOs to decrease the volatility of future firm stock returns. This reduced volatility is achieved, in part, by greater asset liquidity and diversification policies as well as by reduced R&D expenditures and leverage.

He (2013) investigates the ramifications of CEO inside-leverage on financial reporting quality. Specifically, he finds that greater managerial inside-leverage is associated with lower abnormal accruals and higher earnings reporting quality. He also finds that this translates to a negative relation between inside-leverage and stock price crashes as managers with greater inside-leverage are less inclined to conceal negative information.[1] These findings are in agreement with the notion that CEOs with greater debt-like compensation are averse to actions that may increase the probabil-

[1] The central measure of this paper is a function of the ratio of CEO D/E to Firm D/E.

ity of default or bankruptcy within a firm as debt-like compensation is an unsecured liability.

3.3. Data Selection and Variable Measurement

In constructing the necessary variables for this paper, I follow the same process as described in Amadeus (2015). However, I utilize CEO-specific compensation information in creating my compensation related variables. First, I construct my measures of managerial inside-leverage by using information from Execucomp. Namely, I define CEO inside-leverage, CEO D/E, as the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in $000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in $000s). I obtain information pertaining to CEO Inside-Equity, CEO Delta, and CEO Vega from Coles, Daniel, and Naveen (2013). I then merge this data with the crash-jump sample from Amadeus (2015) in arriving at my final sample for this paper. I also construct a measure of Firm D/E as well as alternate measures of managerial inside-leverage mentioned in Cassell, Huang, Sanchez, and Stuart (2012). My results only hold for inside-leverage measured as CEO D/E as well as its decomposition. I do not find a symmetric link between inside-leverage and firm crashes. My final merged sample features 3,476 stock fiscal-year observations spanning fiscal years 2007-2011. I winsorize Size, Opaque, ROE, M/B, Leverage, JIFP Smirk, Firm D/E, CEO Cash Compensation, CEO Delta, CEO Vega, and CEO D/E at the 1st and 99th percentiles.

3.4. Hypothesis Development and Research Design

3.4.1. Hypothesis Development

If managerial inside-leverage decreases managerial risk-taking, as measured by the probability of positive stock price jumps, I would expect $\lambda_1, \psi_1, \gamma_1$, and ϕ_1 to be both negative and significant in Equation 3.1-Equation 3.4, respectively. In order to better understand the individual roles of CEO Deferred Compensation and CEO Pension remuneration in influencing stock-price jump risk, I decompose my measure of managerial inside-leverage into its constituent components. If managerial deferred compensation and pension remuneration both decrease managerial risk taking behavior, I would expect to find $\lambda_1, \lambda_2, \psi_1, \psi_2, \gamma_1, \gamma_2$, and ϕ_1, ϕ_2 to be negative and significant in Equation 3.6-Equation 3.9, respectively.

3.4.2. Research Design

Within my primary analysis, I use equations of the following form in analyzing the implications of managerial inside-leverage on firms' ex-ante and ex-post idiosyncratic jump risk:

$$\textbf{JIFP Smirk}_{i,t} = \lambda_0 + \lambda_1 \textbf{CEO D/E}_{i,t} + \sum_{j=1}^{m} \beta_j \textbf{Control}_{j,i,t} + \epsilon_{i,t} \tag{3.1}$$

$$\textbf{Jump}_{i,t} = \psi_0 + \psi_1 \textbf{CEO D/E}_{i,t-1} + \sum_{j=1}^{m+1} \mu_j \textbf{Control}_{j,i,t-1} + \eta_{i,t} \tag{3.2}$$

$$\textbf{Jump Frequency}_{i,t} = \gamma_0 + \gamma_1 \textbf{CEO D/E}_{i,t-1} + \sum_{j=1}^{m+1} \omega_j \textbf{Control}_{j,i,t-1} + \theta_{i,t} \tag{3.3}$$

$$\textbf{Jump Sigma}_{i,t} = \phi_0 + \phi_1\textbf{CEO D/E}_{i,t-1} + \sum_{j=1}^{m+1} \delta_j\textbf{Control}_{j,i,t-1} + \tau_{i,t} \tag{3.4}$$

where i is the firm subscript, t is the fiscal year subscript, and j is the control subscript.

Next, I decompose my previous measure of managerial inside-leverage into its constituent components. Namely:

$$\textbf{CEO D/E} = \frac{\textbf{CEO Deferred Compensation} + \textbf{CEO Pension}}{\textbf{CEO Inside-Equity}} \tag{3.5}$$

This decomposition allows me to better understand the individual roles of CEO Deferred Compensation and CEO Pensions in influencing stock-price jump risk.

$$\textbf{JIFP Smirk}_{i,t} = \lambda_0 + \lambda_1\textbf{Deferred}_{i,t} + \lambda_2\textbf{Pension}_{i,t} + \sum_{j=1}^{m+1} \beta_j\textbf{Control}_{j,i,t} + \epsilon_{i,t} \tag{3.6}$$

$$\textbf{Jump}_{i,t} = \psi_0 + \psi_1\textbf{Deferred}_{i,t-1} + \psi_2\textbf{Pension}_{i,t-1} + \sum_{j=1}^{m+2} \mu_j\textbf{Control}_{j,i,t-1} + \eta_{i,t} \tag{3.7}$$

$$\textbf{Jump Freq}_{i,t} = \gamma_0 + \gamma_1\textbf{Deferred}_{i,t-1} + \gamma_2\textbf{Pension}_{i,t-1} + \sum_{j=1}^{m+2} \omega_j\textbf{Control}_{j,i,t-1} + \theta_{i,t} \tag{3.8}$$

$$\textbf{Jump Sigma}_{i,t} = \phi_0 + \phi_1\textbf{Deferred}_{i,t-1} + \phi_2\textbf{Pension}_{i,t-1} + \sum_{j=1}^{m+2} \delta_j\textbf{Control}_{j,i,t-1} + \tau_{i,t} \tag{3.9}$$

where i is the firm subscript, t is the fiscal year subscript, and j is the control subscript.

3.5. Empirical Analysis

Table 3.1 shows that the average CEO in my final sample has \$3.7 million dollars in deferred compensation as well as \$4.8 million dollars in pensions. Similarly, the average CEO also has a total equity compensation portfolio valued at \$105.5 million dollars with a delta of \$685,000 and a vega of \$193,000. Together, this translates to an average CEO Inside Debt/Inside Equity ratio of 0.43. The average firm D/E ratio is 0.54. Panel A of Figure 3.1 presents the temporal trends in CEO deferred compensation as well as pension pay and Panel B shows the trend in CEO Inside-Debt and Inside-Equity. Finally, Figure 3.2 features the fluctuation in CEO D/E and Firm D/E between fiscal years 2006-2010. The average magnitude of a stock price positive jump in my sample is 22.24%. Table 3.2 reveals that roughly 0.418% of the stock fiscal weeks in my sample are characterized as jump weeks (755/180,620).

I begin my empirical analysis by examining the ramifications of managerial inside-leverage on firm jump risk. As managerial inside-debt is largely unsecured, I would expect managerial risk-taking to decrease with managerial inside-leverage. Columns (1) and (2) of Table 3.3 confirms this hypothesis as the coefficient on CEO D/E is both negative and significant. In columns (3) and (4), I introduce a measure of the option market's ex-ante expectation of a firm's future positive jump risk probability, the jump idiosyncratic firm put smirk (JIFP Smirk). Surprisingly, JIFP Smirk does not appear be significant in predicting future firm-specific jumps and does not substantially alter the magnitude or significance of the point estimates on CEO D/E in columns (1) and (2). In order to better understand the individual roles of CEO Deferred Compensation, CEO Pension, and CEO Inside-Equity in influencing stock-price jump risk, I decompose CEO D/E into its constituent components. Table 3.4 presents the results of this decomposition. Namely, columns (1)-(4) of Table 3.4 demonstrate that not all debt-like CEO compensation structures decrease risk-taking equally. Namely, while the coefficient on the present value of CEO pension pay is significant at the 1% level, CEO Deferred Compensation does not appear to have a significant influence on firm jump risk.

In Table 3.5, my outcome variable is the number of firm-specific positive jumps within a given stock-fiscal year. I find a negative relation between managerial inside-leverage and the number of stock price positive jumps. Table 3.6 presents the results when I decompose CEO D/E into its components. As expected, I find that CEO Pension pay reduces the number of firm specific positive jumps within a fiscal year but this relation does not extend to CEO Deferred Compensation. In Table 3.7, my outcome variable is the magnitude of the largest positive jump within a given stock fiscal year. I find a negative relation between CEO D/E and Jump Sigma. As in previous tests, Table 3.8 suggests that CEO pension pay decreases jump magnitudes while deferred compensation does not appear to have a significant influence.

In Table 3.9, I examine if the option-implied volatility smirk incorporates the realized relation between managerial inside-leverage, CEO Pension pay, and firm-specific jumps. Columns (1) and (2) reveal that the coefficient on CEO D/E is insignificant. Table 3.10 further reveals that the option-implied volatility smirk does not appear to capture the negative relation between CEO Pension pay and firm-specific positive jumps. Next, I examine the economic significance of the relationship between managerial inside-leverage and firm jump risk. Column (2) of Table 3.11 reveals that a bottom-to-top decile fluctuation in CEO D/E results in a roughly 4.99 percentage point decrease in a firm's unconditional ex-post positive jump probability. More specifically, Table 3.12 shows that a bottom-to-top decile fluctuation in the present value of CEO Pension pay leads to a 5.33 percentage point reduction in a firm's unconditional ex-post positive jump probability. This represents a roughly 25% decrease in a firm's unconditional ex-post idiosyncratic jump probability. Again, deferred compensation does not appear to play a prominent role in reducing firm jump risk.

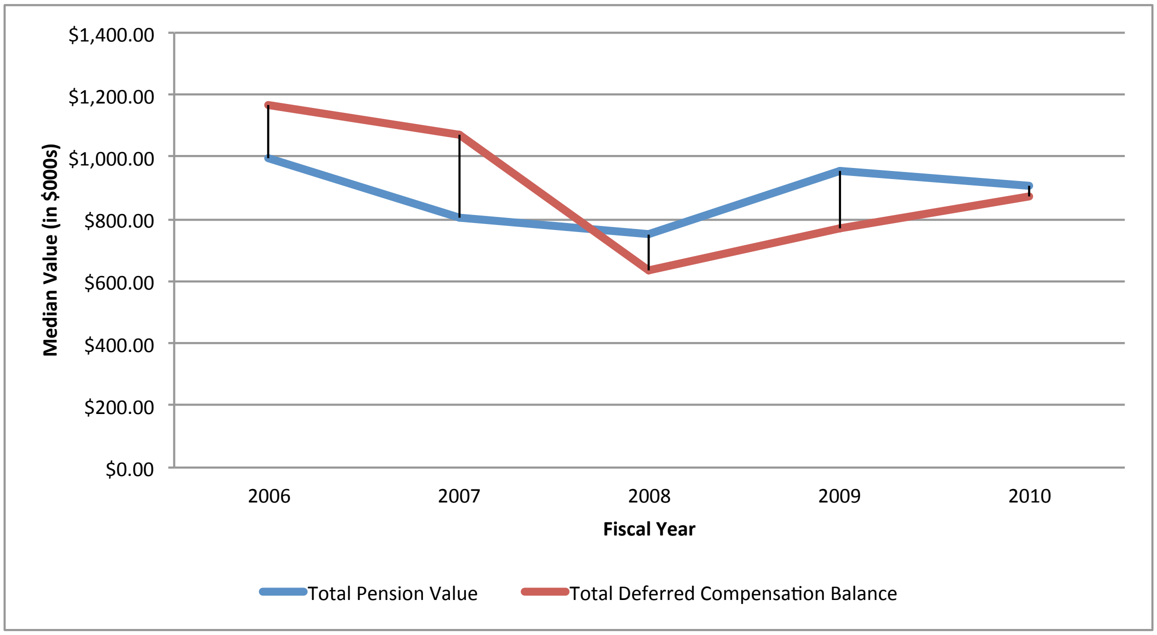
3.6. Summary and Conclusion

Within this paper, I present evidence suggesting that not all debt-like managerial remuneration structures decrease managerial risk-taking equally. I find that CEO pension pay appears to be more effective than deferred compensation in reducing managerial risk-taking behavior. Namely, I find that a bottom-to-top decile increase in the present value of CEO pension pay leads to a roughly 25% decrease in a firm's unconditional ex-post idiosyncratic jump probability. In contrast, I do not find a significant relation between deferred compensation and firm jump risk. Finally, I find that information in option-implied volatility smirks does not appear to reflect these aforementioned dynamics.

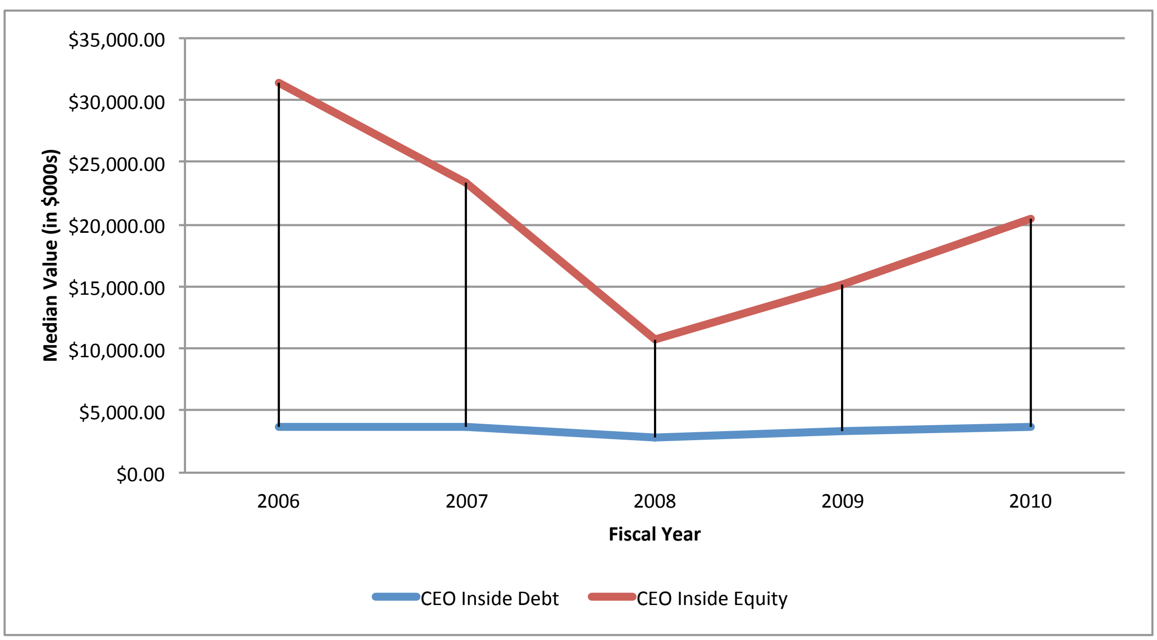
3.7. Figures and Tables

Figure 3.1: CEO Inside Debt Compensation

Panel A: CEO Pension and Deferred Compensation Values



Panel B: CEO Inside Debt vs. CEO Inside Equity



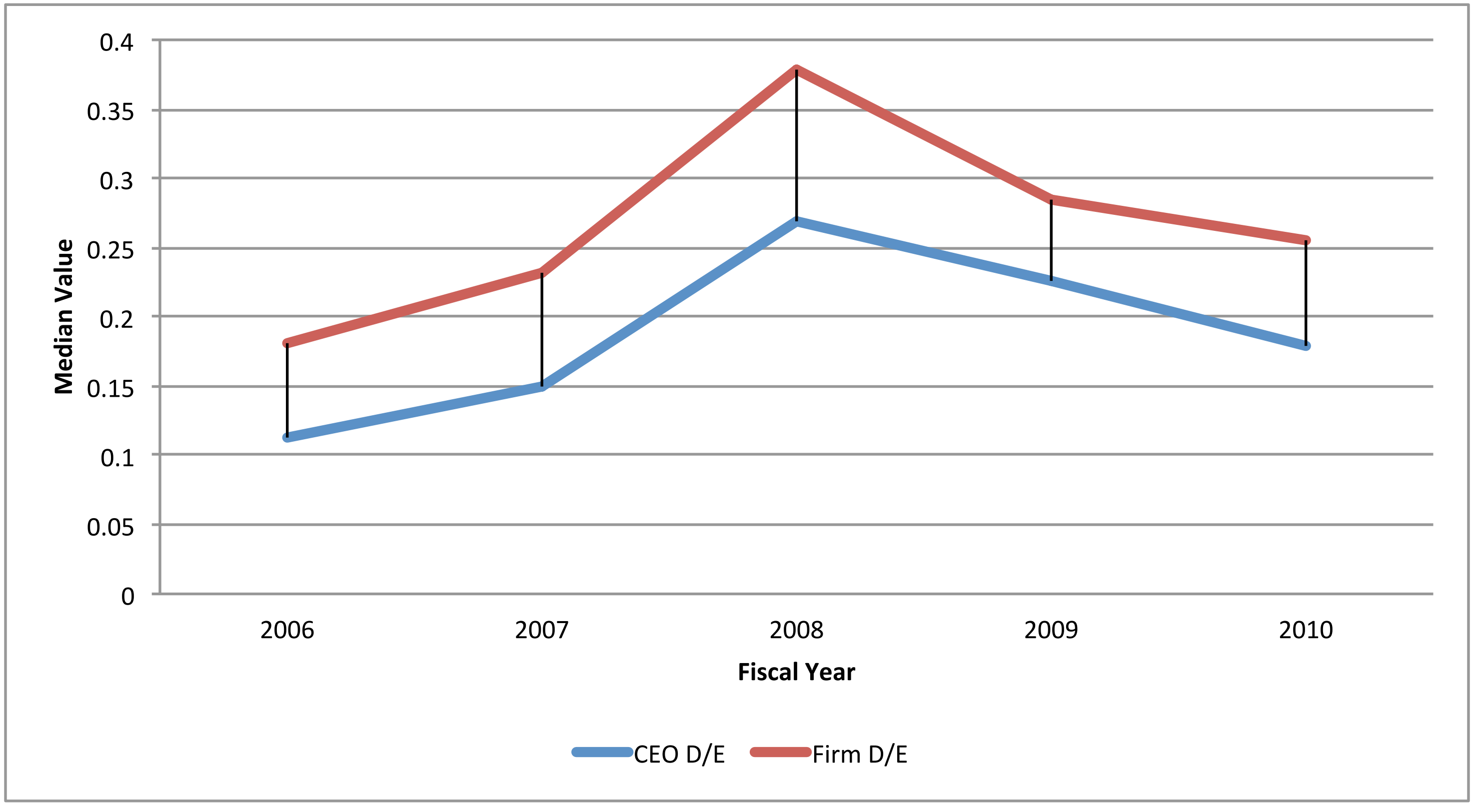


Figure 3.2: CEO Inside-Leverage vs. Firm Leverage

Table 3.1: Summary Statistics

This table presents summary statistics for variables related to executive compensation incentives, idiosyncratic firm crash risk, idiosyncratic positive jump risk, and firm properties. My primary sample consists of 3,476 firm fiscal year observations spanning fiscal years 2007 through 2011. I winsorize the variables Size, Opaque, ROE, M/B, Leverage, JIFP Smirk, Firm D/E, CEO CashComp, CEO Delta, and CEO Vega, and CEO D/E at the first and 99th percentiles. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in $000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in $000s). JIFP Smirk is the jump risk related idiosyncratic firm put smirk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. All remaining variables are defined in Appendix B.

Full Sample of Firm Fiscal Years with Non-Missing Variables							
Variable	Mean	Std	5%	25%	50%	75%	95%
Executive Incentives:							
CEO CashComp	1139.54	810.52	490.38	742.46	950.00	1193.27	2668.75
CEO Delta	685.17	1322.97	23.62	104.72	255.79	654.19	2801.94
CEO Vega	192.56	261.30	0.04	29.02	95.51	238.80	740.57
ln(1+CEO CashComp)	6.89	0.50	6.20	6.61	6.86	7.09	7.89
ln(1+CEO Delta)	5.56	1.40	3.20	4.66	5.55	6.48	7.94
ln(1+CEO Vega)	4.28	1.72	0.04	3.40	4.57	5.48	6.61
CEO D/E	0.43	0.68	0.00	0.05	0.18	0.47	1.72
CEO Deferred Compensation	3,708	9,311	0.00	151	839	3,176	15,949
CEO Pension	4,773	9,160	0.00	0.00	884	5,962	21,170
Inside Equity	105,532	1,098,667	1,871	7,714	18,285	45,097	233,458
ln(1+CEO Deferred Compensation)	5.98	3.04	0.00	5.03	6.73	8.06	9.68
ln(1+CEO Pension)	5.14	4.02	0.00	0.00	6.79	8.69	9.96
ln(1+CEO Inside Equity)	9.86	1.48	7.53	8.95	9.81	10.72	12.36
Idiosyncratic Firm Jump Risk:							
JIFP Smirk	1.11	0.41	0.75	0.93	1.03	1.19	1.81
Jump	0.21	0.41	0.00	0.00	0.00	0.00	1.00
Jump Frequency	0.22	0.43	0.00	0.00	0.00	0.00	1.00
Jump Sigma	2.61	0.65	1.75	2.15	2.51	2.97	3.85
Firm Properties:							
Opaque	1.53	3.36	0.04	0.14	0.33	1.25	6.89
ROE	0.10	0.32	-0.34	0.06	0.12	0.20	0.44
Size	8.16	1.47	5.89	7.10	8.01	9.12	10.83
M/B	2.64	3.07	0.62	1.33	2.03	3.23	7.18
Leverage	0.61	0.20	0.30	0.48	0.60	0.75	0.93
Firm D/E	0.54	0.81	0.02	0.12	0.26	0.56	2.09
Idiosyncratic Vol.	0.04	0.02	0.02	0.02	0.03	0.05	0.08

Table 3.2: Weekly Returns During Idiosyncratic Firm Stock-Price Jump Weeks

This table presents summary statistics pertaining to firm, industry, and market weekly returns during idiosyncratic firm stock-price jump weeks. A week is classified as a jump week if a firm experiences an idiosyncratic weekly stock return jump rising 3.09 or more standard deviations above its mean idiosyncratic weekly return for a particular fiscal year. The notation $*, **, * * *$ indicates statistical significance at the $10\%, 5\%,$ and 1% levels, respectively. The aforementioned significance levels pertain to difference-in-means paired t-tests and difference-in-medians Wilcoxon rank-sum (Mann-Whitney) tests for mean and median returns during jump and non-jump weeks.

Panel A: Firm Weekly Returns During Jump vs. Non-Jump Weeks

Variable	N(Weeks)	Mean	Median	Variance
Jump Weeks	755	0.2224***	0.1599***	0.1090
Non-Jump Weeks	179,865	0.0006	0.0021	0.0045
Total	180,620			

Panel B: Industry Weekly Returns During Jump vs. Non-Jump Weeks

Variable	N(Weeks)	Mean	Median	Variance
Jump Weeks	755	0.0107***	0.0080	0.0017
Non-Jump Weeks	179,865	0.0007	0.0039	0.0016
Total	180,620			

Panel C: Market Weekly Returns During Jump vs. Non-Jump Weeks

Variable	N(Weeks)	Mean	Median	Variance
Jump Weeks	755	0.0047***	0.0059***	0.0009
Non-Jump Weeks	179,865	0.0004	0.0030	0.0010
Total	180,620			

Panel D: Jump Week Frequencies Within Firm Fiscal Year Sample

Number of Crashes	N(Years)	Percentage of Sample	Cumulative Percentage
0	2,741	78.86	78.86
1	715	20.57	99.42
2	20	0.58	100
Total	3,476	100	

Table 3.3: Effect of Executive Compensation Convexity on the Occurrence of Idiosyncratic Firm Jumps: Linear Probability Model Analysis

The dependent variable, Jump, is a binary indicator specifying the occurrence of an idiosyncratic firm jump within a given firm fiscal year. Specifically, Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. JIFP Smirk, is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump	(2) Jump	(3) Jump	(4) Jump
JIFP Smirk			0.0096	0.0109
			(0.69)	(0.76)
CEO D/E	**-0.0243****	**-0.0250****	**-0.0242****	**-0.0248****
	(-2.52)	**(-2.54)**	**(-2.47)**	**(-2.50)**
ln(1+CEO Vega)	0.0083**	0.0083**	0.0082**	0.0082**
	(2.08)	(2.13)	(2.11)	(2.17)
ln(1+CEO Delta)	-0.0091	-0.0092	-0.0089	-0.0090
	(-1.09)	(-1.08)	(-1.04)	(-1.03)
ln(1+CEO CashComp)	0.0070	0.0065	0.0068	0.0064
	(1.04)	(0.98)	(1.00)	(0.94)
ROE	-0.0302	-0.0311	-0.0304	-0.0314
	(-0.92)	(-0.95)	(-0.93)	(-0.96)
Size	-0.0186**	-0.0181**	-0.0185**	-0.0180**
	(-2.49)	(-2.49)	(-2.49)	(-2.50)
M/B	0.0050	0.0051	0.0050	0.0051
	(1.12)	(1.12)	(1.12)	(1.13)
Firm D/E	0.0070	0.0067	0.0069	0.0065
	(0.41)	(0.39)	(0.40)	(0.38)
Opaque	0.0030***	0.0030***	0.0031***	0.0030***
	(3.62)	(3.50)	(3.57)	(3.49)
Idiosyncratic Vol.	0.3751	0.3849	0.3790	0.3862
	(1.04)	(1.23)	(1.03)	(1.22)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.006	0.006	0.006
Year-FE	No	Yes	No	Yes

Table 3.4: Effect of Executive Compensation Convexity on the Occurrence of Idiosyncratic Firm Jumps: Linear Probability Model Analysis

The dependent variable, Jump, is a binary indicator specifying the occurrence of an idiosyncratic firm jump within a given firm fiscal year. Specifically, Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. JIFP Smirk, is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in $000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in $000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump	(2) Jump	(3) Jump	(4) Jump
JIFP Smirk			0.0116	0.0126
			(0.84)	(0.90)
ln(1+CEO Deferred Compensation)	**0.0008**	**0.0008**	**0.0008**	**0.0008**
	(0.28)	**(0.27)**	**(0.28)**	**(0.27)**
ln(1+CEO Pension)	**-0.0037*****	**-0.0037*****	**-0.0037*****	**-0.0037*****
	(-2.68)	**(-2.62)**	**(-2.65)**	**(-2.59)**
ln(1+CEO Inside-Equity)	-0.0372***	-0.0389***	-0.0380***	-0.0396***
	(-3.22)	(-3.21)	(-3.24)	(-3.24)
ln(1+CEO Vega)	0.0045	0.0044	0.0043	0.0042
	(1.07)	(1.08)	(1.07)	(1.08)
ln(1+CEO Delta)	0.0389**	0.0407**	0.0400**	0.0417**
	(2.19)	(2.20)	(2.18)	(2.20)
ln(1+CEO CashComp)	0.0057	0.0051	0.0055	0.0049
	(0.84)	(0.74)	(0.80)	(0.70)
ROE	-0.0251	-0.0257	-0.0253	-0.0261
	(-0.80)	(-0.81)	(-0.80)	(-0.82)
Size	-0.0208**	-0.0202**	-0.0206**	-0.0201**
	(-2.53)	(-2.51)	(-2.52)	(-2.51)
M/B	0.0044	0.0045	0.0045	0.0046
	(1.00)	(1.00)	(1.01)	(1.01)
Firm D/E	0.0059	0.0056	0.0058	0.0054
	(0.34)	(0.33)	(0.34)	(0.32)
Opaque	0.0030***	0.0029***	0.0030***	0.0029***
	(3.60)	(3.41)	(3.55)	(3.41)
Idiosyncratic Vol.	0.3531	0.3951	0.3588	0.3974
	(1.09)	(1.41)	(1.08)	(1.40)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.006	0.006	0.005
Year-FE	No	Yes	No	Yes

Table 3.5: Effect of Executive Compensation Convexity on the Number of Idiosyncratic Firm Jumps: Linear Model Analysis

The dependent variable, Jump Freq, is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. A firm experiences an idiosyncratic jump within a fiscal year if its idiosyncratic weekly returns jump by 3.09 or more standard deviations above their firm fiscal year mean. JIFP smirk is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump Frequency	(2) Jump Frequency	(3) Jump Frequency	(4) Jump Frequency
JIFP Smirk			0.0027	0.0039
			(0.19)	(0.27)
CEO D/E	**-0.0223***	**-0.0228***	**-0.0223***	**-0.0228***
	(-1.90)	**(-1.91)**	**(-1.89)**	**(-1.90)**
ln(1+CEO Vega)	0.0074*	0.0076*	0.0074*	0.0075*
	(1.84)	(1.90)	(1.85)	(1.91)
ln(1+CEO Delta)	-0.0076	-0.0079	-0.0075	-0.0078
	(-0.86)	(-0.88)	(-0.83)	(-0.86)
ln(1+CEO CashComp)	0.0085*	0.0082*	0.0084*	0.0081*
	(1.96)	(1.84)	(1.88)	(1.77)
ROE	-0.0260	-0.0268	-0.0260	-0.0269
	(-0.76)	(-0.79)	(-0.77)	(-0.79)
Size	-0.0199**	-0.0192**	-0.0198**	-0.0192**
	(-2.40)	(-2.39)	(-2.39)	(-2.39)
M/B	0.0064	0.0065	0.0064	0.0065
	(1.28)	(1.28)	(1.29)	(1.29)
Firm D/E	0.0127	0.0123	0.0126	0.0123
	(0.68)	(0.66)	(0.68)	(0.66)
Opaque	0.0025***	0.0024**	0.0025***	0.0024**
	(2.66)	(2.55)	(2.63)	(2.55)
Idiosyncratic Vol.	0.2733	0.3009	0.2744	0.3014
	(0.77)	(0.95)	(0.77)	(0.95)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.005	0.005	0.005
Year-FE	No	Yes	No	Yes

Table 3.6: Effect of Executive Compensation Convexity on the Number of Idiosyncratic Firm Jumps: Linear Model Analysis

The dependent variable, Jump Freq, is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. A firm experiences an idiosyncratic jump within a fiscal year if its idiosyncratic weekly returns jump by 3.09 or more standard deviations above their firm fiscal year mean. JIFP smirk is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump Freq	(2) Jump Freq	(3) Jump Freq	(4) Jump Freq
JIFP Smirk			0.0048	0.0058
			(0.35)	(0.41)
ln(1+CEO Deferred Compensation)	**0.0019**	**0.0019**	**0.0019**	**0.0019**
	(0.63)	**(0.63)**	**(0.63)**	**(0.63)**
ln(1+CEO Pension)	**-0.0032****	**-0.0032****	**-0.0032****	**-0.0032****
	(-2.14)	**(-2.09)**	**(-2.13)**	**(-2.08)**
ln(1+CEO Inside-Equity)	-0.0496***	-0.0516***	-0.0499***	-0.0519***
	(-3.14)	(-3.16)	(-3.22)	(-3.23)
ln(1+CEO Vega)	0.0020	0.0021	0.0020	0.0020
	(0.42)	(0.44)	(0.42)	(0.44)
ln(1+CEO Delta)	0.0541***	0.0560***	0.0545***	0.0564***
	(2.92)	(2.92)	(2.95)	(2.95)
ln(1+CEO CashComp)	0.0066*	0.0060	0.0065*	0.0060
	(1.87)	(1.58)	(1.75)	(1.49)
ROE	-0.0215	-0.0220	-0.0216	-0.0222
	(-0.65)	(-0.67)	(-0.66)	(-0.67)
Size	-0.0228**	-0.0221**	-0.0227**	-0.0221**
	(-2.55)	(-2.53)	(-2.54)	(-2.52)
M/B	0.0059	0.0059	0.0059	0.0059
	(1.17)	(1.17)	(1.18)	(1.17)
Firm D/E	0.0118	0.0114	0.0117	0.0113
	(0.64)	(0.63)	(0.64)	(0.63)
Opaque	0.0025***	0.0024**	0.0025***	0.0024**
	(2.73)	(2.57)	(2.70)	(2.57)
Idiosyncratic Vol.	0.2754	0.3425	0.2778	0.3435
	(0.89)	(1.24)	(0.88)	(1.23)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.005	0.006	0.005
Year-FE	No	Yes	No	Yes

Table 3.7: Effect of Executive Compensation Convexity on the Magnitude of Idiosyncratic Firm Jumps

The dependent variable, Jump Sigma, is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. JIFP smirk is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in $000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in $000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump Sigma	(2) Jump Sigma	(3) Jump Sigma	(4) Jump Sigma
JIFP Smirk			0.0350	0.0382
			(1.12)	(1.24)
CEO D/E	**-0.0264****	**-0.0262***	**-0.0259***	**-0.0257***
	(-2.00)	**(-1.93)**	**(-1.92)**	**(-1.86)**
ln(1+CEO Vega)	0.0131**	0.0135**	0.0130**	0.0134**
	(2.16)	(2.12)	(2.17)	(2.13)
ln(1+CEO Delta)	-0.0022	-0.0032	-0.0015	-0.0025
	(-0.20)	(-0.32)	(-0.14)	(-0.25)
ln(1+CEO CashComp)	0.0250	0.0244	0.0244	0.0239
	(1.34)	(1.33)	(1.27)	(1.26)
ROE	-0.0151	-0.0161	-0.0158	-0.0171
	(-0.42)	(-0.44)	(-0.44)	(-0.47)
Size	-0.0367**	-0.0358**	-0.0364**	-0.0354**
	(-2.48)	(-2.48)	(-2.38)	(-2.38)
M/B	0.0072*	0.0073*	0.0073*	0.0074*
	(1.71)	(1.70)	(1.73)	(1.73)
Firm D/E	0.0164	0.0164	0.0159	0.0159
	(0.60)	(0.60)	(0.58)	(0.58)
Opaque	0.0044	0.0037	0.0045	0.0037
	(.)	(.)	(.)	(.)
Idiosyncratic Vol.	0.9062**	1.0077***	0.9205**	1.0122***
	(2.53)	(3.20)	(2.50)	(3.10)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.005	0.006	0.006
Year-FE	No	Yes	No	Yes

Table 3.8: Effect of Executive Compensation Convexity on the Magnitude of Idiosyncratic Firm Jumps

The dependent variable, Jump Sigma, is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. JIFP smirk is the jump idiosyncratic firm put smirk. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in $000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in $000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. The dependent variable is measured at time t while all independent variables are measured at time $t-1$. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) Jump Sigma	(2) Jump Sigma	(3) Jump Sigma	(4) Jump Sigma
JIFP Smirk			0.0374	0.0404
			(1.20)	(1.32)
ln(1+CEO Deferred Compensation)	**-0.0019**	**-0.0019**	**-0.0019**	**-0.0019**
	(-0.38)	**(-0.37)**	**(-0.38)**	**(-0.38)**
ln(1+CEO Pension)	**-0.0057***	**-0.0057***	**-0.0058***	**-0.0058***
	(-1.82)	**(-1.79)**	**(-1.79)**	**(-1.77)**
ln(1+CEO Inside-Equity)	-0.0480**	-0.0499**	-0.0505**	-0.0521**
	(-2.10)	(-2.06)	(-2.26)	(-2.20)
ln(1+CEO Vega)	0.0087	0.0090	0.0083	0.0086
	(1.31)	(1.30)	(1.31)	(1.29)
ln(1+CEO Delta)	0.0591**	0.0599**	0.0626**	0.0631**
	(2.31)	(2.13)	(2.50)	(2.29)
ln(1+CEO CashComp)	0.0243	0.0237	0.0237	0.0231
	(1.50)	(1.48)	(1.40)	(1.39)
ROE	-0.0093	-0.0102	-0.0101	-0.0113
	(-0.28)	(-0.30)	(-0.30)	(-0.33)
Size	-0.0371**	-0.0361**	-0.0367**	-0.0357**
	(-2.25)	(-2.25)	(-2.15)	(-2.15)
M/B	0.0066	0.0066	0.0067	0.0067
	(1.53)	(1.53)	(1.55)	(1.55)
Firm D/E	0.0162	0.0164	0.0159	0.0160
	(0.58)	(0.59)	(0.56)	(0.57)
Opaque	0.0042***	0.0035	0.0043***	0.0035
	(20.03)	(.)	(25.64)	(.)
Idiosyncratic Vol.	0.8698**	0.9966***	0.8881**	1.0039***
	(2.27)	(2.79)	(2.28)	(2.72)
Observations	3476	3476	3476	3476
Adjusted R^2	0.006	0.006	0.007	0.006
Year-FE	No	Yes	No	Yes

Table 3.9: Effect of Executive Compensation Convexity on Jump Idiosyncratic Firm Put Smirks

The dependent variable, JIFP Smirk, is the jump idiosyncratic firm put smirk. The jump idiosyncratic firm put smirk is the ratio of the idiosyncratic implied volatility (variance) of in-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. All variables are measured at time t. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) JIFP Smirk	(2) JIFP Smirk
CEO D/E	**-0.0146**	**-0.0122**
	(-0.98)	**(-0.76)**
ln(1+CEO Vega)	0.0023	0.0031
	(0.27)	(0.34)
ln(1+CEO Delta)	-0.0202***	-0.0200***
	(-2.82)	(-2.74)
ln(1+CEO CashComp)	0.0158	0.0142
	(1.52)	(1.23)
ROE	0.0177	0.0238
	(0.77)	(1.13)
Size	-0.0111	-0.0101
	(-0.41)	(-0.36)
M/B	-0.0031	-0.0031
	(-1.03)	(-1.16)
Firm D/E	0.0125	0.0137
	(1.05)	(1.16)
Opaque	-0.0024	-0.0005
	(-1.24)	(-0.34)
Idiosyncratic Vol.	-0.4076	-0.1201
	(-0.68)	(-0.20)
Observations	3476	3476
Adjusted R^2	0.005	0.017
Year-FE	No	Yes

Table 3.10: Effect of Executive Compensation Convexity on Jump Idiosyncratic Firm Put Smirks

The dependent variable, JIFP Smirk, is the jump idiosyncratic firm put smirk. The jump idiosyncratic firm put smirk is the ratio of the idiosyncratic implied volatility (variance) of in-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. All variables are measured at time t. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) JIFP Smirk	(2) JIFP Smirk
ln(1+CEO Deferred Compensation)	**0.0005**	**0.0007**
	(0.27)	**(0.41)**
ln(1+CEO Pension)	**0.0011**	**0.0013**
	(0.37)	**(0.43)**
ln(1+CEO Inside-Equity)	0.0674***	0.0533**
	(2.73)	(2.47)
ln(1+CEO Vega)	0.0096	0.0088
	(1.25)	(1.12)
ln(1+CEO Delta)	-0.0943***	-0.0785***
	(-3.58)	(-3.47)
ln(1+CEO CashComp)	0.0163	0.0143
	(1.36)	(1.07)
ROE	0.0210	0.0263
	(0.85)	(1.13)
Size	-0.0118	-0.0112
	(-0.45)	(-0.41)
M/B	-0.0029	-0.0030
	(-1.01)	(-1.13)
Firm D/E	0.0091	0.0107
	(0.86)	(1.01)
Opaque	-0.0023	-0.0005
	(-1.28)	(-0.34)
Idiosyncratic Vol.	-0.4901	-0.1806
	(-0.86)	(-0.30)
Observations	3476	3476
Adjusted R^2	0.006	0.017
Year-FE	No	Yes

Table 3.11: Effect of Executive Compensation Convexity on Idiosyncratic Firm Jumps: Scaled Decile Rank Linear Model Analysis

The dependent variables are JIFP Smirk, Jump, Jump Frequency, and Jump Sigma, respectively. All independent variables are transformed by first calculating their decile rank each fiscal year, subtracting one, and then dividing by nine. The coefficient on the respective scaled decile rank variable is the change in the corresponding dependent variable stemming from a bottom-to-top decile transition in the independent variable. JIFP smirk is the jump idiosyncratic firm put smirk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) JIFP Smirk	(2) Jump	(3) Jump Frequency	(4) Jump Sigma
Rank(JIFP Smirk)		0.0170**	0.0106	0.0175
		(2.06)	(0.91)	(0.62)
Rank(CEO D/E)	**0.0027**	**-0.0499*****	**-0.0486*****	**-0.0868*****
	(0.07)	**(-5.05)**	**(-3.54)**	**(-2.90)**
Rank(CEO Vega)	-0.0470	0.0691**	0.0638*	0.1127***
	(-0.85)	(2.10)	(1.86)	(4.73)
Rank(CEO Delta)	-0.0381	-0.0573	-0.0520	-0.0822
	(-1.38)	(-1.23)	(-1.08)	(-1.48)
Rank(Cash Comp)	0.0185	-0.0032	-0.0001	0.0309
	(0.69)	(-0.24)	(-0.01)	(0.99)
Rank(ROE)	-0.0149	-0.0079	0.0013	-0.0047
	(-1.11)	(-0.30)	(0.05)	(-0.21)
Rank(Size)	-0.0482	-0.0837**	-0.0875**	-0.1869***
	(-0.39)	(-2.54)	(-2.28)	(-3.16)
Rank(M/B)	-0.0164	0.0412	0.0439	0.0944**
	(-1.01)	(1.09)	(1.11)	(2.14)
Rank(Firm D/E)	0.0762***	0.0063	0.0138	0.0395
	(3.71)	(0.14)	(0.29)	(0.81)
Rank(Opaque)	0.0687	0.0132	0.0071	0.0058
	(1.64)	(0.74)	(0.40)	(0.21)
Rank(Idiosyncratic Vol.)	-0.0736	0.0202	0.0204	0.0039
	(-1.57)	(1.26)	(1.03)	(0.15)
Observations	3476	3476	3476	3476
Adjusted R^2	0.009	0.005	0.004	0.005

Table 3.12: Effect of Executive Compensation Convexity on Idiosyncratic Firm Jumps: Scaled Decile Rank Linear Model Analysis

The dependent variables are JIFP Smirk, Jump, Jump Frequency, and Jump Sigma, respectively. All independent variables are transformed by first calculating their decile rank each fiscal year, subtracting one, and then dividing by nine. The coefficient on the respective scaled decile rank variable is the change in the corresponding dependent variable stemming from a bottom-to-top decile transition in the independent variable. JIFP smirk is the jump idiosyncratic firm put smirk. Jump is set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return. Jump Frequency is the number of idiosyncratic firm stock-price jumps within a given firm fiscal year. Jump Sigma is the largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean. CEO CashComp is the CEO's total cash remuneration within a given firm fiscal year. CEO Delta is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price. CEO Vega is the dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. CEO D/E is the ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s). Idiosyncratic Volatility is the standard deviation of idiosyncratic firm weekly returns. Intercept term is included but not reported. All t-statistics in parentheses are clustered at the firm and year level. The notation $*, **, ***$ indicates statistical significance at the 10%, 5%, and 1% levels, respectively. The remaining variables are defined in Appendix B.

	(1) JIFP Smirk	(2) Jump	(3) Jump Frequency	(4) Jump Sigma
Rank(JIFP Smirk)		0.0169**	0.0103	0.0177
		(2.22)	(0.93)	(0.63)
Rank(CEO Deferred Compensation)	**0.0169**	**0.0183**	**0.0275**	**0.0067**
	(1.38)	**(0.71)**	**(1.05)**	**(0.14)**
Rank(CEO Pension Value)	**0.0077**	**-0.0533*** **	**-0.0500*** **	**-0.0821** **
	(0.18)	**(-3.24)**	**(-2.91)**	**(-2.04)**
Rank(CEO Inside-Equity)	0.0806	0.0543	0.0555	0.0617
	(0.54)	(0.35)	(0.34)	(0.24)
Rank(CEO Vega)	-0.0355	0.0745	0.0690	0.1170*
	(-0.91)	(1.60)	(1.45)	(1.95)
Rank(CEO Delta)	-0.1308	-0.0937	-0.0925	-0.1040
	(-0.91)	(-0.52)	(-0.50)	(-0.35)
Rank(Cash Comp)	0.0154	-0.0040	-0.0017	0.0298
	(0.59)	(-0.29)	(-0.14)	(0.94)
Rank(ROE)	-0.0152	-0.0063	0.0025	-0.0024
	(-1.02)	(-0.24)	(0.10)	(-0.12)
Rank(Size)	-0.0521	-0.0882**	-0.0938**	-0.1918***
	(-0.42)	(-2.54)	(-2.34)	(-3.02)
Rank(M/B)	-0.0173	0.0382	0.0408	0.0913**
	(-1.28)	(0.99)	(1.01)	(2.00)
Rank(Firm D/E)	0.0749***	0.0065	0.0136	0.0388
	(3.67)	(0.14)	(0.29)	(0.78)
Rank(Opaque)	0.0694*	0.0118	0.0058	0.0040
	(1.65)	(0.66)	(0.33)	(0.14)
Rank(Idiosyncratic Vol.)	-0.0757	0.0175	0.0181	0.0013
	(-1.57)	(1.23)	(1.07)	(0.04)
Observations	3476	3476	3476	3476
Adjusted R^2	0.009	0.005	0.004	0.005

Appendices

A. Estimation of Compensation Incentives

Delta is the dollar change in the value of the executive's equity portfolio (in \$000s) associated with a 1% increase in the firm's stock price. Similarly, vega is the dollar change in the value of the executive's equity portfolio (in \$000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns. The closed form expressions for the delta and vega of a call option on an underlying security with dividends are provided by the Black and Scholes (1973) option pricing model as modified to account for dividend payouts:

$$\text{Option Value} = Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma\sqrt{T}\right) \tag{10}$$

$$\Delta = \frac{\partial(\text{Option Value})}{\partial S} \tag{11}$$

$$= e^{-dT}N(Z)$$

$$\nu = \frac{\partial(\text{Option Value})}{\partial \sigma} \tag{12}$$

$$= e^{-dT}N'(Z)S\sqrt{T}$$

$$Z = \frac{\ln\left(\frac{S}{X}\right) + T\left[r - d + \frac{\sigma^2}{2}\right]}{\sigma\sqrt{T}} \tag{13}$$

where N is the cumulative density function for the normal distribution, N' is the probability density function for the normal distribution, d is the natural logarithm of the expected dividend yield, T is the time to maturity of the option in years, S is the price of the underlying stock, X is the exercise price of the option, r is the natural logarithm of the risk-free interest rate, and σ is the expected stock return volatility. Accordingly, the dollar change in the value of an option associated with a 1% increase in the firm's stock price is $.01 \times \Delta \times S$. The dollar change in the value of an option associated with a one percentage-point increase in the standard deviation of the firm's equity returns is $.01 \times \nu$.

The methodology in Core and Guay (2002) is used to aggregate the delta and vega of individual option grants so as to arrive at the total delta and total vega of the executive's option portfolio. The total delta of the executive's portfolio of stocks is then added to the total option portfolio delta in calculating the total delta of the executive's equity portfolio. The total vega of the executive's equity portfolio is approximated as the total vega of the option portfolio as Guay (1999) finds that stock options, but not common stock, substantially increase the sensitivity of the executive's wealth to firm equity risk.

B. Variable Definitions

1. **CEO Cash Compensation**: Total current compensation (Salary+Bonus) of the CEO—`TOTAL_CURR`.

2. **CEO Delta**: Dollar change in the value of the CEO's total equity compensation portfolio (in \$000s) associated with a 1% increase in the firm's stock price.

3. **CEO D/E**: Ratio of the total value of a CEO's inside-debt compensation to the total value of a CEO's inside-equity compensation. Inside-debt compensation is defined as the sum of a CEO's total aggregate balance in deferred compensation as well as the present value of a CEO's accumulated pension benefits (in \$000s). Inside-Equity compensation is defined as the total value of a CEO's current and outstanding portfolios of stock- and option-based remuneration (in \$000s).

4. **Discretionary Accruals**: Discretionary accruals are calculated by estimating the modified Jones model. For all firms within each Fama-French industry in a given fiscal year, I estimate the following cross-sectional regression:

$$\frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} = \alpha_0\left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] + \beta_1\left[\frac{\Delta\mathbf{Sales}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \beta_2\left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] + \varepsilon_{i,t}$$

Discretionary accruals, for each firm fiscal year, are then calculated as follows:

$$\mathbf{DiscAcc}_{i,t} = \frac{\mathbf{TA}_{i,t}}{\mathbf{Assets}_{i,t-1}} - \widehat{\alpha}_0 \left[\frac{1}{\mathbf{Assets}_{i,t-1}}\right] - \widehat{\beta}_1 \left[\frac{\Delta\mathbf{Sales}_{i,t} - \Delta\mathbf{Receivables}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right] - \widehat{\beta}_2 \left[\frac{\mathbf{PPE}_{i,t}}{\mathbf{Assets}_{i,t-1}}\right]$$

where $\mathbf{TA}_{i,t}$ is the total accruals, $\mathbf{Assets}_{i,t}$ is the total assets, $\Delta\mathbf{Sales}_{i,t}$ is the change in sales, $\Delta\mathbf{Receivables}_{i,t}$ is the change in receivables, and $\mathbf{PPE}_{i,t}$ is the property, plant, and equipment of firm i in fiscal year t, respectively.

5. **Firm D/E**: Defined as $\texttt{(dltt+dlc)/(csho*prcc}_f\texttt{)}$.

6. **Idiosyncratic Firm Weekly Returns**: I estimate the below model for each stock fiscal year and I define idiosyncratic firm weekly returns as $\mathbf{ln(1+\varepsilon)}$:

$$\boldsymbol{r}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_{1,i}\boldsymbol{r}_{m,t-1} + \boldsymbol{\beta}_{2,i}\boldsymbol{r}_{j,t-1} + \boldsymbol{\beta}_{3,i}\boldsymbol{r}_{m,t} + \boldsymbol{\beta}_{4,i}\boldsymbol{r}_{j,t} + \boldsymbol{\beta}_{5,i}\boldsymbol{r}_{m,t+1} + \boldsymbol{\beta}_{6,i}\boldsymbol{r}_{j,t+1} + \boldsymbol{\varepsilon}_{it}$$

where $\boldsymbol{r}_{i,t}$ is the weekly return for stock i in week t, $\boldsymbol{r}_{m,t}$ is the weekly return for the CRSP value-weighted market index in week t, and $\boldsymbol{r}_{j,t}$ is the weekly return for stock i's value-weighted Fama-French industry index j during week t. I include leads and lags to account for non-synchronous trading (Dimson, 1979).

7. **Idiosyncratic Volatility**: The standard deviation of idiosyncratic firm weekly returns for a given firm fiscal year.

8. **Jump**: Set to one if, within its fiscal year, a firm experiences one or more idiosyncratic weekly returns rising 3.09 or more standard deviations above the mean idiosyncratic firm weekly return.

9. **Jump Frequency**: The number of idiosyncratic firm stock-price jumps within a given firm fiscal year.

10. **Jump Idiosyncratic Firm Put Smirk**: The ratio of the idiosyncratic implied volatility (variance) of in-the-money put options to the idiosyncratic implied volatility (variance) of at-the-money put options for a given firm fiscal year. Specifically, I define JIFP Smirk for a given firm i in fiscal year t as follows:

$$\textbf{JIFP Smirk}_{i,t} = \frac{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ITM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ITM}\right]}{\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM} - \left[\hat{\boldsymbol{\beta}}^2_{\text{i,t-1,Vasicek}} \times \hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}\right]}$$

where the deltas of the in-the-money (ITM) put options and at-the-money (ATM) put options are -.8 and -.5, respectively. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,ITM}$ is the average implied volatility (variance) of in-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ITM}$ is the average implied volatility (variance) of in-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{i,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon firm put options as measured over the 10 trading days prior to the start of fiscal year t. $\hat{\boldsymbol{\sigma}}^2_{S\&P500,t-1,ATM}$ is the average implied volatility (variance) of at-the-money 91-day horizon S&P 500 put options as measured over the 10 trading days prior to the start of fiscal year t.

11. **Jump Sigma**: The largest standard deviation jump in idiosyncratic firm weekly returns above their firm fiscal year mean.

12. **Leverage**: Total assets minus the book value of common equity scaled by total assets —`(AT-CEQ)/AT`.

13. **MTB**: Market value of common equity scaled by the book value of common equity—`(PRCC_F*CSHO)/CEQ`.

14. **Opaque**: Three year moving sum of the absolute value of discretionary accruals:

$$\textbf{Opaque}_t = \sum_{i=t-3}^{t-1} |\textbf{DiscAcc}_i|$$

15. **ROE**: Income before extraordinary items scaled by the book value of common equity—`IBC/CEQ`.

16. **Size**: Natural logarithm of the market value of common equity—`ln(PRCC_F*CSHO)`.

17. **Total Accruals**: Income before extraordinary items and discontinued operations minus the cash flow from operating activities—`(IBC_t-OANCF_t)`.

18. **CEO Vega**: Dollar change in the value of the CEO's total equity compensation portfolio (in $000s) associated with a one percentage-point increase in the standard deviation of the firm's equity returns.

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