THREE STUDIES ON THE USE OF CEO EQUITY COMPENSATION

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ABSTRACT

This dissertation contains three studies relating to executive equity compensation. In the first study (Chapter 2), I investigate whether firms adjust CEO's equity incentives in response to the firms' prior earnings management. I find that the risk-taking incentives from new equity grants are lower for firms with higher prior real earnings management (REM), but not for firms with higher accruals-based earnings management (AEM). My finding suggests that boards perceive the consequences of REM are more value-reducing than AEM and that they take stronger actions against REM by reducing the CEO's risk-taking incentives arising from equity incentives. In addition, I this result is driven by firms with higher institutional ownership, suggesting that institutional investors play an important monitoring role in structuring executive compensation contracts to limit the CEOs' value-reducing behaviors. In the second study (Chapter 3), I investigate how the firm's downside risk and upside potential differentially affect the choice between cash and equity compensation and the choice between stock options and restricted stock compensation. First, I find that, as downside risk (upside potential) increases, boards grant more cash compensation (more equity compensation) and less equity compensation (less cash compensation). This is consistent with the idea that, when downside risk increases, a CEO requires a higher risk premium for equity compensation and, thus, the board shifts compensation away from equity compensation to cash compensation. The reverse is true for the increased upside potential. When upside potential increases, the observed compensation contract will contain less cash and more equity compensation.

Second, I find that the proportion of CEO option compensation increases with downside risk and decreases with upside potential. This is because, when downside risk increases, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases but restricted stock has positive value as long as the stock price is positive. In contrast, when upside potential increases, because of stock options' leverage effect, a CEO will prefer stock options to restricted stock. In the third study (Chapter 4), I study how executive stock options differentially affect the firm's systematic and idiosyncratic risk by exploiting the passage of Financial Accounting Standard (FAS) 123R as an exogenous shock to CEO option compensation. I find that option-based compensation and the proportion of idiosyncratic risk in total risk is negatively associated. This is consistent with the idea that since, unlike risk-neutral investors, risk-averse CEOs have limited ability to eliminate firm specific idiosyncratic, idiosyncratic risk is unwanted by under-diversified CEOs. Thus, CEO option compensation creates incentives to increase the firm's systematic risk relative to the firm's idiosyncratic risk.

For my family.

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CHAPTER 1
INTRODUCTION

Equity-based compensation is one of the mechanisms to align managers' interests with those of shareholders (Jensen and Meckling 1976). Without proper incentives, executives generally prefer to consume perquisites and undertake less risk than what optimizes firm value. Smith and Stulz (1985) argue that option-based compensation mitigates managerial risk aversion and induces greater risk-taking behavior because the objective option value, e.g., the Black-Scholes value, increases with stock return volatility. As such, stock- and option-based compensation has been widely used by firms (Hall and Murphy 2003). Motivated by this, prior studies have examined the relationship between option-based compensation and firm risk-taking (e.g., Aggarwal and Samwich 1999; Guay 1999; Jin 2002, Coles, Daniel, and Naveen 2006).

However, prior studies also provide evidence that CEO equity compensation has resulted in an unintended consequence – earnings management (e.g., Cheng and Warfield 2005; Bergstresser and Phillippon 2006; Jiang, Petroni, and Wang 2010; Armstrong, Larcker, Ormazabal, and Taylor 2013). Especially, Armstrong et al. (2013) argue that earnings management can be view as a special case of engaging in a risky project that increases both equity value and risk and document positive effects of option-based compensation on earnings management. Thus, in my first study (Chapter 2), unlike prior studies that study the incentive effects of CEO equity compensation on earnings management, I reverse the direction of this relationship and seek to understand whether firms take actions to dis-incentivize earnings management by adjusting CEO equity compensation. This research question is important since prior studies provide evidence that earnings management has negative consequences on the firm, such as future stock and operating underperformance, increased shareholder lawsuits, and increased transparency costs.

I show that the risk-taking incentives from new equity grants are lower for firms with higher prior real earnings management (REM), but not for firms with higher accruals-based earnings management (AEM). This result suggests that boards perceive the consequences of REM are more value-reducing than AEM and that they take stronger actions against REM by reducing the CEO's risk-taking incentives arising from equity incentives. In addition, I find that the negative relation between REM and risk-taking incentives from new equity grants are driven by firms with higher institutional ownership, suggesting that institutional investors play an important monitoring role in structuring executive compensation contracts to limit the CEOs' incentives to engage in costly REM. In sum, I provide evidence consistent with firms constantly revising CEO compensation (i.e., reducing CEO risk-taking incentives) to restrain managers' value-reducing behavior.

In the second study (Chapter 3), I aim to understand how firms' asymmetric risk environment affects the CEO compensation structure. As mentioned earlier, equity compensation is to mitigate agency related problems. One important aspect of equity compensation is that it is tied to a firm's uncertain future outcomes. Therefore, understanding firm risk environment is an important consideration for CEO equity compensation. Traditional option pricing models, e.g., Black-Scholes (1973), use symmetric volatility as an input. Accordingly, the vast majority of prior studies examine the relation between symmetric risk and CEO compensation (e.g., Guay 1999; Jin 2002). However, a stock option's payoff is piece-wise linear to its underlying stock price (i.e., asymmetric payoff) while stock's payoff is linear. Thus, I investigate the relationship between firms' asymmetric risk environment and CEO compensation. Specifically, I investigate how the firm's downside risk and upside potential differentially affect the choice between cash and equity compensation and the choice between stock options and restricted stock compensation. First, regarding the choice between cash and equity compensation, when downside risk increases, a CEO requires a higher risk premium for equity compensation. Thus, as downside risk increases, granting equity incentives will be costlier and the board shifts compensation away from equity compensation to cash compensation. Thus, I predict that, as downside risk increases, the observed compensation contract will contain more cash and less equity compensation. In contrast, when upside potential increases, there is no upper limit to the payoff of equity compensation. Thus, I predict that, as upside potential increases, the observed compensation contract will contain less cash and more equity compensation. Second, regarding the choice between stock options and restricted stock, when downside risk increases, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases. In contrast, restricted stock has positive value as long as the stock price is positive. When upside potential increases, because of stock options' leverage effect (i.e., a steeper slope in the in-the-money price range), a CEO will prefer stock options to restricted stock. Thus, I predict that the proportion of CEO option compensation (the proportion of stock option in total equity compensation) increases with downside risk and decreases with upside potential. I provide consistent results with my predictions.

In the third study (Chapter 4), I investigate how executive stock options differentially affect the firm's systematic and idiosyncratic risk. According to the Capital Asset Pricing Model (CAPM), only systematic risk is priced by the market since diversified investors can eliminate idiosyncratic risk through diversification. Unlike risk-neutral shareholders, risk-averse CEOs have limited ability to eliminate idiosyncratic (or firm-specific) risk since they usually hold large positions in their firms and are often prohibited from hedging the firm-specific risk associated with their compensation. Thus, idiosyncratic risk is unwanted by under-diversified CEOs. Thus, I hypothesize that CEO option compensation creates incentives to increase the firm's systematic risk relative to the firm's idiosyncratic risk. To examine a casual effect of option compensation on the firm's systematic and idiosyncratic risk, I exploit the passage of Financial Accounting Standard (FAS) 123R as an exogenous shock to CEO option compensation. I show that option-based compensation and the proportion of idiosyncratic risk in total risk is negatively associated. My finding is consistent with the idea that executives prefer projects that are primarily characterized by systematic risk than by idiosyncratic risk.

CHAPTER 2
THE IMPACT OF EARNINGS MANAGEMENT ON CEO EQUITY INCENTIVES

2.1. Introduction

Prior literature offers evidence that executive equity compensation is positively associated with earnings management (e.g., Cheng and Warfield 2005; Bergstresser and Philippon 2006; Jiang, Petroni, and Wang 2010; Armstrong, Larcker, Ormazabal, and Taylor 2013). In one notable study, Armstrong et al. (2013) show that an executive's risk-taking incentives (portfolio vega) have an unambiguously positive effect on financial misreporting, including earnings management. Additional studies provide further support for the position that earnings management is associated with future stock and operating underperformance and shareholder lawsuits, suggesting the negative consequences of earnings management on firm value (e.g., DuCharme, Malatesta, and Sefcik 2004; Cohen and Zarowin 2010; Kothari, Mizik, and Roychowdhury 2016). In addition, Leuz, Nanda, and Wysocki (2003) argue that earnings management imposes transparency costs on shareholders by decreasing their ability to monitor managers' performance.

Collectively, these findings raise an important question regarding whether firms take actions to dis-incentivize earnings management by adjusting executive equity compensation, especially risk-taking incentives. Hazarika, Karpoff, Nahata (2012) find that the likelihood and speed of forced CEO turnover are positively related to firms' accruals-based earnings management. Their finding implies that boards act proactively to discipline managers who manage earnings aggressively before it leads to costly external consequences. Replacing the CEO, however, is an extreme form of internal discipline, and can be a very costly organizational change. Instead of adopting such extreme stances, in some cases a lighter disciplinary action by the board (e.g., altering compensation contracts) may be more appropriate to counteract managerial self-serving behavior. Although prior studies find evidence that strong corporate governance limits financial statement fraud (e.g., Beasley 1996), fraudulent financial statement reporting (e.g., Dechow, Sloan, and Sweeney 1996), and earnings management (e.g., Leuz, Nanda, and Wysocki 2003), there exists no evidence as to whether boards take corrective actions by altering executive equity compensation against CEOs who engage in earnings management. Thus, in this chapter I investigate whether firms adjust the level of executives' risk-taking incentives arising from new equity grants in response to prior earnings management.[1]

Crocker and Slemrod (2007) theoretically show that encouraging productive effort and simultaneously eliminating incentives to manipulate earnings on which a manager's pay is based is impossible. This implies that earnings management is unavoidable or even optimal. However, it is possible that executives engage in earnings management more than the board anticipated at the time the compensation contract is made. In those situations, boards have an incentive to alter their executive's compensation contract. Furthermore, Core and Guay (1999) argue that over time the

[1] Cheng (2004) shows that changes in R&D spending are positively associated with the value of CEO annual option grants when potential horizon problems are present, suggesting compensation committees respond in anticipation of opportunistic reductions in R&D spending. One major distinction between Cheng (2004) and my study is that I investigate whether firms take corrective actions in responses to the *realized* earnings management activities, whereas Cheng (2004) focuses on the firms' precautious action to prevent *potential* underinvestment in R&D, a type of real earnings management strategy.

executives' holdings of stock and options can deviate from the optimal level, either because the optimal levels shift or because of changes in the incentives provided by the CEOs' equity portfolio. This deviation of equity incentives from the optimal level can lead to sub-optimal behavior on the part of the executives (e.g., excessive earnings management). In addition, although earnings management can benefit shareholders, and not all earnings management attempts are due to executives' opportunism[2], aggressive earnings management is likely to impose costs on shareholders (Leuz, Nanda, and Wysocki 2003; Hazarika, Karpoff, and Nahata 2012). Recent studies document the negative consequences of earnings management on a firm's operating performance and/or firm value (e.g., Bhojraj, Picconi, and McInnis 2009; Cohen and Zarowin 2010; Kothari, Mizik, and Roychowdhury 2016; Bereskin, Hsu, and Rotenburg 2017). Further, real earnings management (REM) is more likely to be costlier than accrual-based earnings management (AEM) because REM implies the deviation from an otherwise optimal operating decisions, imposing a "real" cost on the firm (Cohen and Zarowin 2010; Kothari et al. 2016). Therefore, the consequences of AEM and REM may be perceived differently by the board of directors. In this chapter, I investigate the impact of both AEM and REM on new equity grants.

Before examining whether firms adjust the level of CEO equity incentives in response to prior earnings management activities, I re-examine the relation between CEO

[2] The non-opportunistic motivations for engaging in earnings management suggested in the literature include: to achieve better contractual outcomes (e.g., to avoid covenant violations and to lower the cost of capital) and to enhance the firm's credibility and reputation with stakeholders by meeting benchmarks (Dechow, Sloan, and Sweeney 1996; Bartov, Givoly, and Hayn 2002; Graham, Harvey, and Rajgopal 2005).

equity incentives and earnings management. Earlier studies that investigate the impact of CEO equity incentives on earnings management activities are mixed[3]. In addition, although more recent work by Armstrong, Larker, Ormazabal, and Taylor (2013) provides convincing evidence that CEO equity incentives, more precisely risk-taking incentives, are positively associated with financial misreporting including AEM, they do not examine the relationship between CEO equity incentives and REM. Further, the widely used measure of risk-taking incentive – portfolio vega – focuses narrowly on the incentives generated by stock options and does not capture the risk-taking incentives generated by managers' stock holdings in levered firms (Anderson and Core 2017; Boyallian and Ruiz-Verdu 2017). Because of limited liability, equity holders have the incentive to increase equity value by shifting risk to debt holders (Jensen and Meckling 1976). Anderson and Core (2017) incorporate risk-taking incentives arising from stock holdings and calculate total equity sensitivity to firm volatility.[4] I use Anderson and Core's (2017) equity sensitivity measure as a proxy for risk-taking incentives.

In my first stage analysis where I investigate the impact of CEO equity incentives on AEM and REM, I find that CEO portfolio delta (i.e., CEO's wealth sensitivity to stock price) is not associated with AEM, consistent with Armstrong et al. (2013). They argue

[3] For example, Cheng and Warfield (2005) and Bergstresser and Philippon (2006) provide evidence that CEO equity incentives are positively associated with CEO's likelihood of engaging in earnings management activities. However, Jiang, Petroni, and Wang (2010) show that the positive relationship between CEO equity incentives and AEM disappears in the post-SOX period.

[4] To be more precise, Anderson and Core (2017) also include the sensitivity of the manager's inside debt to firm volatility for their overall sensitivity measure. This total sensitivity measure requires data on CEOs' inside debt, which data (*pension_value_tot* and *defer_balance_tot*) became available only after 2006. However, they show that their total sensitivity measure that includes the sensitivity of debt is 99% correlated with the equity sensitivity measure that ignores debt incentives. Thus, I proceed to use equity sensitivity measure as a risk-taking incentive proxy in my study.

that, if earnings management increases both equity value and risk (i.e., a special case of risky project), a risk-averse CEO will trade off any expected increase in equity value ("*reward effect*") and expected increase in risk ("*risk effect*"). Delta captures the two countervailing incentive effects and, thus, the relation between delta and AEM is ambiguous. Consistent this this conjecture, I document that delta and AEM are insignificantly associated. In contrast, I find that delta is negatively associated with REM. This result is consistent with idea that the risk effect of REM captured by delta outweighs the reward effect. Thus, delta, on average, has negative impact on REM. With regard to the effect of CEO equity sensitivity to volatility (i.e., risk-taking incentives) on AEM and REM, I find that equity sensitivity is positively associated with both AEM and REM. This is consistent with Armstrong et al.'s (2013) finding that risk-taking incentives create unambiguously positive effects on earnings management.

I next show that the equity sensitivity to volatility associated with new equity grants is lower for firms with higher prior REM. This negative relation suggests that firms lower risk-taking incentives, which are shown to be positively associated with REM in my first stage analysis, to limit REM. In contrast, my findings suggest no significant relationship between prior AEM and risk-taking incentives incurred in new equity grants. This is an especially interesting result since I also find a positive association between equity sensitivity and AEM in my first stage analysis. I interpret this result as a function of boards' perception that the consequences of REM are more value-reducing than AEM, thus encouraging them to take stronger action against REM.

There may be a concern that my results are compounded by a mechanical relation between earnings management and risk-taking incentive measures, rather than my results capturing the boards' intentional responses to earnings management. For example, the risk-taking measure in this chapter is a positive function of stock price. In addition, if a manager engages in greater earnings management activities to mask the decline in stock market performance, we would observe higher earnings management, resulting in the negative relation between prior earnings management and new risk-taking incentives. Note that this negative relation can be observed even without the board's intentional intervention to limit earnings management by reducing CEO risk-taking incentives. In particular, Shue and Townsend (2016) document firms' tendency to grant the same number of options each year before mid-2000s. Thus, I additionally investigate the relation between prior earnings management and new equity grants using the number of options instead of dollar value. My inferences do not change.

In an additional analysis, I examine how institutional investor monitoring, as proxied by the percentage of institutional ownership, affects the relationship between prior earnings management and the adjustment of risk-taking incentives. Large institutional investors have the resources and ability to monitor, discipline, and influence managers, reducing managers' opportunistic behavior. Hartzell and Starks (2003) provide evidence that institutional investors serve a monitoring role in mitigating the agency problem between shareholders and managers by influencing executive compensation. Further, prior studies suggest that the presence of institutional investors constrains real earnings management (Bushee 1998; Roychowdhury 2006; Zang 2012). I show that the negative relation between REM and risk-taking incentives from new equity grants are driven by firms with higher institutional ownership. My findings suggest that institutional investors play a monitoring role by influencing executive compensation contracts to restrain managers' value-reducing behavior.

My findings make three primary contributions in the compensation, corporate governance, and earnings management literature. First, they shed light on another internal governance mechanism that limits CEOs' earnings management activities – altering CEO equity incentives. Prior studies show that strong corporate governance limits financial statement reporting (e.g., Dechow, Sloan, and Sweeney 1996) and earnings management (e.g., Leuz, Nanda, and Wysocki 2003). Similarly, Hazarika et al. (2012) focus on forced CEO turnover, an extreme and costly internal discipline mechanism aimed at dealing with problematic earnings management. Instead, I focus on a more direct and less extreme internal governance mechanism and show that boards limit CEOs' value-reducing activities by proactively re-incentivizing equity incentives. My results complement Core and Guay (1999) who provide evidence that firms set optimal equity incentive levels and grant new equity incentives in a manner that is consistent with the economic theory of optimal contracting (Jensen and Meckling 1976). Second, my results imply that the costs of REM are perceived by the board to be more severe than those of AEM. Third, I provide indirect evidence that institutional investors play an important monitoring role by affecting CEO compensation contracts, a key governance subject.

This chapter is organized as follows. Section 2.2 discusses the related literature and develops my hypotheses. Section 2.3 describes data and variable measurement.

Section 2.4 describes research design. My primary results are presented in Section 2.5. Section 2.6 concludes.

2.2. Related Literature and Hypotheses Development

2.2.1. Equity Compensation and Earnings Management

Equity incentives are designed to align the interest of the CEO with that of shareholders, limiting the CEO's opportunistic behavior (Jensen and Meckling 1976). Thus, theoretically, CEOs with higher equity incentives should act in the interests of shareholders. However, there also exist concerns that "high-powered" equity incentives might also incentivize CEOs to manage earnings in order to boost stock prices in the short run. If a CEO believes that the expected benefits he can extract by temporarily inflating the stock price are greater than the expected costs (i.e., the decrease in long-term firm value), the CEO will manage earnings. In addition, if poor stock performance can result in a forced CEO turnover (Coughlan and Schmidt 1985), the expected benefits of engaging in earnings management will be even higher. Consistent with this idea, Cheng and Warfield (2005) and Bergstresser and Philippon (2006) show that equity incentives are positively associated with AEM.

However, the "high-powered" equity incentives explanation above does not precisely describe the relation between equity incentives and earnings management. Armstrong, Larcker, Ormazabal, and Taylor (2013) argue that, if financial misreporting is viewed as a special case of a risky project that increases both equity value and equity risk, a risk-averse CEO will trade off any expected *reward* and *risk* associated with the misreporting decision. In this case, the sensitivity of the CEO's wealth to changes in the company's stock price – portfolio delta – captures the two countervailing effects on misreporting (earnings management, in this case) and the theoretical relationship between portfolio delta and misreporting remains ambiguous.[5] In contrast, the sensitivity of the CEO's wealth to changes in risk – portfolio vega – will unambiguously encourage CEO's misreporting decisions, which increase equity risk. Armstrong et al. (2013) document results consistent with their prediction. Thus, I consider risk-taking incentive as one of the main drivers for earnings management.

However, the widely used measure of risk-taking incentive in the literature as used in Armstrong et al. (2013), portfolio vega, focuses narrowly on the risk-taking incentives from stock options and does not capture the risk-taking incentives generated by managers' stock holdings in levered firms. Because of limited liability, equity in a levered-firm can be viewed as a call option on firm value with an exercise price equal to the face value of debt. Thus, equity holders have the incentive to increase equity value by shifting risk to debt holders (Jensen and Meckling 1976). Acknowledging this shortcoming of vega, Anderson and Core (2017) derive and calculate a measure of total equity sensitivity to firm volatility, which considers the manager's risk-taking incentives arising from stock holdings as well as option holdings. They show that their new measure

[5] Armstrong et al. (2013) claim that the mixed evidence in the prior literature on the impact of equity incentives on earnings management activities is attributable to ignoring the two countervailing effects of equity incentives on earnings management. Prior studies' mixed evidence on the impact of equity incentives on earnings management activities are well summarized in Armstrong, Larcker, Ormazabal, and Taylor (2013) as well as in Armstrong, Jagolinzer, and Larker (2010).

explains firms' risk choices better than vega. Anderson and Core's (2017) equity sensitivity measure, instead of vega, is used as a proxy for risk-taking incentives.

2.2.2. Consequences of Earnings Management

Healy and Wahlen (1999) claim, ''Earnings management occurs when managers use judgment in financial reporting, and in structuring transactions to alter financial reports to either mislead some stakeholders about the underlying economic performance of the company or to influence contractual outcomes that depend on reported accounting practices.'' According to this definition, while CEOs may manage earnings for opportunistic reasons, they may also manage earnings for better contractual outcomes. This suggests that there are situations where earnings management is not due to managers' opportunistic behavior. For example, Dechow, Sloan, and Sweeney (1996) show that CEOs engage in earnings management to avoid debt covenant violation and to lower the cost of capital. Bartov, Givoly, and Hayn (2002) report that firms that meet or beat current analysts' earnings expectations (MBE) enjoy a higher return over the quarter than those that fail to meet expectations, even when meeting or beating analysts' earnings expectations is likely to have been achieved through earnings management.

This positive association between MBE by engaging in earnings management and future performance is consistent with the signaling explanation that only managers confident in superior future performance will engage in costly earnings management. Similarly, Graham, Harvey, and Rajgopal (2005) document that a majority of executives in their survey believe that meeting benchmarks builds credibility with the capital market.

In addition, Shivakumar (2000) argues that earnings management before equity offerings is not intended to mislead investors, but is instead the issuers' rational response to anticipated market behavior at offering announcements. That is, since issuers cannot credibly signal the absence of earnings management, investors treat all firms announcing an offering as having overstated prior earnings, and consequently discount their stock prices.

In contrast, other stream of studies documents the negative consequences of earnings management. Rangan (1998) finds evidence that earnings management activities around seasoned equity offerings (SEOs), as measured by discretionary accruals, are associated with subsequent poor operating and stock performance. Similarly, Teoh, Welch, and Wong (1998) find that initial public offerings (IPOs) that are associated with earnings management experience subsequent declines in stock performance. Bhojraj, Hribar, Picconi, and McInnis (2009) find that firms that beat analyst forecasts using REM and AEM subsequently have worse operating performance and stock market performance than firms that miss analyst forecasts without earnings management.

It is less arguable, however, that REM is costlier than AEM, at least in the long-term. AEM does not involve altering operations and does not have a first-order effect on cash flows. In contrast, REM implies by definition the deviation from optimal operating decisions, imposing a “real” cost and resulting in direct cash flow consequences. Graham et al. (2005) report that the most preferred REM method is through the reduction of expenditure on R&D, advertising, and maintenance, likely reducing firm value. Despite the potentially greater long-term costs of REM, CEOs may engage in REM to avoid the regulatory scrutiny and personal penalties associated with AEM (Cohen et al. 2008; Kothari et al. 2016). Consistent with the negative consequences of REM, Cohen and Zarowin (2010) and Kothari et al. (2016) find that both AEM and REM are associated with a decline in post-SEO operating performance, although the negative association is stronger for REM. Kim and Sohn (2011) find that their proxy for the cost of capital is positively associated with AEM and REM, but that the positive association is stronger for REM than for AEM. Badertscher (2011) finds that during the period of overvaluation, CEOs engage in AEM in the early stages of overvaluation before moving to REM in order to sustain their overvalued equity. He interprets this finding as firms choosing to engage in more costly forms of earnings management (i.e. REM) as a last resort, and only when firms are restricted in their ability to engage in further AEM. Bereskin, Hsu, and Rotenberg (2017) investigate more direct consequences of REM, and show that R&D cuts related to earnings management are associated with fewer patents, less influential output, and lower innovative efficiency.

2.2.3. Hypotheses Development

The discussion thus far suggests that the CEOs' risk-taking incentives arising from equity compensation has a positive impact on earnings management. Moreover, REM is more likely to be perceived by boards as value-reducing than AEM. However, this argument alone is not enough to predict that boards would take corrective action in response to earnings management. Crocker and Slemrod (2007) theoretically show that encouraging productive effort and simultaneously eliminating the incentives to manipulate earnings is impossible. This implies that some earnings management is to be expected, even optimal. In this case, boards would not take corrective actions in response to prior earnings management. However, it is possible that executives manage earnings more than is expected by the board because of changes in economic environments and unforeseen factors when the executive's compensation contract was being deliberated. In that situation, boards have the incentive to alter their CEO's compensation contract. In addition, Core and Guay (1999) argue that the executives' stock and options holdings can deviate from the optimal level over time (Core and Guay 1999). This deviation of equity incentives from the optimal level can also lead to excessive earnings management. If earnings management activities are viewed as value-reducing by the board of directors, CEO compensation will be adjusted to limit earnings management, especially REM. Thus, my first hypothesis is a joint test of the consequences of earnings management activities on firm value perceived by the board and whether boards proactively alter executive compensation to limit earnings management. My first hypothesis is as follows:

H1: Firms will reduce CEO's risk-taking incentives by lowering risk-taking incentives arising from new equity grants in response to prior earnings management.

Since REM is likely to be costlier than AEM, as discussed in Section 2.2.2, firms' responses to REM are likely to be stronger than to AEM. Thus, my second hypothesis is as follows:

H2: Firms will reduce CEO's risk-taking incentives of new equity grants more aggressively in response to prior REM than AEM.

The hypotheses above investigate whether CEO compensation contracts function as a type of corporate governance mechanism that can be affected by the strength of external monitoring. Hartzell and Starks (2003) find that institutional investors serve a monitoring role in mitigating the agency problem between shareholders and managers by influencing executive compensation. In addition, the presence of institutional investors constrains real earnings management (Bushee 1998; Roychowdhury 2006; Zang 2012). Thus, my third hypothesis is as follows:

H3: The reduction in risk-taking incentives from new equity grants in response to prior earnings management will be higher for firms with higher institutional ownership.

2.3. Data and Variable Measurement

2.3.1. Sample

I obtain executive compensation data from Standard & Poor's (S&P's) Execucomp Database, financial statement data from S&P's Compustat Fundamental Annual Database, stock market-related data from the Center for Research in Security Prices (CRSP) Database, and institutional ownership data from Thomson Reuters Institutional (13f) Holdings Database. Following prior literature, I exclude financial (SIC codes between 6000 and 6999) and utilities firms (SIC codes between 4400 and 5000) because of their different regulatory environment. My sample covers the period 1995 to 2015.[6] My main sample consists of 10,727 CEO-years (1,168 unique firms).

2.3.2. CEO Incentive Measures

I measure CEO incentives using total cash compensation, the sensitivity of the CEO's wealth to changes in equity price (portfolio delta), and the sensitivity of the CEO's wealth to changes in firm risk (portfolio equity sensitivity). In particular, I use portfolio equity sensitivity as a proxy for my risk-taking measure (Anderson and Core 2017). The most widely used risk-taking incentive in the literature, portfolio vega (e.g., Guay 1999; Coles, Daniel, and Naveen 2006; Hayes, Lemmon, and Qiu 2012), does not capture the risk-taking incentives arising from stock holdings. As discussed in Section 2.1, however, because of limited liability, a unit of stock in a levered-firm can be viewed as a call option on firm value with an exercise price equal to the face value of debt. Acknowledging this shortcoming of vega, Anderson and Core (2017) derive and calculate a measure of total equity sensitivity to firm volatility that considers the manager's stock holdings as well as option holdings. I employ Anderson and Core's (2017) equity sensitivity measure, instead of portfolio vega, as a proxy for risk-taking incentives.[7] Further, prior studies investigating the impact of vega argue that it is important to control for delta to isolate the effect of vega on risk-taking (Armstrong and Vashishtha 2012; Armstrong et al. 2013). Thus, in my first

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[6] My measure of risk-taking incentives – equity sensitivity (Anderson and Core 2017) – requires information on number of firm options outstanding (*optosey*), which is available beginning in 1995 in Compustat.

[7] I thank Joshua Anderson and John Core for kindly proving me with their measures and program.

stage analysis where I investigate the impact of executives' incentives on earnings management, I control for delta (incentives to increase stock price) along with cash compensation. Following Core and Guay (2002), I calculate a CEO's portfolio delta as the dollar change in the CEO's equity portfolio for a 1% change in stock price. Additionally, following Anderson and Core (2017), I calculate a CEO's portfolio equity sensitivity as the dollar change in the CEO's equity portfolio for a 1% change in firm volatility.

2.3.3. Real Earnings Management (REM) Measure

To capture REM, I focus on opportunistic reductions in discretionary expenses. Graham et al. (2005) report that the reduction of discretionary expenses such as R&D, advertising, and maintenance is the preferred method for managing earnings by executives. In addition, while other types of real earnings management activities such as aggressive price discounts and overproduction have negative effects on profit margin and cash flow from operations, the reduction of discretionary expenses has positive effects on profit margin and operating cash flow (Roychowdhury 2006). Bushee (1998) terms the reduction of R&D expenditure, which is one of my inputs to discretionary expenses along with SG&A and advertising expenses, to meet earnings benchmarks as "myopic". Consistent with this idea, Bereskin, Hsu, and Rotenberg (2017) find that R&D cuts related to earnings management are negatively associated with future innovation related outputs, which in turn have adverse effects on firms' long-term profitability. Therefore, I expect that the firms' responses to REM using discretionary expenses would be most dramatic compared to other types of REM such as price discounts and overproduction, and focus on this type of REM in my study.

To measure the normal level of discretionary expenses, I use the Roychowdhury's (2006) model, which includes sales as an explanatory variable. The model for discretionary expenses is:

$$\frac{DiscExp_{it}}{Assets_{it-1}} = \alpha_0 + \alpha_1 \frac{1}{Assets_{it-1}} + \beta \frac{Sales_{it}}{Assets_{it-1}} + Firm\ Fixed\ Effects + Year\ Fixed\ Effects + u_{it}, \quad (2.1)$$

where *DiscExp* is the sum of R&D, SG&A, and advertising expenses. The residual (u_{it}) from Eq. (2.1) captures the deviation of discretionary expenses from normal operation. I multiply the residual by negative one so that higher values indicate greater extent of REM. Kothari et al. (2016) point out that models ignoring fixed effects suffer from model misspecification. That is, firms' real operating processes may not be well described by sales and size. Thus, such firms could be habitually misclassified as having unusually high or low discretionary expenses due to, for example, their growth strategies. This problem can persist even with industry and year fixed effects because firms can often deviate from industry-year norms to differentiate themselves (Owens, Wu, and Zimmerman 2013). Including firm fixed effects mitigates this issue by allowing the residual to reflect how far the firm's expenses deviated from the firm's own average. In addition, following Kothari et al. (2016), I allow data from years beyond year *t* to be included in the estimation of REM. This technique takes advantage of the full time-series data for each firm for more accurate estimations and addresses the possibility that there may not be enough data as of year *t* to detect REM. The model is estimated with a pooled regression.

2.3.4. Accruals-based Earnings Management (AEM) Measure

My measure for AEM is based on a modified Jones model augmented for net income following Kothari et al. (2016). The model for total accruals is:

$$\frac{TA_{it}}{Assets_{it-1}} = \alpha_0 + \alpha_1\left(\frac{1}{Assets_{it-1}}\right) + \alpha_2\left(\frac{TA_{it-1}}{Assets_{it-1}}\right) + \beta_1\left(\frac{\Delta REV_{it} - \Delta AR_{it}}{Assets_{it-1}}\right) + \beta_2\frac{PPE_{it}}{Assets_{it-1}} + \beta_3\frac{NI_{it}}{Assets_{it-1}} + Firm\ Fixed\ Effects + Year\ Fixed\ Effects + v_{it}, \tag{2.2}$$

where *TA* is total accruals, which is defined as income before extraordinary items minus cash flow from operations; *ΔAR* is the change in accounts receivable; *ΔREV* is the change in revenues; and *PPE* is net property, plant, and equipment. The residual (v) from Eq. (2.2) is the measure for AEM: discretionary accruals (*DACC*). Unlike the modified Jones model (Kothari, Leone, and Wasley 2005), the above model includes firm and year fixed effects as in the REM model (Eq. (2.1)) to address the model misspecification issue. In addition, as described in the estimation of REM, I allow data from years beyond year *t* to be included. The model is estimated with a pooled regression.

2.4. Research Design

2.4.1. 1st Stage Analysis: The Impact of CEO Equity Incentives on Earnings Management

To better understand how the boards would adjust CEOs' risk-taking incentives in response to prior earnings management, it is necessary to first examine the effect of CEO risk-taking incentives on earning management activities. Armstrong et al. (2013) find that portfolio vega is positively associated with financial misreporting, but do not consider its effects on REM. Thus, in my 1st stage analysis, I re-examine the relationships between CEOs' risk-taking incentives and both AEM and REM. I estimate regressions that take the following form:

$$DACC_{it}\ (or\ REM_{it}) = \alpha + \beta_1\ CashComp_{it-1} + \beta_2\ Delta_{it-1} + \beta_3\ EquitySens_{it-1} + \gamma\ Controls_{it-1} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + \varepsilon_{it}, \quad (2.3a)$$

where the dependent variable is either *DACC* or *REM*. *Controls* is a vector of control variables. Following prior literature, I control for firm size (*MVE*), growth opportunities (*BM*), financial leverage (*Leverage*), firm age (*FirmAge*), R&D expenditures (*R&D*), investment expenditures (*Investment*), past accounting performance (*ROA*), past stock performance (*Annret*), the volatility of cash flows (σ*CFO*), and the volatility of sales (σ*Sales*).[8] All independent variables are lagged by one year to reduce simultaneity and endogeneity concerns. Further, I include the firm fixed effects to control for the unobserved time-invariant firm characteristics to mitigate the endogeneity issue. Year fixed effects are

[8] See Appendix A for variable definitions.

included to capture the impact of economic conditions as well as other potential year differences in incentives. My inferences are based on firm-level clustered standard errors.

One might argue that CEO compensation is endogenously determined and that the boards already have designed optimal compensation contracts in anticipation of some levels of earnings management. If this is the case, the observed levels of earnings management are already optimal, and equity incentives and earnings management are endogenously determined. However, Core and Guay (1999) argue that the optimal incentive levels can shift over time due to the changes in the economic determinants of CEO compensation. Thus, I additionally investigate how the deviations of delta and equity sensitivity from their optimal levels are associated with earnings management. Using the determinants of delta and equity sensitivity based on prior literature (e.g., Core and Guay 1999), I estimate the predicted and excess levels of delta and equity sensitivity.[9] Then I replace the raw levels of delta and equity sensitivity with excess delta and excess equity sensitivity. The regression takes the following form:

$$DACC_{it}\ (or\ REM_{it}) = \alpha + \beta_1\ LnCashComp_{it-1} + \beta_2\ LnExcessDelta_{it-1} + \beta_3\ LnExcessEquitySens_{it-1} + \gamma\ Controls_{it-1} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + \varepsilon_{it} \quad (2.3b)$$

[9] See Appendix B for optimal delta and equity sensitivity to volatility models.

2.4.2. 2nd Stage Analysis: The Impact of Earnings Management on Annual Grants of CEO Equity Incentives

In my 2nd stage analysis, I examine how firms grant new equity incentives to adjust the levels of portfolio delta and equity sensitivity to volatility in response to prior earnings management. I estimate regressions that take the following form:

$$LnNewDelta_{i,t}\ (or\ LnNewEquitySens_{it}) = \alpha + \beta_1\ AvgDACC_{it-1,t-3} +$$
$$\beta_2\ AvgREM_{it-1,t-3} + \gamma_1\ LnCashComp_{it-1} +$$
$$\gamma_2\ LnExcessDelta_{it-1}\ (or\ LnExcessEquitySens_{it-1}) + \delta\ Controls_{it-1} +$$
$$Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it}, \quad (2.4)$$

where *AvgDACC* (*AvgREM*) is *DACC* (*REM*) averaged over the period *t-1* to *t-3*. *ExcessDelta* and *ExcessEquitySens* are from optimal delta model and equity sensitivity model, respectively (see Appendix B). *Controls* is a vector of control variables: CEO tenure (*Tenure*), CEO age (*Age*), firm size (*MVE*), growth opportunities (*BM*), financial leverage (*Leverage*), firm age (*FirmAge*), R&D expenditures (*R&D*), investment expenditures (*Investment*), past accounting performance (*ROA*), past stock performance (*Return*), the volatility of cash flows (σ*CFO*), and the volatility of sales (σ*Sales*). All independent variables are lagged by one year. I include the year and firm fixed effects. My inferences are based on firm-level clustered standard errors.

Regarding the regression model choice, I use Tobit regression model for Eq. (2.4) instead of OLS regression model. That is because the value of a new equity grant is left-censored at zero. Firms grant new equity incentives when the net benefits of a grant are greater than zero, and firms do not always grant new equity incentives each year. Unablated descriptive statistics shows that 83% of CEO-year observations grant either stock options or restricted stock, and that 69% of CEO-year observations grant stock options. Thus, running OLS regression models will lead to biased estimates for the coefficients in Eq. (2.4).

2.4.3. 2nd Stage Analysis: The Role of Institutional Investors

To investigate how institutional investors affects the relationship between prior earnings management and the adjustment of risk-taking incentives, I interact high institutional investor dummy (*H_InstInvestor*) with *AvgDACC* and *AvgREM* in Eq. (2.4), where *H_InstInvestor* is a dummy variable equal to one if the percentage of institutional investor holdings in the firm is higher than the median of institutional investor holdings by fiscal year, and zero otherwise. I include industry and year fixed effects. The regression models take the following form:

$$LnNewDelta_{i,t}\ (or\ LnNewEquitySens_{it}) = \alpha + \beta_1\ AvgDACC_{it-1,t-3} * H\_InstInvest\_dum_{it-1} + \beta_2\ AvgREM_{it-1,t-3} * H\_InstInvest\_dum_{it-1} + \beta_3\ AvgDACC_{it-1,t-3} + \beta_4\ AvgREM_{it-1,t-3} + \beta_5\ H\_InstInvest\_dum_{it-1} + \gamma_1\ LnCashComp_{it-1} + \gamma_2\ LnExcessDelta_{it-1}(or\ LnExcessEquitySens_{i,t-1}) + \boldsymbol{\delta}\ Controls_{it-1} + Year\ Fixed\ Effects + Industry\ Fixed\ Effects + u_{it} \qquad (2.5)$$

2.5. Results

2.5.1. Descriptive Statistics

Table 2-1 presents descriptive statistics for my sample. Panel A reports descriptive statistics for CEO equity incentive measures[10] and shows that the value of the median total cash compensation is $1,427,940. The median CEO portfolio delta is $227,559 and the median CEO portfolio equity sensitivity is $38,547. That is, the CEO wealth changes by $227,559 for a 1% change in stock price and the wealth by $38,547 for a 1% change in firm volatility for a median CEO. The value of median delta for new equity grants is $20,863 and the value of median equity sensitivity for new equity grants is $5,337. These numbers can be interpreted similarly. Panel A also shows that in 83% of the 7,584 CEO-year observations, new equity incentives are granted. This number is slightly higher than the 74% observed in Core and Guay (1999), and indicates equity compensation is more widely used than before. Panel B reports descriptive statistics for earnings management measures. The median of signed discretionary accruals is 0.7% of total assets, and the median of real earnings management is 0.9% of total assets. These numbers are significantly smaller than those reported in the prior studies that do not control for firm- and year-fixed effects but are similar in magnitude reported in Kothari et al. (2016) that controls for firm- and year-fixed effects. Panel C reports descriptive statistics for control variables.

[10] In Table 1-1, I show the numbers before log-transformation for log-transformed variables in the regression analyses (Delta, NewDelta, EquitySens, NewEquitySens, NewEquitySens, CashComp, MVE, FirmAge).

Table 2-1. Descriptive Statistics

This table presents descriptive statistics for firms in my sample. My sample is constructed from the intersection of Execucomp (compensation) and CRSP/Compustat (accounting and stock price data), and Thomson Reuters Institutional (13f) Holdings (institutional ownership) for the time period 1995 to 2015 and covers a total of 10,727 firm-years (1,168 firms). Panel A reports descriptive statistics for measures of CEO incentives. Panel B reports descriptive statistics for measures of earnings management. Panel C reports descriptive statistics for control variables. All variables are winsorized at the 1 and 99 percent levels. All CEO incentive variables and earnings management variables are measured at year t and all firm characteristics variables are measured at year t-1. All variables are as defined in Appendix A.

Panel A: CEO incentive variables

Variable	*Mean*	*Std Dev*	*25th*	*Median*	*75th*
Delta (in thousands)	545.5	919.8	91.7	227.6	586.2
NewDelta (in thousands)	45.4	68.4	4.9	20.9	55.1
EquitySens (in thousands)	75.2	101.5	14.4	38.5	90.7
NewEquitySens (in thousands)	12.9	19.9	0.0	5.3	16.6
CashComp (in thousands)	1,842.1	1,405.6	877.2	1,427.9	2,358.9
Opt Grant # / CSHO	0.16%	0.23%	0.00%	0.08%	0.21%
Stk Grant # / CSHO	0.04%	0.09%	0.00%	0.00%	0.04%

Panel B: Earnings management variables

Variable	*Mean*	*Std Dev*	*25th*	*Median*	*75th*
DACC	0.003	0.054	-0.025	0.007	0.034
REM	0.019	0.093	-0.030	0.009	0.058

Panel C: Control variables

Variable	*Mean*	*Std Dev*	*25th*	*Median*	*75th*
MVE (in millions)	7,753.4	18,119.7	732.4	1,914.9	5,857.7
BTM	0.48	0.36	0.25	0.40	0.62
Lev	0.51	0.21	0.37	0.51	0.64
FirmAge	31.48	16.61	17.00	28.00	47.00
R&D	0.03	0.05	0.00	0.01	0.05
Investment	0.07	0.06	0.03	0.05	0.09
ROA	0.05	0.09	0.02	0.06	0.09
Annret	0.14	0.44	-0.13	0.10	0.34
σ(Sale)	0.27	0.20	0.13	0.21	0.32
σ(CFO)	0.05	0.03	0.03	0.04	0.06
CEOTenure	7.89	6.53	3.00	6.00	10.00
CEOAge	55.88	6.81	51.00	56.00	60.00
CF Shortfall	-0.17	0.11	-0.23	-0.17	-0.11
σRet	0.12	0.05	0.08	0.10	0.14
σ(Idio Risk)	0.02	0.01	0.01	0.02	0.03
Free CF prob	0.00	0.02	0.00	0.00	0.00
Instown	0.76	0.17	0.65	0.77	0.87

2.5.2. 1st Stage Analysis: The Impact of CEO Equity Incentives on Earnings Management

Table 2-2 presents the results of the OLS regression models that examine the effects of CEO equity incentives on AEM and REM, measured by *DACC* and *REM*, respectively. *LnDelta* and *LnEquitySens* are used as CEO equity incentive measures in Columns (1) and (2). All earnings management measures are measured in year *t* and all independent variables are measured in year *t-1* to reduce simultaneity and endogeneity concerns. I acknowledge that if the dependent variables and independent variables are sticky over time, the observed relationship is likely to reflect a mere association rather than a causal relationship. If this is the case, the sign of the relationship between equity incentives and earnings management should not change in the second stage analysis where I examine the impact of earnings management on new equity incentives. However, I find that the direction of the relationship changes from the first stage analysis to the second stage analysis. For example, *LnEquitySens* and *REM* in the first stage are positively associated (Table 2-2) whereas *AvgREM* and *LnNewEquitySens* are negatively associated (Table 2-3). Thus, I am less worried that my results simply reflect the mere association between earnings management activities and CEO equity incentives. In addition, I include firm-fixed effects in all my regression models. This regression model specification examines within-firm variation and mitigates the concern that the observed association is affected by time-invariant unobservable variables.

Table 2-2. The Effects of CEO Equity Incentives on Earnings Management: 1st Stage Analysis

This table presents results from OLS regressions that estimate the effects of CEO equity incentives on AEM and REM, measured by *DACC* and *REM*, respectively. Columns (1) and (2) use *LnDelta* and *LnEquitySens* as CEO equity incentive measures and Columns (3) and (4) use *LnExcessDelta* and *LnExcessEquitySens* estimated in Appendix B as CEO equity incentive measures. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix A. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses. Sample includes a total of 10,727 firm-years (1,168 firms) from 1995 to 2015.

	(1) *DACC*	(2) *REM*	(3) *DACC*	(4) *REM*
LnCashComp	0.00402**	0.00637***	0.00428**	0.00562**
LnDelta	-0.000870	-0.00738***		
LnEquitySens	0.00197**	0.00389**		
LnExcessDelta			-0.000300	-0.00691***
LnExcessEquitySens			0.00157*	0.00371**
LnMVE	-0.00382*	0.0292***	-0.00391*	0.0249***
BTM	-0.0139***	0.0268***	-0.0138***	0.0292***
Leverage	0.0213**	0.0461***	0.0228**	0.0493***
LnFirmAge	0.0104	-0.0233	0.0105	-0.0234
R&D	-0.138**	-1.653***	-0.142**	-1.656***
Investment	0.0124	-0.0414	0.0126	-0.0431
ROA	-0.114***	-0.0217	-0.114***	-0.0213
Annret	0.00238	-0.0193***	0.00215	-0.0203***
Sale	-0.00577	0.0639***	-0.00583	0.0635***
CFO	-0.00943	-0.359***	-0.0104	-0.356***
Intercept	-0.0593*	-0.139**	-0.0608**	-0.126**
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	10,727	10,727	10,727	10,727
adj. R-sq	0.173	0.576	0.173	0.576

I show that *LnDelta* and *DACC* is insignificantly associated (*LnDelta* coef -0.000870, *t-stat* -0.77). This is consistent with Armstrong et al. (2013), who argue that delta captures the two countervailing incentive effects, “reward” and “risk” effects, thus the relation between delta and AEM remains ambiguous. In contrast to the relationship between *LnDelta* and *DACC*, I find that *LnDelta* is negatively associated with *REM* (*LnDelta* coef -0.00738, *t-stat* -4.00). This result may suggest that, on average, the cost of the expected increase in risk associated with engaging in REM outweighs the expected rewards, thus deterring REM. With regard to the effect of CEO equity sensitivity to volatility (i.e., risk-taking incentives) on AEM and REM, I find that *LnEquitySens* is positively associated with both *AEM* and *REM* (*LnEquitySens* coefs 0.00197 and 0.00389, *t-stat*s 2.22 and 2.58, respectively). This is consistent with the idea that the risk-taking incentives unambiguously create incentives to manage earnings. In terms of economic significance, an interquartile increase in *LnEquitySens* is associated with a 0.0035 increase in *DACC* (or a 0.065 unit increase of its standard deviation) and is associated with a 0.0069 increase in *REM* (or a 0.074 unit increase of its standard deviation).

In Columns (3) and (4), I replace my test variables, *LnDelta* and *LnEquitySens*, with *LnExcessDelta* and *LnExcessEquitySens*.[11] This analysis is to reduce the concern that equity incentives and earnings management are simultaneously determined and thus that the earnings management is already considered at the time of compensation contract. If this is the case, firms need not alter CEO equity compensation in response to earnings management since the observed level of earnings management is already factored into compensation contract. One might ask, why would firms allow any level of earnings management? That is encouraging productive effort and simultaneously eliminating incentive to manipulate earnings on which is pay is based can be too costly (Crocker and Slemrod 2007). However, CEOs' holdings of equity incentives can become misaligned

[11] See Appendix B for the estimation of *LnExcessDelta* and *LnExcessEquitySens*.

with optimal levels due to the shift in the economic determinants of equity incentives or the unloading of the CEO equity portfolio. If the deviations of equity incentives from their optimal levels induce higher earnings management, some portion of earnings management is sub-optimal, creating firms' incentives to alter equity incentives to reduce earnings management. *LnExcessDelta* and *LnExcessEquitySens* capture the deviations from their optimal levels. I find similar results to those for Columns (1) and (2) (*LnExcessDelta* coef 0.00157, *t-stat*s 1.74; *LnExcessEquitySens* coef 0.00371, *t-stat*s 2.46).

2.5.3. 2nd Stage Analysis: The Impact of Earnings Management on Annual Grants of CEO Equity Incentives

In the second stage analysis, I reverse the direction of the relationship between earnings management and equity incentives in the first stage and examine how firms adjust equity incentives with new equity grants in response to prior earnings management (Table 2-3). In the first stage analysis, I show that CEO risk-taking incentives are unambiguously and positively associated with both AEM and REM. Thus, I hypothesize that firms will reduce CEO's risk-taking incentives by lowering risk-taking incentives arising from new equity grants in response to prior earnings management (*H1*). I measure the levels of prior AEM and REM by taking the prior three-year averages of *DACC* and *REM*, respectively, from *t-1* to *t-3* to increase the power of these test variables. The predicted signs of the coefficients of these variables, *AvgDACC* and *AvgREM*, are both negative. The coefficients of *AvgDACC* and *AvgREM* are -0.119 and -0.496, respectively. However, only the coefficient of *AvgREM* is statistically significant. This result supports my second hypothesis that firms will reduce CEO's risk-taking incentives of new equity grants more aggressively in response to prior REM than to AEM. This is because, unlike AEM, REM imposes a "real" cost and resulting in direct cash flow consequences. In terms of economic significance, a quartile increase in *AvgREM* is associated with a 0.169 decrease in *LnNewEquitySens* (or a 2.14 unit decrease of its standard deviation).

2.5.4. 2nd Stage Analysis: # analysis

To address the concern that the negative relationship between prior earnings management and risk-taking incentives from new equity grants, I replace *LnNewDelta* (Column (1) in Table 2-3) and *LnNewEquitySens* (Column (2) in Table 2-3) with the natural logarithm of the number of new restricted stock grant (Column (1) in Table 2-4) and the natural logarithm of the number of new stock option grant (Column (2) in Table 2-4), respectively. Consistent with prior studies, the natural logarithm of the number of new stock option grant captures the CEO's risk-taking incentives. Similarly, the dependent variables of Columns (3) and (4) are the percentage of the percentage of the number of new restricted stock grant over the firm's total shares outstanding and the number of new stock option grant over the firm's total shares outstanding. Similar to the results from Table 2-3, I show that *AvgREM* is negatively associated with both *LnOPTS_GRNT* (#) in Column (2) and *OPTSGRNT* (%) in Column (4). This result also supports my conjecture that firms reduce risk-taking incentives from new equity grants when they observe high levels of REM.

Table 2-3. The Impact of Earnings Management on Annual CEO Equity Incentive Grants: 2nd Stage

This table presents results from Tobit regression models that estimate the impact of earnings management activities on annual CEO equity incentive grants. All dependent and control are measured in year *t* and earnings management measures (*DACC* and *REM*) and incentive residual measures (*ExcessDelta* and *ExcessEquitySens*) are measured in year *t-1*. All variables are as defined in Appendix A. All columns include firm and year fixed effects. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. Sample includes a total of 10,727 firm-years (1,168 firms) from 1995 to 2015.

	(1)	(2)
	LnNewDelta	*LnNewEquitySens*
AvgDACC	1.035**	-0.119
AvgREM	-0.453**	-0.496**
LnCashComp	0.0473	-0.0273
LnExcessDelta	0.00979	
LnExcessEquitySens		0.190***
LnCEOTenure	-0.104***	-0.0713***
LnCEOAge	-1.209***	-1.206***
LnMVE	0.613***	0.555***
BTM	-0.0179	0.00299
Leverage	-0.0266	0.128
R&D	1.546*	-0.295
Investment	-0.552	-0.271
CF Shortfall	-1.101***	-0.671***
ROA	-0.369	`
Annret	0.301***	-0.0403
σRet	0.542	4.004***
Intercept	1.328***	1.175***
Firm Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
N	10727	10727
Pseudo R-sq	0.186	0.216

Table 2-4. The Impact of Earnings Management on the Number of Annual CEO Stock Grants (or Option Grants) (2nd Stage; # Analysis)

This table presents results from Tobit regression models that estimate the impact of earnings management activities on annual CEO equity grants. Columns (1) and (2) use the natural logarithm of the number of stock grants and the natural logarithm of options grants as a dependent variable, respectively. Columns (3) and (4) use the percentage of the number of stock grants over common shares outstanding and the percentage of the number of option grants over common shares outstanding as a dependent variable, respectively. All dependent and control are measured in year *t* and earnings management measures (*DACC* and *REM*) and incentive residual measures (*ExcessDelta* and *ExcessEquitySens*) are measured in year *t-1*. All variables are as defined in Appendix A. All columns include firm and year fixed effects. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. Sample includes a total of 10,727 firm-years (1,168 firms) from 1993 to 2015.

	(1) LnRSTK_GRNT (#)	(2) LnOPTS_GRNT (#)	(3) RSTK (%)	(4) OPTSGRNT (%)
AvgDACC	2.900***	-2.253***	0.000472	-0.000112
AvgREM	1.032*	-0.709*	0.000302	-0.000735*
LnCashComp	0.212**	-0.138*	0.0000959**	-0.0000278
LnExcessDelta	-0.330***	-0.114**	-0.0000439	-0.000148***
LnExcessEquitySens	0.155***	0.344***	0.0000257	0.000210***
LnCEOTenure	-0.366***	-0.127***	-0.000180***	-0.000215***
LnCEOAge	-0.372	-2.457***	0.0000236	-0.00186***
LnMVE	-0.565***	0.498***	-0.000433***	-0.000218***
BTM	-0.0113	0.387***	-0.000199***	0.000171
Leverage	2.048	0.841	0.000267	-0.000873
R&D	-1.492*	-0.320	-0.000568	-0.000615
Investment	-1.319**	-0.511	-0.000664***	-0.000276
CF Shortfall	0.212	-1.148***	-0.0000631	-0.00111**
ROA	0.434***	0.0590	0.000256***	0.000432***
Annret	-9.875***	4.750***	-0.00310***	0.00374***
σ*Ret*	0.244	-0.0810	-0.0000469	0.000143
Intercept	2.555***	2.331***	0.00110***	0.00230***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	10,727	10,727	10,727	10,727
Pseudo R-sq	0.195	0.164	-0.146	-0.095

2.5.5. 2nd Stage Analysis: The Role of Institutional Investors

In Table 2-5, I examine how institutional investor monitoring, as proxied by the percentage of institutional ownership, affects the relationship between prior earnings management and the adjustment of risk-taking incentives. I interact *AvgDACC* and *AvgREM* with *H_InstInvestor*, where *H_InstInvestor* is a dummy variable equal to one if the percentage of institutional investor holdings in the firm is higher than the median of institutional investor holdings by fiscal year, and zero otherwise. The results indicate that firms with higher institutional holdings, on average, grant more annual equity incentives in terms of delta (*H_InstInvestor* coef 0.290, *t-stat* 8.28) and in terms of equity sensitivity (*H_InstInvestor* coef 0.183, *t-stat* 5.59). Interestingly, however, I find that the negative relationship between *AvgREM* and *NewEquitySens* in Table 2-3 (*AvgREM* coef -0.496, *t-stat* -2.38) remains significant only among firms with higher institutional ownership (*AvgREM * H_InstInvestor* coef -0.825, *t-stat* -2.08), but not among firms with lower institutional ownership (*AvgREM* coef -0.386, *t-stat* -1.35). That is, the result in my primary analysis (Table 2-3) appears to be driven by firms with higher institutional holdings. In addition, the insignificant relationship between *AvgDACC* and *NewEquitySens* shown in Table 2-3 (*AvgDACC* coef -0.119, *t-stat* -0.29) becomes significant among firms with higher institutional ownership (*AvgDACC* coef -2.870, *t-stat* -3.51). Collectively, the result suggests that firms with higher institutional ownership tend to grant more equity incentives than firms with lower institutional ownership, and that institutional investors actively monitor CEOs' opportunistic behavior and re-incentivize equity incentives if such behavior is observed. This result is consistent with the idea large institutional investors have the resources and ability to monitor, discipline, and influence managers, reducing managers' opportunistic behavior.

Table 2-5. The Impact of Institutional Investors on the Relationship between Earnings management and Equity Incentive Adjustment

This table presents results from Tobit regression models that estimate the impact of earnings management activities on annual CEO equity grants. All dependent and control are measured in year *t* and earnings management measures (*DACC* and *REM*) and incentive residual measures (*ExcessDelta* and *ExcessEquitySens*) are measured in year *t-1*. All variables are as defined in Appendix A. All columns include firm and year fixed effects. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. Sample covers the period 1995 to 2015.

	(1) NewDelta	(2) NewEquitySens
*AvgDACC * H_InstInvestor*	-2.076**	-2.870***
*AvgREM * H_InstInvestor*	0.0420	-0.825**
AvgDACC	1.702***	1.401**
AvgREM	-0.135	-0.386
H_InstInvestor	0.290***	0.183***
LnCashComp	0.219***	0.124***
LnExcessDelta	0.0259	
LnExcessEquitySens		0.186***
LnCEOTenure	-0.0726***	-0.0933***
LnCEOAge	-1.019***	-0.681***
LnMVE	0.508***	0.493***
BTM	-0.0869	-0.00723
Leverage	2.138***	1.274***
R&D	-0.969***	-1.070***
Investment	-0.658***	-0.250
CF Shortfall	-0.840***	-0.359
ROA	0.310***	-0.0270
Annret	-0.134	2.920***
σ*Ret*	0.0636	0.373***
Intercept	1.001	-2.330
Firm Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
N	9950	9950
Pseudo R-sq	0.082	0.086

2.6. Conclusions

In this chapter, I investigate how prior AEM and REM, which are likely to be value-reducing, affect new equity grants. I show that the risk-taking incentives from new equity grants are lower for firms with higher prior REM, but not for firms with higher AEM. In addition, I show that the negative relation between REM and risk-taking incentives from new equity grants are driven by firms with higher institutional ownership, suggesting that institutional investors play an important role in structuring executive compensation contracts to restrain costly REM. The results are consistent with firms altering compensation contracts to restrain managers' value-reducing behavior.

My findings make three primary contributions in the compensation, corporate governance, and earnings management literature. First, they shed light on another internal governance mechanism that limits CEOs' earnings management activities – altering CEO equity incentives. I show that boards limit CEOs' value-reducing activities by proactively re-incentivizing equity incentives. Second, my results imply that the costs of REM perceived by the board are more severe than those of AEM. Lastly, I provide indirect evidence that institutional investors play an important monitoring role by affecting CEO compensation contract.

CHAPTER 3
ASYMMETRIC RISK AND CEO COMPENSATION

3.1. Introduction

To mitigate agency problems, a significant portion of CEO compensation is normally tied to the firm's uncertain future outcome. Prior research suggests that the CEO pay-setting process is a negotiation between the board and the CEO (Hermalin and Weisbach 1998; Bebchuk, Fried, and Walker 2002), which suggests that CEOs influence both the amount and structure of the compensation package. Since a risk-averse CEO demands a risk premium for bearing risk associated with such compensation, firms offer compensation contingent on firm's performance only if the benefit (e.g., minimizing CEO's rent seeking behavior, inducing optimal incentive and risk-taking, etc.) is greater than the cost (i.e., risk premium). The benefit and cost of contingent compensation depends on the firm's investment opportunities and the firm's risk environment (Guay 1999; Del Viva, Kasanen, and Trigeorgis 2017). Therefore, firm risk is an important determinant of CEO compensation. Prior studies focus the relation between *symmetric* risk and CEO compensation (e.g., Aggarwal and Samwick 1999; Guay 1999; Jin 2002). In this chapter, I examine the impact of *asymmetric* risk on CEO compensation. Specifically, I investigate the differential impact of downside risk versus upside potential on compensation structure, i.e., the choice between cash and equity compensation and the choice between stock options and restricted stock.

Traditional option pricing models, e.g., Black-Scholes (1973), use symmetric volatility as an input. Similarly, the vast majority of prior studies examine the relation between *symmetric* risk and CEO compensation (e.g., Guay 1999; Jin 2002).[12] The key findings of these studies suggest that the CEO's valuation of stock options differs from the valuation of risk-neutral shareholders because of the CEO's risk-aversion and lack of diversification (e.g., Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002; Jin 2002; Tian 2004). An important aspect of a stock option is that its payoff is piece-wise linear to its underlying stock price (i.e., asymmetric payoff). Consistent with this idea, Hall (1998) documents that CEOs view at-the-money or out-of-the-money options as near worthless, confirming that there exists a wedge between the Black-Scholes option pricing model and CEOs' valuation of stock options.

When downside risk increases, a CEO requires a higher risk premium for equity compensation. Thus, as downside risk increases, granting equity incentives will be more costly. Consequently, the board could shift compensation away from equity compensation to cash compensation. Researchers suggest, e.g., Lambert and Larcker (2004) and Dittman, Yu, and Zhang (2017), that the optimal contract protects the CEO from losses for bad outcomes. Thus, I predict that, as downside risk increases, the observed compensation contract will contain more cash and less equity compensation.

With regard to the choice between restricted stock and options, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases as downside risk increases. In contrast, restricted stock has value as long as the stock price is positive (i.e., positive intrinsic value). Thus, I predict a risk-averse CEO will increase his or her

[12] One exception is Gormely, Matsa, and Milbourn (2013). They investigate the impact of increased legal liability as a proxy for downside risk on CEO equity incentives.

preference for restricted stock to stock options as downside risk increases since restricted stock offers some downside protection. In contrast, when upside potential increases, there is no upper limit to the payoff of equity compensation (i.e., the leverage effect of equity compensation). Thus, I predict that a CEO would prefer equity compensation to cash compensation when upside potential increases. In addition, because of stock options' leverage effect (i.e., steeper slope in the in-the-money price range), a CEO will prefer stock options to restricted stock when upside potential increases. Thus, I predict that the proportion of CEO option compensation (the proportion of stock option over total equity compensation) decreases with downside risk and increases with upside potential.

This chapter is organized as follows. Section 3.2 discusses the related literature and develops my hypotheses. Section 3.3 describes data and variable measurement. Section 3.4 describes research design. My primary results are presented in Section 3.5. Section 3.6 concludes.

3.2. Related Literature and Hypotheses Development

3.2.1. Cash versus Equity Compensation

In addition to the sorting and retention of employees (e.g., Oyer and Schaefer 2005), stock and option grants are used to incentivize the CEO to maximize shareholder wealth. However, since equity compensation is risky (i.e., dependent on uncertain future outcomes), a risk-averse CEO requires a risk premium for bearing risk associated with equity compensation (Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002).

The marginal benefit and cost of equity compensation depend on the firm's risk environment as well as the CEO's risk-aversion. Prior studies argue that firms set higher levels of cash compensation for executives who are exposed to higher levels of compensation risk (Antle and Smith 1985; Lambert, Larcker, and Verrecchia 1991). Furthermore, Lambert and Larcker (2004) and Dittman, Yu, and Zhang (2017) show that the optimal contract protects the CEO from losses for bad outcomes. Consistent with this idea, I predict that a CEO would require higher risk premium for equity compensation as downside risk increases. Thus, the board is likely to shift CEO compensation away from equity compensation to cash compensation as downside risk increases. In contrast, as upside potential increase, the board need not pay as much risk premium. In addition, from the CEO's perspective, there is no upper limit for the payoff of equity compensation increases. Thus, I predict that a CEO would prefer cash compensation (equity compensation) to equity compensation (cash compensation) when downside risk (upside potential) increases. Thus, I posit my first hypothesis:

H1: As downside risk (upside potential) increases, the percentage of cash compensation will increase (decrease).

3.2.2. Stock versus Option Grants

The payoffs from stock and option grants are directly linked to the firm's stock price – a fundamental reason for granting equity incentives. However, a distinguishing feature between the two types of equity incentives is how their payoff relates to stock price. The payoff to a share of stock is linear in the firm's stock price as long as that price is greater than zero, whereas the payoff to a stock option is linear above the exercise price and zero otherwise (i.e., piecewise linear or convex payoff)[13]. Prior literature predicts and finds that option grants, but not stock grants, increase the convexity of the CEO wealth and firm performance relation and CEO's risk-taking behavior (Guay 1999).

Nonetheless, because of the complex nature of equity incentives, prior literature is mixed on the consequences of stock options and the circumstances in which either form of equity incentive is preferred over the other. For example, Guay (1999), Coles, Daniel, and Naveen (2006), and Low (2009) present evidence of a positive relation between vega and risk-taking. In contrast, Aggarwal and Samwick (1999) and Milidonis and Stathopoulos (2014) find a negative relation between firm risk and pay-performance sensitivity. In addition, studies that model the choice between stock options and restricted stock provide different predictions about the preference for stock versus option grants from the shareholders' perspective due to the different assumptions in the models, and model and parameter choices (e.g., Feltham and Wu 2001; Hall and Murphy 2002; Lambert and Larcker 2004; Dittmann and Maug 2007; Dittmann, Yu, and Zhang 2017). Feltham and Wu (2001) show stock is optimal when the agent can influence only the mean of the outcome, and options are optimal when the agent can influence both the mean and variance of the outcome. Hall and Murphy (2002) suggest granting at-the-money options maximizes incentives when grants are an add-on to existing pay packages, while stock grants are preferred when grants are accompanied by reductions in cash

[13] A share of stock is an extreme case of a stock option with exercise price of zero. Guay (1999) describes stock in a levered firm as a European call option to buy the firm with an exercise price equal to the face value of debt.

compensation. Dittmann and Maug (2007) predicts that most CEOs should not hold any stock options and, instead, receive lower base salaries and receive additional stock. They interpret their findings contradicting current practice as evidence of rent extraction. In contrast, Lambert and Larcker (2004) argue that prior studies ignore incentive effects of option-based contracts and show that stock options generally dominate stock grants in the optimal compensation contract.

The mixed results in the literature suggests that it is not clear that the incentives created by equity compensation are understood by academics, practitioners or CEOs (Hall 1998). In addition, the assumptions embedded in the Black-Scholes model are not completely applicable to employee stock options. For example, the Black-Scholes model assumes that the riskiness of the option's payoff can be perfectly hedged by continuously and costlessly revising a portfolio of call options, stock, and riskless bonds. However, a risk-averse CEO who cannot freely trade stock options and is prohibited from hedging his compensation risk, would request risk premiums for bearing risks associated with option and stock grants. This suggests that the CEO's valuation of equity compensation is different from the market valuation/cost to the firm (e.g., Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002; Jin 2002; Tian 2004). In practice, the utility function of an individual CEO is not observable, creating a wedge between theory and practice. Guay (1999) states that there is no clear method of determining the value of an employee stock option from the employee's perspective, as opposed to the firm's perspective.

In addition to the difficulty in valuing equity incentives from the perspective of CEOs, there is disagreement about the asymmetric incentive effects of stock options even to academics. That is, some researchers argue that stock options limit downside risk (e.g., Bryan, Hwang, and Lilien 2000; Ryan and Wiggins 2001). For example, Bryan et al. (2000) claim that "stock options protect risk-averse CEOs from downside risk and simultaneously provide a high upside potential". In contrast, Carter, Lynch, and Tuna (2007) argues that "If executives are more risk-averse, then we might see more restricted stock because it always provides some positive intrinsic value to the executive".

To illustrate the latter, consider the following case (see Appendix C). A CEO is granted $1,000,000 worth of either at-the-money stock options or restricted stock, but not both. Assuming a current stock price of $30, the CEO will receive 90,467 stock options or 33,333 shares of restricted stock.[14] If stock price increases by 90%[15], at maturity the final payoffs to stock options and restricted stock are $2,442,614 and $1,900,000, respectively. In contrast, if the stock price decreases by 90%, the final payoffs to the stock options and restricted stock will be $0 and $100,000, respectively. This numerical example demonstrates that stock options do not provide downside protection.

Motivated by this observation, I examine how asymmetry in risk, i.e., downside risk versus upside potential, affects the use of stock option and stock grants. To develop predictions on the differential impact of downside versus upside risk on CEO equity compensation grants, I assume that stock options are granted at-the-money, consistent

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[14] The parameters are $\sigma = 0.2$, maturity = 10 years, $r_f = 0.03$ in yearly terms.
[15] Continuously compounded yearly return of 0.64 for 10 years will generate stock return of 0.9.

with real world practices. When downside risk increases, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases. In contrast, stock grants have value as long as the stock price is positive (i.e., positive intrinsic value). Consistent with this idea, Hall (1998) documents that CEOs view at-the-money or out-of-the-money options as near worthless. Thus, I predict a risk-averse CEO prefers stock over stock options as downside risk increases.

In contrast, when upside potential increases, a CEO would want to take advantage of the leverage effect of stock options. The value of a stock option is always less than one unit of stock because of the positive exercise price of a stock option. That is, a share of stock is worth multiple stock options. Therefore, for the equivalent value, once they are in-the-money, stock options have a steeper slope than stock – the leverage effect of stock options. Thus, when upside potential is more likely, a CEO will prefer stock options to stock grants.

The above predictions are related to the CEO's preference as to the form of equity incentives when facing downside risk versus upside potential. Prior research suggests that CEOs influence their own compensation (Hermalin and Weisbach 1998; Bebchuk et al. 2002). Thus, I posit that the CEO's preference over a particular type of compensation with downside risk versus upside potential would be reflected in the actual compensation. My second hypothesis is:

H2: As downside risk (upside potential) increases, the percentage of stock options relative to stock grants will decrease (increase).

3.3. Data and Variable Measurement

3.3.1. Data

The initial sample consists of firm-year observations in the ExecuComp database during the period 1993-2015. Since I lag as my independent variables by one year in my regression models, my sample starts in 1993 even though ExecuComp began in 1992.[16] I then merge the dataset with Compustat and Center for Research in Security Prices (CRSP) datasets. I exclude financial (SIC 6000-6999) and utilities (4000-4999) firms. My initial sample consists of 1,700 unique firms, with a total of 17,570 firm-year observations (see Table 3-1). My sample is well distributed across industries and the top 5 industries in my sample are retail, electronic equipment, computer software, business services, and machinery industries which jointly represent about 34% of my sample (see Table 3-2).

Table 3-1. Sample Selection

Sample Selection Procedure	Firm-year Observations
Execucomp from 1993 to 2015	41,010
Less:	
Financial (SIC 6000 - 9000) and utilities (SIC 4000 - 4999) firms	(9,010)
Missing data for Execucomp variables	(4,454)
Missing data for Compustat variables	(7,143)
Missing data for CRSP variables	(927)
Missing data for Thomson Reuters Institutional (13f) Holdings variable	(1,906)
Total	**17,570**

[16] Execucomp data is available since 1992.

Table 3-2. Industry Distribution of the Sample

This table presents industry distribution of my sample based on the Fama and French 49 industry classification.

Industry	Nobs.	%	Industry	Nobs.	%
Agriculture	53	0.3	Automobiles and Trucks	491	2.79
Food Products	432	2.46	Aircraft	222	1.26
Candy & Soda	57	0.32	Shipbuilding, Railroad Equipment	66	0.38
Beer & Liquor	69	0.39	Defense	73	0.42
Tobacco Products	37	0.21	Precious Metals	102	0.58
Recreation	145	0.83	Mines	71	0.4
Entertainment	179	1.02	Coal	8	0.05
Printing and Publishing	192	1.09	Petroleum and Natural Gas	745	4.24
Consumer Goods	426	2.42	Communication	307	1.75
Apparel	347	1.97	Personal Services	295	1.68
Healthcare	218	1.24	Business Services	978	5.57
Medical Equipment	608	3.46	Computers	431	2.45
Pharmaceutical Products	718	4.09	Computer Software	1,154	6.57
Chemicals	705	4.01	Electronic Equipment	1,327	7.55
Rubber and Plastic Products	134	0.76	Measuring and Control Equipment	513	2.92
Textiles	128	0.73	Business Supplies	425	2.42
Construction Materials	524	2.98	Shipping Containers	135	0.77
Construction	237	1.35	Transportation	634	3.61
Steel Works Etc	450	2.56	Wholesale	667	3.8
Fabricated Products	35	0.2	Retail	1,515	8.62
Machinery	977	5.56	Restaurants, Hotels, Motels	375	2.13
Electrical Equipment	237	1.35	Almost Nothing	128	0.73

3.3.2. Measures of Downside Risk and Upside Potential

To measure asymmetric risk, I first use downside and upside market betas (denoted by β^- and β^+, respectively) – introduced by Bawa and Lindenberg (1997):

$$\beta_{i,t}^{-} = \frac{cov(r_{i,d}, r_m | r_m < \mu_m)}{var(r_m | r_m < \mu_m)}, \; \beta_{i,t}^{+} = \frac{cov(r_{i,d}, r_m | r_m > \mu_m)}{var(r_m | r_m > \mu_m)}, \tag{3.1}$$

where $r_{i,d}$ (r_m) is firm *i*'s (the market's) daily excess return, and μ_m is the average daily market excess return during the fiscal year *t*.[17, 18] Thus, β^- (β^+) measures how strongly a firm's stock returns covary with the market over periods when the excess market is below (above) its yearly mean. Regular, downside, and upside betas are, by construction, not independent of each other. To examine the incremental effects of downside risk and upside potential, following Ang, Chen, and Xing (2006), I compute a relative downside beta (β^- - β) and a relative upside beta (β^+ - β). I also control for the "regular" beta and idiosyncratic volatility, as measured in the market model, as well as other proxies for symmetric risk to examine the incremental effects of asymmetric risk on compensation. In addition, to examine the effect of downside risk relative to upside potential, I compute the difference between downside beta and upside beta (β^- - β^+) as a combined asymmetric risk measure.

As another proxy for asymmetric risk, I use the down-to-up volatility of firm-specific daily returns (*DUVOL*), which captures asymmetric volatilities between above- and below-mean firm-specific returns (Chen, Hong, and Stein 2001; Kim, Li, and Zhang 2011). A higher value of DUVOL indicates greater downside risk.

$$DUVOL_{i,t} = \log\{(\left(n_{up} - 1\right) \textstyle\sum_{down} R_{i,t}^2)/((n_{down} - 1) \textstyle\sum_{up} R_{i,t}^2)\} \tag{3.2}$$

[17] Using daily data, rather than monthly data, provides greater statistical power when betas may be time-varying (see Ang and Chen (2005) and Lewellen and Nagel (2005)).
[18] I use the equal-weighted market return because past studies examining nonlinearities in stock returns have found asymmetric risk to be bigger among smaller firms (see comments by Ang, Chen, and Xing (2006)).

For each firm *i* over fiscal-year *t*, firm-specific weekly returns are separated into two groups: ‘‘down’’ days when the returns are below the annual mean, and ‘‘up’’ days when the returns are above the annual mean. The standard deviation of firm-specific daily returns is calculated separately for each of these two groups. DUVOL is the natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the ‘‘down’’ days to the standard deviation of firm-specific daily returns in the ‘‘up’’ days.

3.3.3. Measures of CEO Compensation

To investigate the impact of asymmetric risk on CEO compensation structure, I focus on *annual* CEO compensation *awards*. While the cumulative CEO compensation portfolio is likely to slowly adjust, boards can adjust new compensation quickly. For the first set of regression models, I examine the impact of asymmetric risk on the *level* of the natural logarithm of one plus cash, value of stock option, or value of restricted stock *awards*.[19] Thus, the dependent variable is either the natural logarithm of one plus cash, stock option, or restricted stock awards. For the second set of regression models, I examine the impact of asymmetric risk on the *proportion* of each form of compensation award. The dependent variable is either the percentage of cash, stock option, or restricted stock awards over the sum of the three components – cash, stock option, and restricted stock. Using these dependent variables, I focus on the choice among the three types of compensation components.

[19] Cash award is the sum of salary and bonus.

3.4. Empirical Models

3.4.1. Level Analysis

To examine the impact of firms' downside risk versus upside potential environment on CEO compensation structure, I estimate regressions that take the following forms:

$$Compensation\ Component_{i,t} = \alpha + \beta_1\ rel\beta^{-}_{it-1} + \beta_2\ rel\beta^{+}_{it-1} + \gamma\ Symmetric\ Risk_{it-1} + \delta\ Controls_{it-1} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (3.3a)$$

For the first set of regression models, I examine the impact of β^{-}- β (*rel* β^{-}) and β^{+}- β (*rel* β^{+}) on the levels of cash, stock option, and restricted stock awards.[20] Thus, the dependent variable is either the natural logarithm of one plus cash, stock option, or restricted stock awards. To understand the impact of asymmetric risk on CEO compensation structure in addition to that of symmetric risk, I control for symmetric risk proxies such as market beta (β), idiosyncratic risk (*IR*) and the standard deviation of net income (σNI). I also control for the factors that are found to be related with compensation structure in the prior studies. *Controls* is a vector of control variables: firm size (*MVE*), past stock performance (*Annret*), past accounting performance (*ROA*), change in net income (ΔNI), growth opportunities (*BM*), financial leverage (*Leverage*), big N (*BigN*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), free

[20] Cash award is the sum of salary bonus, and non-equity incentive compensation.

cashflows (*Free_CF*), R&D expenditures (*R&D*), *PP&E*, CEO age (*Age*), CEO tenure (Tenure), CEO share ownership (*Shrown*), CEO duality (*Dual*), and CEO gender (*Male*). All independent variables are lagged by one year. I also include fixed effects to capture time variation and to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

To examine the effect of downside risk relative to upside potential, I compute the difference between downside beta and upside beta as a combined asymmetric risk measure (β^{-} - β^{+}) and estimate the following regression models:

$$Compensation\ Component_{i,t} = \alpha_0 + \alpha_1\ \beta^- - \beta^+{}_{it-1} + \gamma\ Symmetric\ Risk_{it-1} + \delta\ Controls_{it-1} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (3.3b)$$

To investigate the impact of *DUVOL* on CEO compensation structure, I replace $\beta^- - \beta^+$ with *DUVOL* and estimate the following regression models:

$$Compensation\ Component_{i,t} = \alpha + \beta\ DUVOL_{it-1} + \gamma\ Symmetric\ Risk_{it-1} + \delta\ Controls_{it-1} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (3.4)$$

3.4.2. Ratio Analysis

Since I am interested in understanding the impact of asymmetric risk on the choice among cash, stock, and option compensation, I also use the proportion of cash, stock, or option awards over the sum of cash, stock, and option compensation. Thus, the dependent variable is alternatively is either the proportion of cash, stock option, or restricted stock awards over the sum of cash, stock, and option compensation. I estimate regressions that take the following forms:

$$Proportion\ of\ Compensation\ Component_{i,t} = \alpha + \beta\ Asymmetric\ Risk_{it-1} + \\ +\gamma\ Symmetric\ Risk_{it-1} + \delta\ Controls_{it-1} + Year\ Fixed\ Effects + \\ Firm\ Fixed\ Effects + u_{it} \quad (3.5)$$

Asymmetric Risk is alternatively either β^- and β^+, $\beta^- - \beta^+$, or *DUVOL*. I control for symmetric risk proxies and the factors that are found to be related with compensation structure in the prior studies. *Controls* is a vector of control variables: firm size (*MVE*), past stock performance (*Return*), past accounting performance (*ROA*), change in net income (Δ*NI*), growth opportunities (*BM*), financial leverage (*Lev*), big N (*BigN*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), free cashflows (*Free_CF*), R&D expenditures (*R&D*), *PP&E*, CEO age (*CEO_Age*), CEO tenure (*CEO_Tenure*), CEO share ownership (*CEO_Shrown*), CEO duality (*Duality*), and CEO gender (*Male*). All independent variables are lagged by one year. I also include fixed effects to capture time variation and to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

In addition, to focus on the impact of asymmetric risk on the choice between equity compensation components (i.e., stock versus option), I use the proportion of option awards over the sum of stock and option awards as the dependent variable. When a firm does not grant any stock or option compensation, I set the dependent variable to 0.5.[21] I estimate the following regression model.

$$Proportion\ of\ Option\ Awards_{i,t} = \alpha + \beta\ Asymmetric\ Risk_{it-1} +$$
$$+\gamma\ Symmetric\ Risk_{it-1} + \delta\ Controls_{it-1} + Year\ Fixed\ Effects +$$
$$Firm\ Fixed\ Effects + u_{it} \qquad (3.6)$$

3.5. Results

3.5.1. Descriptive Statistics

Table 3-3 presents the descriptive statistics. Panel A shows that the means of cash, option, and restricted stock compensation are \$1.7 million, \$1.5 million, and \$1.1 million, representing 35.3%, 31.5%, and 24.4% of the mean total compensation, respectively. The average ratio of option awards to the sum of option and restricted stock awards is 0.6, suggesting that the option compensation slightly dominates stock compensation in my sample. Panel B reports the descriptive statistics for asymmetric risk measures. The negative mean value of $Rel\beta^{-}$, -0.08, indicates that firms' undiversifiable risk is less sensitive to the market risk, and the positive mean value of $Rel\beta^{+}$, 0.05, indicates that firms' undiversifiable risk is more sensitive to the market risk. The mean of *DUVOL*, 0.94, indicates that, on average, the volatility of stock returns during ''down''

[21] In untabulated robustness analysis, I drop the observations if a firm does not grant any stock or option compensation and redo the analysis. I obtain similar results; the main references are unchanged.

days when the returns are below the annual mean is slightly higher than the volatility of stock returns during "up" days when the returns are above the annual mean.

Table 3-3. Descriptive Statistics

This table presents descriptive statistics for firms in my sample. My sample is constructed from the intersection of Execucomp (compensation), Compustat (accounting data), CRSP (stock price data), and Thomson Reuters Institutional (13f) Holdings (institutional ownership) for the time period 1993 to 2015 and covers a total of 17,570 firm-years (1,700 firms). Panel A reports descriptive statistics for measures of CEO incentives. Panel B reports descriptive statistics for measures of risk. Panel C reports descriptive statistics for control variables. All variables are winsorized at the 1 and 99 percent levels. All dependent variables are measured at year t and all dependent variables are measured at year t-1. All variables are as defined in Appendix D.

Panel A: CEO incentive variables

Variable	Mean	Std Dev	25th	Median	75th
Cash (in thousands)	1,653.9	1,456.0	701.4	1,200.0	2,086.5
Option Awards (in thousands)	1,476.3	2,626.5	0.0	495.2	1,725.4
Stock Awards	1,144.2	2,215.1	0.0	0.0	1,298.7
Option/Equity	0.60	0.37	0.34	0.50	1.00
Total Compensation	4,685.4	5,081.5	1,369.0	2,944.7	5,988.1

Panel B: Risk variables

Variable	Mean	Std Dev	25th	Median	75th
β	1.28	0.60	0.86	1.21	1.61
$Rel\beta^-$	-0.08	0.39	-0.28	-0.06	0.13
$Rel\beta^+$	0.05	0.50	-0.19	0.06	0.31
$\beta^- - \beta^+$	-0.13	0.75	-0.51	-0.12	0.25
DUVOL	0.94	0.24	0.78	0.91	1.06
σRet	0.03	0.01	0.02	0.02	0.03
σIR	0.02	0.01	0.02	0.02	0.03
σNI	0.05	0.06	0.02	0.03	0.06

Panel C: Control variables

Variable	Mean	Std Dev	25th	Median	75th
MVE (in millions)	6,595.6	16,837.1	519.9	1,410.3	4,477.9
Annret	0.17	0.49	-0.13	0.11	0.36
ROA	0.05	0.09	0.02	0.06	0.09
BTM	0.48	0.36	0.25	0.41	0.62
Lev	0.50	0.21	0.35	0.51	0.64
BigN	0.95	0.23	1.00	1.00	1.00
Instown	0.70	0.20	0.57	0.72	0.84
HHI	0.09	0.08	0.05	0.07	0.10

Free_CF	0.03	0.10	0.01	0.04	0.07
R&D	0.03	0.05	0.00	0.01	0.04
PP&E	0.28	0.21	0.12	0.23	0.39
CEO_Age	55.8	7.3	51.0	56.0	61.0
CEO_Tenure	8.62	7.61	3.00	6.00	11.00
CEO_Shrown	0.03	0.06	0.00	0.01	0.02
Duality	0.59	0.49	0.00	1.00	1.00
Male	0.98	0.16	1.00	1.00	1.00

3.5.2. Correlation Matrix of Risk Measures

Table 3-4 presents the correlation coefficients between risk measures used in this chapter. I focus on the correlations between risk measures to investigate whether symmetric and asymmetric risk measures capture different aspects of firms' risk environment. The correlation coefficients between β_t and $Rel\beta_t^-$ and between β_t and $Rel\beta_t^+$ are -0.24 and 0.16, which are relatively low in magnitude. In addition, the correlation coefficient between *DUVOL* and σRet_t is -0.14. This implies that symmetric and asymmetric risk measures capture different information about firms' risk environment. Thus, it is important to consider both symmetric and asymmetric risk when studying the impact of risk on firm decisions. Another observation is that the autocorrelation coefficients of $Rel\beta^-$, $Rel\beta^+$, *DUVOL* are 0.13, -0.36, and -0.14, respectively. These statistics suggest that the asymmetric risk measures used in this chapter keep changing over time and that they capture the changes in firms' asymmetric risk environment. In addition, this suggests that the results in my analyses are not driven by time-invariant unobserved firm characteristics that are correlated with the asymmetric risk measures used in this chapter.

Table 3-4. Correlation Matrix for Risk Variables

This table presents Pearson correlations among risk variables. Correlations significant at the $p < 0.05$ level are reported in bold.

	β_t	β_{t-1}	$rel\beta^-_t$	$rel\beta^-_{t-1}$	$rel\beta^+_t$	$rel\beta^+_{t-1}$	$\beta^- - \beta^+_t$	$\beta^- - \beta^+_{t-1}$	$DUVOL_t$	$DUVOL_{t-1}$	σRet_t	σRet_{t-1}	σIR_t	σIR_{t-1}	σNI_t
β_t	**1**														
β_{t-1}	**0.71**	**1**													
$rel\beta^-_t$	**-0.24**	**-0.26**	**1**												
$rel\beta^-_{t-1}$	**-0.18**	**-0.23**	**0.13**	**1**											
$rel\beta^+_t$	**0.16**	**0.13**	**-0.37**	**-0.07**	**1**										
$rel\beta^+_{t-1}$	**0.05**	**0.14**	**-0.07**	**-0.36**	**0.06**	**1**									
$\beta^- - \beta^+_t$	**-0.24**	**-0.23**	**0.78**	**0.12**	**-0.86**	**-0.08**	**1**								
$\beta^- - \beta^+_{t-1}$	**-0.13**	**-0.22**	**0.12**	**0.77**	**-0.07**	**-0.87**	**0.11**	**1**							
$DUVOL_t$	**-0.06**	**-0.06**	**0.09**	**0.04**	**-0.08**	-0.01	**0.10**	**0.02**	**1**						
$DUVOL_{t-1}$	**-0.06**	**-0.07**	**0.01**	**0.10**	-0.01	**-0.08**	0.01	**0.11**	**0.05**	**1**					
σRet_t	**0.48**	**0.39**	**-0.13**	**-0.08**	0.00	**-0.04**	**-0.06**	**-0.02**	**-0.14**	**-0.10**	**1**				
σRet_{t-1}	**0.47**	**0.49**	**-0.13**	**-0.14**	**0.02**	-0.01	**-0.08**	**-0.06**	**-0.16**	**-0.14**	**0.71**	**1**			
σIR_t	**0.37**	**0.31**	**-0.10**	**-0.07**	**-0.03**	**-0.05**	**-0.03**	-0.01	**-0.15**	**-0.12**	**0.96**	**0.69**	**1**		
σIR_{t-1}	**0.39**	**0.39**	**-0.11**	**-0.11**	0.00	**-0.03**	**-0.05**	**-0.03**	**-0.17**	**-0.15**	**0.73**	**0.96**	**0.75**	**1**	
σNI_t	**0.33**	**0.32**	**-0.07**	**-0.07**	-0.01	**-0.02**	**-0.03**	**-0.02**	**-0.09**	**-0.09**	**0.44**	**0.45**	**0.44**	**0.45**	**1**
σNI_{t-1}	**0.30**	**0.33**	**-0.07**	**-0.07**	-0.01	**-0.02**	**-0.03**	**-0.02**	**-0.09**	**-0.09**	**0.37**	**0.43**	**0.37**	**0.43**	**0.87**

3.5.3. Level Analysis

Table 3-5 represents the results of the OLS regression models that examine the effects of *Relβ⁻* and *Relβ⁺* on the levels of CEO annual cash, option, and stock awards. All compensation measures are measured in year *t* and all independent variables are measured in year *t-1* to mitigate the simultaneity concern. As noted in the previous section, my asymmetric risk measures are time-sensitive. In addition, I include firm-fixed effects in all my regression models, which allow me to examine within-firm variation and mitigate the concern that the observed findings reflect the mere correlation between dependent variables and unobservable time-invariant factors.

Table 3-5. Level Analysis – The Effects of *Relβ*⁻ and *Relβ*⁺ on the CEO Compensation

This table presents results from OLS regressions that estimate the effects of *Relβ*⁻ and *Relβ*⁺ on the levels of CEO cash, option, and stock awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. *Relβ*⁻ is downside beta minus market beta and *Relβ*⁺ is upside beta minus market beta (see Eq. (3.1) for downside beta and upside beta calculation). *Cash_Awards*, *Equity_Awards*, *Option_Awards*, and *Stock_Awards* are the natural logarithm of one plus annual cash compensation, the sum of annual option and stock grants, annual option grants, and annual stock grants, respectively. Other variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1)	(2)	(3)	(4)
	Cash_Awards	*Equity_Awards*	*Option_Awards*	*Stock_Awards*
Relβ⁻	0.0318**	0.0347	-0.106	0.241***
Relβ⁺	0.00531	0.0563	0.152***	-0.0738
β	0.0236*	0.0946	-0.0960	0.201**
σIR	-3.907***	0.844	39.26***	-54.67***
σNI	0.182	-0.593	0.641	0.0548
MVE	0.232***	0.767***	0.241***	1.132***
Annret	0.0908***	0.0399	0.00817	-0.0138
ROA	-0.173*	-0.240	0.0815	-1.762***
ΔNI	0.000980***	-0.00225	-0.00168	0.00196
BTM	0.278***	0.491***	-0.569***	1.952***
Lev	0.621***	0.926***	-1.236***	3.713***
BigN	-0.105*	0.137	0.808***	-0.587*
Instown	0.434***	1.191***	0.192	2.585***
HHI	1.498***	3.086***	-2.990**	10.97***
Free_CF	0.347***	0.321	-0.263	1.304***
R&D	0.0661	2.038	-2.651	6.310***
PP&E	-0.644***	-1.627***	0.392	-5.549***
CEO_Age	0.0817	-1.048***	-2.032***	-0.118
CEO_Tenure	0.0390***	0.0298	-0.0174	-0.0227
CEO_Shrown	-0.852***	-6.350***	-4.173***	-2.092*
Duality	-0.0541***	-0.106	0.106	-0.286**
Male	-0.117*	-0.267	0.790*	-1.099***
Intercept	4.577***	3.429**	9.726***	-5.862***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,570	17,570	17,570	17,570
Adj. R-sq	0.691	0.397	0.389	0.443

The positive coefficient on $Rel\beta^-$ in Column (1) where I examine the impact of asymmetric risk on the level of annual cash compensation indicates that, as downside risk increases, boards grant more cash compensation. In contrast, the coefficient on $Rel\beta^-$ in Column (2) where I examine the impact of asymmetric risk on the level of the sum of stock and option awards is insignificant. This indicates that, although boards do not reduce the level of equity compensation, they increase cash compensation to compensate for the increase in downside risk, which CEOs dislike. Interestingly, the coefficient on $Rel\beta^+$ in Column (2) is insignificant, implying that boards do not decrease cash compensation as upside potential increases. This suggests that the boards' adjustment of cash compensation is asymmetric to downside risk versus upside potential.

Now, to better understand the choice between stock and option awards, I investigate the impact of $Rel\beta^-$ and $Rel\beta^+$ on option awards and stock awards in Columns (3) and (4), respectively. The positive coefficient on $Rel\beta^+$ in Column (3) indicates that boards increases option awards as upside potential increases and the positive coefficient on $Rel\beta^-$ in Column (4) indicates that boards increases stock as downside risk increases. Similar to the asymmetric effects of $Rel\beta^-$ and $Rel\beta^+$ on cash awards in Column (1), only upside potential, but not downside risk, affects option awards and only downside risk, but not upside potential, affects stock awards. This result is consistent with the idea that, as upside potential increases, the leverage effects of option dominate and, thus, that boards grant more stock compensation to the CEOs. In contrast, as downside risk increases, boards provide more stock awards to protect the CEOs from downside risk since stock has positive value as long as the stock price is positive (i.e., positive intrinsic value).

The above findings in Table 3-5, however, are interesting since I test the impact of asymmetric risk on CEO compensation after controlling for the proxies for symmetric risk, including market risk (β), idiosyncratic risk (σIR), and the volatility of accounting performance (σNI). The systematic risk, β, is marginally and positively associated with cash awards in Column (1) and is positively associated with stock awards in Column (4). However, it is not associated with either option awards or equity awards. Idiosyncratic risk, σIR, has negative effects on cash awards and stock awards but has positive effects on option awards. However, firms' accounting performance risk has no impacts on compensation.

BTM, an inverse measure of firms' growth opportunities, is positively associated with cash, equity and stock awards but is negatively associated with option awards. Smith and Watts (1992) hypothesize and find a positive relation between firm's growth opportunities and the degree to which firms use equity incentives to tie a manager's wealth to firm value. I find only *Option_Awards*, but not *Stock_Awards*, are positively associated with firms' growth opportunities. I find that firms' financial leverage, *Lev*, is positively associated with cash, equity and stock awards but is negatively associated with option awards, suggesting the negative impact of firm financial leverage on option compensation. Herfindahl-Hirschman Index (*HHI*), an inverse measure of market competition, is positively associated with positively associated with cash, equity and stock awards but is negatively associated with option awards, indicating that market competition has positive impact on option compensation.

In Table 3-6, I used a combined asymmetric risk measure – β^{-} - β^{+}. Higher value of β^{-} - β^{+} indicates greater downside risk. Thus, using this asymmetric risk proxy measures, I test how the magnitude of β^{-} relative to that of β^{+} affect CEO compensation. The insignificant coefficient on β^{-} - β^{+} in Column (2) implies that boards do not adjust the total value of equity compensation. The positive coefficients in Columns (1) and (4) and the negative coefficient in Column (3) indicate that, as downside risk relative to upside potential increases, boards increase cash and stock compensation but decrease option compensation, consistent with the findings from Table 3-5. To summarize, although boards do not adjust the total value of equity compensation, they shift away from option compensation to stock compensation as downside risk relative to upside potential increases.

Table 3-6. Level Analysis – The Effects of β^{-} - β^{+} on the CEO Compensation

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the levels of CEO cash, option, and cash awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. β^{-} - β^{+} is downside beta minus upside beta (see Eq. (3.1) for downside beta and upside beta calculation). *Cash_Awards*, *Equity_Awards*, *Option_Awards*, and *Stock_Awards* are the natural logarithm of one plus annual cash compensation, the sum of annual option and stock grants, annual option grants, and annual stock grants, respectively. Other variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
β^{-}-β^{+}	0.00952*	-0.0255	-0.136***	0.138***
β	0.0237*	0.0930	-0.0972	0.201**
σIR	-3.977***	0.685	39.20***	-55.00***
σNI	0.181	-0.593	0.645	0.0476
MVE	0.233***	0.769***	0.241***	1.135***
Annret	0.0918***	0.0434	0.0107	-0.00978
ROA	-0.171*	-0.235	0.0837	-1.754***
ΔNI	0.000984***	-0.00225	-0.00168	0.00198
BTM	0.279***	0.494***	-0.567***	1.957***

Lev	0.623***	0.931***	-1.234***	3.721***
BigN	-0.104*	0.139	0.809***	-0.585*
Instown	0.435***	1.191***	0.190	2.587***
HHI	1.493***	3.079***	-2.987**	10.94***
Free_CF	0.348***	0.324	-0.262	1.308***
R&D	0.0662	2.042	-2.647	6.310***
PP&E	-0.643***	-1.627***	0.390	-5.545***
CEO_Age	0.0816	-1.049***	-2.033***	-0.119
CEO_Tenure	0.0389***	0.0295	-0.0174	-0.0232
CEO_Shrown	-0.847***	-6.335***	-4.165***	-2.070*
Duality	-0.0540***	-0.106	0.106	-0.285**
Male	-0.117*	-0.266	0.791*	-1.097**
Intercept	4.571***	3.417**	9.723***	-5.888***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,570	17,570	17,570	17,570
Adj. R-sq	0.691	0.397	0.389	0.442

In Table 3-7, I use *DUVOL* as an asymmetric risk measure. Unlike $Rel\beta^-$, $Rel\beta^+$, and $\beta^- - \beta^+$, which measure the asymmetric sensitivity to the market risk, this asymmetric risk proxy measures asymmetry in a firm's total risk. Higher value of *DUVOL* indicates that firm's stock return is more volatile during "down" days than during "up" days. In these models, I control for the standard deviation of stock returns instead of market beta and idiosyncratic risk. The coefficients on *DUVOL* in Columns (1)-(3) are insignificant, which is inconsistent with the results in Table 3-6. However, the positive coefficient on DUVOL in Column (4) indicates that boards increase stock compensation when downside risk increases to protect CEOs from bad outcomes, consistent with my prediction.

Table 3-7. Level Analysis – The Effects of *DUVOL* on the CEO Compensation

This table presents results from OLS regressions that estimate the effects of *DUVOL* on the levels of CEO cash, option, and stock awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. *DUVOL* is the natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the ‘‘down’’ days to the standard deviation of firm-specific daily returns in the ‘‘up’’ days (see Eq. (3.2)). *Cash_Awards*, *Equity_Awards*, *Option_Awards*, and *Stock_Awards* are the natural logarithm of one plus annual cash compensation, the sum of annual option and stock grants, annual option grants, and annual stock grants, respectively. Other All variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
DUVOL	0.0296	0.0608	-0.132	0.342***
σRet	-1.064*	6.468**	29.53***	-29.48***
σNI	0.134	-0.690	0.489	-0.170
MVE	0.243***	0.787***	0.198**	1.231***
Annret	0.0937***	0.0464	-0.00565	0.0202
ROA	-0.162*	-0.218	0.154	-1.755***
ΔNI	0.00107***	-0.00195	-0.00176	0.00259
BTM	0.269***	0.443***	-0.603***	1.920***
Lev	0.612***	0.876***	-1.259***	3.673***
BigN	-0.108*	0.133	0.827***	-0.626*
Instown	0.465***	1.220***	-0.0427	2.951***
HHI	1.534***	3.078***	-3.369**	11.47***
Free_CF	0.343***	0.273	-0.341	1.339***
R&D	0.0981	2.000	-2.847	6.597***
PP&E	-0.674***	-1.676***	0.554	-5.844***
CEO_Age	0.0951	-1.023***	-2.049***	-0.0257
CEO_Tenure	0.0391***	0.0305	-0.0202	-0.0194
CEO_Shrown	-0.861***	-6.385***	-4.193***	-2.145*
Duality	-0.0561***	-0.109	0.112	-0.303***
Male	-0.121*	-0.272	0.817*	-1.143***
Intercept	4.412***	3.214*	10.27***	-7.284***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,569	17,569	17,569	17,569
Adj. R-sq	0.690	0.398	0.387	0.436

3.5.4. *Ratio Analysis*

In the previous section, I regress asymmetric risk measures on the level of each compensation component (see Table 3-8). I perform ratio analysis in this section. In Columns (1) – (3), the dependent variables are the percentage of cash awards, option awards, and stock awards over the total compensation, respectively.[22] The negative coefficient of *Relβ⁻* in Column (2) and the positive coefficient in Column (3) indicates boards decrease the proportion of option awards and increase the proportion of stock awards as downside risk increases. In contrast, the positive coefficient of *Relβ⁺* in Column (2) and the negative coefficient in Column (3) indicates boards increase the proportion of option awards and decrease the proportion of stock awards as upside potential increases.

Table 3-8. Ratio Analysis – The Effects of *Relβ⁻* and *Relβ⁺* on the CEO Compensation

This table presents results from OLS regressions that estimate the effects of *Relβ⁻* and *Relβ⁺* on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. *Relβ⁻* is downside beta minus market beta and *Relβ⁺* is upside beta minus market beta (see Eq. (3.1) for downside beta and upside beta calculation). Other variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Cash_Awards (%)*	(2) *Option_Awards (%)*	(3) *Stock_Awards (%)*	(4) *Option/Equity (%)*
Relβ⁻	-0.00124	-0.0150**	0.0159***	-0.0224***
Relβ⁺	-0.00989**	0.0135***	-0.00593**	0.0150***

[22] In untabulated analysis, I replace the denominator in Columns (1) – (3), total compensation, with the sum of cash, option, and stock awards to examine the choice strictly among the three components. The results are similar. One potential explanation for the similar results is that cash, option, and stock compensation comprise significant portion of total compensation (see Table 3) and, thus, that it does not make a big difference if the total compensation or the sum of cash, option, and stock compensation is used.

β	-0.00190	0.000922	0.0108**	-0.0322***
σIR	-1.111***	5.278***	-3.952***	6.152***
σNI	0.102	0.0364	-0.0966	0.0447
MVE	-0.0725***	0.0125**	0.0682***	-0.0770***
Annret	0.00507	-0.00433	-0.00276	-0.00248
ROA	-0.0488	0.101**	-0.0659**	0.139***
ΔNI	0.000407***	-0.000331**	-0.0000407	-0.000205
BTM	-0.0279**	-0.0975***	0.122***	-0.185***
Lev	-0.0459*	-0.186***	0.245***	-0.351***
BigN	-0.0267	0.0627***	-0.0241	0.124***
Instown	-0.0636***	-0.0434**	0.118***	-0.202***
HHI	-0.106	-0.404***	0.610***	-0.963***
Free_CF	0.0188	-0.0880***	0.0712***	-0.125***
R&D	-0.266	-0.152	0.416***	-0.642***
PP&E	0.101**	0.152***	-0.292***	0.411***
CEO_Age	0.0603*	-0.121***	0.0115	-0.136***
CEO_Tenure	-0.000879	-0.00148	-0.000121	0.000998
CEO_Shrown	0.424***	-0.338***	-0.101	-0.155
Duality	-0.00296	0.0175**	-0.0224***	0.0323***
Male	-0.00373	0.0550*	-0.0743**	0.142***
Intercept	0.913***	0.586***	-0.435***	1.730***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,563	17,563	17,563	17,570
Adj. R-sq	0.381	0.364	0.427	0.409

The dependent variable in Column (4) is the value of option awards over the value of option and stock awards. Thus, in this specification, I examine how asymmetric risk affect the choice between option versus stock awards. Similar to results from Columns (2) and (3), as downside risk (upside potential) increases, boards shift away from option awards (stock awards) to stock awards (option awards).

In Table 3-9 and Table 3-10, I perform similar analysis as in Table 3-8 with replacing *Rel*$\beta^-$and *Rel*β^+ with β^- - β^+ and *DUVOL*, respectively. The results generally confirm the inference that, as firms' downside risk relative to upside potential increases, boards grant more annual cash and stock compensation, and less annual option compensation.

Table 3-9. Ratio Analysis – The Effects of β^{-} - β^{+} on the CEO Compensation

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. β^{-} - β^{+} is downside beta minus upside beta (see Eq. (3.1) for downside beta and upside beta calculation). *Cash_Awards*, *Equity_Awards*, *Option_Awards*, and *Stock_Awards* are the natural logarithm of one plus annual cash compensation, the sum of annual option and stock grants, annual option grants, and annual stock grants, respectively. Other variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Cash_Awards (%)*	(2) *Option_Awards*	(3) *Stock_Awards*	(4) *Option/Equity*
β^{-}-β^{+}	0.00553**	-0.0144***	0.00976***	-0.0181***
β	-0.00187	0.000777	0.0108**	-0.0323***
σIR	-1.092***	5.284***	-3.972***	6.169***
σNI	0.102	0.0369	-0.0970	0.0454
MVE	-0.0726***	0.0125**	0.0683***	-0.0771***
Annret	0.00471	-0.00423	-0.00253	-0.00254
ROA	-0.0493	0.101**	-0.0654**	0.138***
ΔNI	0.000406***	-0.000331**	-0.0000398	-0.000206
BTM	-0.0282**	-0.0975***	0.123***	-0.185***
Lev	-0.0464*	-0.186***	0.245***	-0.351***
BigN	-0.0269	0.0627***	-0.0240	0.124***
Instown	-0.0636***	-0.0436**	0.118***	-0.202***
HHI	-0.105	-0.403***	0.608***	-0.961***
Free_CF	0.0185	-0.0880***	0.0714***	-0.125***
R&D	-0.266	-0.152	0.416***	-0.642***
PP&E	0.101**	0.152***	-0.291***	0.410***
CEO_Age	0.0603*	-0.121***	0.0115	-0.136***
CEO_Tenure	-0.000864	-0.00147	-0.000151	0.00103
CEO_Shrown	0.423***	-0.338***	-0.0995	-0.156
Duality	-0.00299	0.0175**	-0.0223***	0.0322***
Male	-0.00395	0.0550*	-0.0741**	0.142***
Intercept	0.915***	0.586***	-0.437***	1.731***
Firm Fixed Effects	Yes	Yes	Yes	Yes

Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,563	17,563	17,563	17,570
Adj. R-sq	0.381	0.365	0.427	0.409

Table 3-10. Ratio Analysis – *DUVOL*

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. *DUVOL* is the natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the ''down'' days to the standard deviation of firm-specific daily returns in the ''up'' days (see Eq. (3.2)). Other variables are as defined in Appendix D. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Cash_Awards (%)*	(2) *Option_Awards*	(3) *Stock_Awards*	(4) *Option/Equity*
DUVOL	0.000720	-0.0187**	0.0194***	-0.0330***
σRet	-0.984***	3.923***	-2.474***	3.526***
σNI	0.105	0.0448	-0.103*	0.0423
MVE	-0.0720***	0.00671	0.0743***	-0.0875***
Annret	0.00496	-0.00551	-0.00102	-0.00594
ROA	-0.0500	0.103**	-0.0679**	0.146***
ΔNI	0.000396***	-0.000336**	-0.00000974	-0.000274
BTM	-0.0254**	-0.103***	0.123***	-0.181***
Lev	-0.0435*	-0.191***	0.244***	-0.345***
BigN	-0.0272	0.0658***	-0.0266	0.128***
Instown	-0.0586***	-0.0724***	0.143***	-0.244***
HHI	-0.0935	-0.450***	0.645***	-1.023***
Free_CF	0.0226	-0.100***	0.0759***	-0.129***
R&D	-0.255	-0.188	0.436***	-0.662***
PP&E	0.0978**	0.170***	-0.310***	0.445***
CEO_Age	0.0606*	-0.126***	0.0164	-0.143***
CEO_Tenure	-0.000874	-0.00167	0.000130	0.000427
CEO_Shrown	0.425***	-0.339***	-0.102	-0.151
Duality	-0.00315	0.0186**	-0.0234***	0.0338***
Male	-0.00444	0.0581*	-0.0771**	0.148***
Intercept	0.900***	0.687***	-0.523***	1.858***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,562	17,562	17,562	17,569
Adj. R-sq	0.381	0.358	0.420	0.401

3.6. Conclusions

Stock-based compensation for CEOs has grown significantly over the past 30years. Since the value of stock-based compensation is linked to firms' uncertain future performance and risk-averse CEOs demand a risk-premium for bearing risk associated with stock-based compensation, firms risk environment is an important consideration. However, little is known about how boards adjust CEOs' incentives in light of firms' asymmetric risk environments.

Because of the complex nature of equity incentives, prior literature is mixed on the circumstances in which either form of equity incentive is preferred over the other. Guay (1999) states that there is no clear method of determining the value of an employee stock option from the employee's perspective, as opposed to the firm's perspective. For example, the assumptions embedded in the Black-Scholes model are not completely applicable to employee stock options.

Furthermore, there is disagreement about the asymmetric incentive effects of stock options. Some researchers argue that options encourage risk since they limit downside risk (e.g., Bryan, Hwang, and Lilien 2000; Ryan and Wiggins 2001). In contrast, other researchers argue that restricted stock provides greater downside protection because the value of stock is always positive (Carter, Lynch, and Tuna 2007). Thus, providing empirical evidence is important.

In this chapter, I study how boards adjust CEO compensation package in response to firms' risk. First, regarding the choice between cash and equity compensation, I provide evidence that firms increase the value of cash awards but do not change the value of equity awards (i.e., the sum of the value of option and stock compensation) as downside risk increases. This finding is consistent with the idea that, although boards do not adjust the total value of equity compensation, they increase the cash compensation to compensate for increased risk. Second, I find that, as downside risk increases, firms grant more stock compensation but less option compensation. This finding implies that, although boards do not change the value of the total compensation, they shift the equity compensation away from option compensation to stock compensation as downside risk increases. This is consistent with the idea that providing option compensation becomes more expensive since risk-averse managers demand a higher risk premium for option compensation as downside risk increases.

The findings in this chapter contribute to the literature by providing evidence that boards respond to changes in their firms' risk environments by adjusting the structure of CEO compensation to reflect risk-averse CEOs' risk preferences. My findings shed light on the importance of considering asymmetric risk when studying the impact of risk on CEO compensation and other corporate decisions such as investment.

CHAPTER 4
THE DIFFERENTIAL IMPACT OF EXECUTIVE STOCK OPTIONS ON SYSTEMATIC AND IDIOSYNCRATIC RISK: EVIDENCE FROM QUASI-EXPERIMENT

4.1. Introduction

In this paper, I exploit the passage of Financial Accounting Standard (FAS) 123R to provide evidence on how executive stock options differentially affect firm's systematic and idiosyncratic risk. The impact of executive stock options on risk-taking has been extensively studied. Early studies generally document a positive relation between stock options and risk-taking (e.g., Agrawal and Mandelker 1987, Guay 1999; Coles, Daniel, and Naveen 2006; Chava and Purnanandam 2010). The prediction that stock options induce risk-taking stems from the fact that the value of an option increases with the volatility of the underlying stock. However, because managers are under-diversified, the relationship between managerial stock options and risk preferences is complex and sometimes even counterintuitive (Glover and Oliver 2017). Lambert, Larcker, and Verrecchia (1991), among others[23], show that a *risk-averse* manager who *cannot* diversify the risk associated with the options' payoff may not prefer an increase in the firm's total risk. If the risk-aversion effects dominate the risk-taking incentive effects, stock options will not provide risk-taking incentives for a risk-averse manager. Supporting this argument, subsequent studies (e.g., Bettis, Bizjak, and Lemmon 2005;

[23] Carpenter (2000) and Ross (2004) show, theoretically, that an increase in option pay can actually decrease a manager's preference for risk. Glover and Oliver (2017) show that, although option compensation generally incentivizes greater risk-taking than stock compensation, additional option compensation, in some cases, leads to lower risk-taking. They show that both the sign and magnitude of this effect depend on the relative amounts of stock, option, and fixed pay in the compensation contract.

Lewellen 2006; Milidonis and Stathopoulos 2014) find a negative relation between stock options and risk-taking.

These studies focus on the firm's *total* risk. However, managers may perceive *systematic* and *idiosyncratic* risk differently than diversified shareholders. According to the Capital Asset Pricing Model (CAPM), only systematic risk is priced by the market since diversified investors can eliminate idiosyncratic risk through diversification. Unlike shareholders, however, managers have limited ability to eliminate idiosyncratic (or firm-specific) risk since they hold large positions in their firms and are often prohibited from hedging firm-specific risk.[24] Thus, idiosyncratic risk, which goes "unrewarded", is unwanted by under-diversified managers. In addition to being rewarded, managers can hedge any unwanted systematic risk by trading the market portfolio. A potential explanation for the mixed evidence in the above literature on the relationship between stock options and the manager's risk-taking behavior is that the literature focuses on total risk, when stock options have differential effects on the two types of risk, i.e., systematic versus idiosyncratic risk.

Tian (2004) numerically demonstrates that stock options create incentives to reduce idiosyncratic risk and incentives to increase systematic risk. Armstrong and Vashishtha (2012) extend the findings in Tian (2004), and numerically show that vega – a widely used risk-taking incentives – provides managers with incentives to increase the

[24] Bettis, Bizjak, and Kalpathy (2015) identified just 2,042 unique derivative transactions by executives to hedge their risk exposure to their firms over the period from 1996 to 2006. Consistent with infrequent use of derivatives, Jin (2002), Tian (2004), Henderson (2005), and Archarya and Bisin (2009) assume in their theoretical models that executives are allowed to hedge systematic risk, but not firm-specific risk.

level of either systematic or idiosyncratic risk, and thus total risk. However, Armstrong and Vashishtha (2012) show that the increase in total risk will be primarily achieved through the increase in systematic risk.

Tian (2004) and Armstrong and Vashishtha (2012) both support the positive impact of stock options on systematic risk. However, in contrast to the *negative* relationship between stock options and idiosyncratic risk as shown in Tian (2004), Armstrong and Vashishtha (2012) predict that vega is *positively* related to idiosyncratic risk. The mixed predictions in the literature about the relationship between vega and idiosyncratic risk is potentially because they depend on unobservable factors, such as the manager's utility function and outside wealth. Thus, the theoretical prediction is sensitive to the model and parameter choices.[25] Henderson (2005) points out that it is difficult to make general statements about "risk" and the value of equity compensation without clarifying what parameters are being held constant and which vary. Furthermore, finance studies (e.g., Goyal and Santa-Clara 2003; Ang, Hodrick, Xing, and Zhang 2006; Ang, Hodrick, Xing, and Zhang 2009; Fu 2009) provide empirical evidence that idiosyncratic risk and expected returns are associated (i.e., idiosyncratic risk is priced). While idiosyncratic risk should not be priced in a complete market, in the presence of market

[25] For example, Tian (2004) sets the level of total risk fixed, whereas Armstrong and Vashishtha (2012) allow it to vary. In addition, the parameters used in Tian (2004) are: the market portfolio's volatility (σ_{sys}) is 20%, the firm's idiosyncratic volatility is 22%, and its beta (β) is 1. In contrast, in Armstrong and Vashishtha (2012), the market portfolio's volatility (σ_{sys}) is 20%, the firm's idiosyncratic volatility is 30%, and its beta (β) is 1.5. In addition, Tian (2004) takes the partial derivative of the subjective value of the CEO's portfolio with respect to either the systematic or idiosyncratic volatility, whereas Armstrong and Vashishtha (2012) calculate the percentage change in the subjective value for a 5% point change in either the systematic or idiosyncratic volatility. Moreover, Tian (2004) does not incorporate restricted stock in the manager's portfolio, but Armstrong and Vashishtha (2012) do.

frictions amid incomplete information idiosyncratic price may be priced (e.g., Merton 1987). These findings will make the predictions on the relationship between executive stock options and the two components of total risk less clear. Since prediction on how options affect systematic and idiosyncratic risk is not definitive, providing empirical evidence is important.

In addition to the mixed theoretical predictions, there is divergence between the theorized and empirical relation between options and idiosyncratic risk in Armstrong and Vashishtha (2012). Although Armstrong and Vashishtha (2012) predict that vega creates incentives to increase the level of idiosyncratic risk, they empirically find that vega is unrelated to idiosyncratic risk. This disagreement between the theoretical prediction and the empirical finding may be due to the difficulty of empirically establishing a causal relationship between executive stock options and managerial risk-taking. Like many other corporate decisions, executive compensation and executive risk-taking is endogenously determined. First, executive compensation and risk-taking decisions are likely to be made simultaneously. That is, the risk environment of the firm affects the compensation contract, and the manager's compensation contract in turn affects his risk-taking behavior, influencing the firm's risk profile. Second, there exist unobservable determinants for both executive compensation and risk-taking. Failing to control for such unobservable factors can lead to unreliable inferences. For example, CEO's risk aversion can determine his risk-taking as well as which firm he chooses to join (Oyer and Schaefer 2005). A risk-averse CEO may self-select into a less risky firm and, at the same time, choose to receive fewer stock options. In this case, we will find a positive relation between stock options and firm risk. Such a positive relationship between stock options and risk-taking does not suggest the causal effect of options on risk-taking but reflects the CEO's risk attitude. Thus, unless CEO risk aversion is properly controlled, which is a great challenge for empirical research, the observed empirical relation can be spurious. This potential endogeneity problem makes it difficult to establish causality and the observed relation could be biased.

To overcome these endogeneity concerns, I exploit the changes in the accounting treatment of stock-based compensation under Financial Accounting Standard (FAS) 123R, as an exogenous shock to option-based compensation, to provide *new* evidence on the causal effect of option-based pay on systematic and idiosyncratic risk. Prior to the implementation of FAS 123R, firms were allowed to expense stock options at their intrinsic value, as opposed to expensing stock options at their fair value under the new rule – FAS 123R. Because nearly all firms granted stock options at-the-money, firms generally reported no expenses for option-based compensation prior to FAS 123R. However, FAS 123R eliminated this favorable accounting treatment of option-based compensation, creating an exogenous incentive to reduce option pay. Consistent with this, prior studies (e.g., Brown and Lee 2011; Hayes, Lemmon, and Qui 2012) document that after the adoption of FAS 123R firms replaced stock option compensation with restricted stock. This resulted in modest or no change in delta, but lower vega (i.e., less convex payoff structure).[26] Importantly, this change in accounting reporting influences

[26] Delta measures the sensitivity of the manager's wealth to the firm's stock price, and vega measures the sensitivity of the manager's wealth to the firm's stock volatility.

CEO option compensation but is not likely to affect the firm's risk-taking opportunities. This shock to CEO option compensation allows me to investigate the *casual* effects of executive stock options on risk-taking.

I employ a difference-in-differences (DiD) design that compares the changes in systematic risk and idiosyncratic risk of firms that were, *ex ante*, likely to be more affected by FAS 123R (treatment group) to those of firms that were, *ex ante*, less likely to be affected (control group). I show that the *levels* of total, systematic, and idiosyncratic risk of firms that were, *ex ante*, more likely to reduce option-based compensation decreased after the implementation of FAS 123R. This indicates a positive relationship between stock options and the levels of total, systematic, and idiosyncratic risk. However, for those firms that were likely to reduce option compensation, systematic risk decreased more relative to idiosyncratic risk. As a result, the *proportion* of systematic risk over total risk for firms that were expected to reduce option-based compensation decreased (i.e., positive relationship between stock options and the proportion of systematic risk).

My findings suggest that, although stock options create incentive to increase both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that CEOs prefer projects that are primarily characterized by systematic risk than by idiosyncratic risk when they are given risk-taking incentives (Acharya and Bisin 2009; Armstrong and Vashishtha 2012).

This paper continues with Section 4.2, in which I develop my hypothesis. Section 4.3 describes data and variable measurement. Section 4.4 discuss empirical analysis and Section 4.5 concludes.

4.2. Hypotheses Development

Using the certainty equivalent valuation frame work which stipulates that the value of a stock option is equal to an immediate cash payment that provides the same utility as the risky option does for a risk-averse manager, Tian (2004) numerically demonstrates that stock options create incentive to reduce idiosyncratic risk. Since unrestricted investors can eliminate idiosyncratic risk through diversification, the firm's expected return is not influenced by idiosyncratic risk. Thus, any increase in idiosyncratic risk will increase the risk of executives' portfolio without any increase in expected return. In contrast, any increase in systematic risk will lead to an increase in the firm's expected return. Furthermore, a CEO can hedge any unwanted firm's systematic risk by trading the market portfolio. Tian (2004) shows that his result holds across assumptions regarding risk aversion, the proportion of option wealth in total wealth, and the ratio of exercise price to stock price.

Armstrong and Vashishtha (2012) not only numerically but also empirically investigate the effects of vega on systematic and idiosyncratic risk. Their numerical analysis shows that vega is positively associated with systematic risk, consistent with Tian (2004). In contrast to Tian (2004), they predict that vega has a positive effect on idiosyncratic risk as well. However, they predict that a larger portion of the increase in total risk caused by vega will come from an increase in systematic risk. This is because, for a given level of vega, an increase in systematic risk always results in a greater increase in a CEO's subjective value than does an equivalent increase in idiosyncratic risk. These differential risk-taking incentives stem from the CEOs' ability to hedge unwanted systematic risk by trading the market portfolio. In the empirical analysis, they document the positive relation between vega and the level of systematic risk, consistent with their predictions, but do not find a relation between vega and the level of idiosyncratic risk, in contrast to their prediction.

To summarize, Tian (2004) and Armstrong and Vashishtha (2012) both support the idea that vega provides managers incentive to increase systematic risk. Thus, my first hypothesis is:

H1: Executive stock options create incentives to increase the level of systematic risk.

Tian (2004) and Armstrong and Vashishtha (2012) provide mixed predictions about the relationship between vega and idiosyncratic risk, a difference that is potentially due to differences in model and parameter choices. Further, confounding the issue, in contrast to the most models in financial economics that state that only systematic risk should affect returns, recent studies (e.g., Goyal and Santa-Clara 2003; Ang, Hodrick, Xing, and Zhang 2006; Ang, Hodrick, Xing, and Zhang 2009; Fu 2009) provide empirical evidence that idiosyncratic risk is priced. Thus, the relation between stock options and idiosyncratic risk remains an empirical question. I state my second hypothesis in null form rather than make directional prediction.

H2: Executive stock options do not create incentives to increase the level of idiosyncratic risk.

4.3. Data and Variable Measurement

4.3.1. Sample

I obtain executive compensation data from Standard & Poor's (S&P's) Execucomp Database, financial statement data from S&P's Compustat Fundamental Annual Database, stock market-related data from the Center for Research in Security Prices (CRSP) Database. The initial sample consists of 10,768 firm-year observations in the ExecuComp database during the period 2002-2004 and the period 2006-2008. I define fiscal year 2006 as the beginning of the post-FAS123R period and exclude fiscal 2005 as it is a transitory year for FAS 123R.[27] Following prior literature, I exclude finance (SIC codes between 6000 and 6999) and utility firms (SIC codes between 4400 and 5000) because of their different regulatory environment. Since I employ difference-in-differences (DiD) research design, I require that all sample firms have at least one year of data in both the pre- and post-FAS 123R periods. My main sample consists of 3,546 firm-year observations (see Table 4-1 for sample selection procedure).

[27] FAS 123R was effective for fiscal year-ends beginning after June 15, 2005.

Table 4-1. Sample Selection

Sample Selection Procedure	Firm-year Observations
Execucomp from 2002 to 2004 and from 2006 to 2008	10,786
Less:	
Financial (SIC 6000 - 9000) and utilities (SIC 4000 - 4999) firms	(550)
Missing data for Execucomp variables	(2,408)
Missing data for Compustat variables	(2,466)
Missing data for CRSP variables	(162)
Missing data for Thomson Reuters Institutional (13f) Holdings variable	(471)
Not having at least one observation in both the pre- and post-FAS 123R periods	(1,183)
Total	**3,546**

4.3.2. Systematic and Idiosyncratic Risk

$$r_{i,d} = \alpha_i + \beta_i \, r_{mkt,d} + \varepsilon_i \quad (4.1)$$

I decompose total risk into systematic and idiosyncratic risk using the market model (Eq. (4.1)). $r_{i,d}$ is the daily stock return for firm i, and $r_{mkt,d}$ is the daily market return for day *d*. Systematic risk is the market beta multiplied by the annualized standard deviation of market return, and idiosyncratic risk is the annualized standard deviation of the error term in the market model. I estimate the market model using daily stock returns and utilize the CRSP equal-weighted market returns as my proxy for market returns model over the fiscal year.

4.4. Empirical Analysis

4.4.1. Descriptive Statistics

Table 4-2 presents the descriptive statistics of CEO compensation, equity incentives, risk variables, and firm and CEO characteristics. Panel A reports the descriptive statistics for my entire sample (excluding 2005), I find that annual option compensation comprises the biggest portion of the total compensation, sequentially followed by salary, bonus, and stock awards. Following Core and Guay (2002), I calculate a CEO's portfolio delta as the dollar change in the CEO's equity portfolio for a 1% change in stock price and a CEO's portfolio vega as the dollar change in the CEO's equity portfolio for a 1% change in stock volatility. The median CEO portfolio delta is $269,900 and the median CEO portfolio vega is $89,300, indicating that the median CEO's wealth changes by $269,900 for a 1% change in stock price and changes by $38,547 for a 1% change in firm volatility.

Table 4-2. Descriptive Statistics

This table presents descriptive statistics of my sample. My sample is constructed from the intersection of Execucomp (compensation), Compustat (accounting data), CRSP (stock price data), and Thomson Reuters Institutional (13f) Holdings (institutional ownership). All variables are as defined in Appendix E. ***, **, and * in Panel B denote statistical significance for the two-sample t-test at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

Panel A. Sample Period of 2002 to 2008 (Excluding 2005)

	Mean	*Std. Dev.*	*25th*	*Median*	*75th*
Fraction of CEO Compensation (%)					
Salary_pct	22%	14%	12%	18%	28%
Bonus_pct	19%	15%	8%	18%	28%
Option_pct	35%	25%	15%	33%	54%
Stock_pct	18%	22%	0%	7%	33%
Equity Incentives					
Delta (in $000s)	694	1,288	107	270	682
Vega (in $000s)	181	246	34	89	218

Risk Variables					
Total_risk	0.03	0.01	0.02	0.02	0.03
Idiosync_risk	0.0006	0.0009	0.0002	0.0004	0.0007
System_risk	0.0003	0.0004	0.0001	0.0001	0.0004
Idiosync/Total_risk	0.70	0.15	0.60	0.72	0.82
Control Variables					
σNI	0.05	0.05	0.02	0.03	0.06
MVE (in $millions)	8,014	17,812	757	2,058	6,419
Annret	0.07	0.43	-0.2	0.04	0.28
ROA	0.05	0.09	0.02	0.05	0.09
ΔNI	-2.37	27.6	-0.73	0.37	2.06
BTM	0.49	0.36	0.26	0.42	0.62
Lev	0.52	0.22	0.37	0.52	0.65
Instown	0.78	0.18	0.67	0.79	0.9
HHI	0.10	0.08	0.06	0.07	0.09
R&D	0.03	0.05	0	0.01	0.04
PP&E	0.25	0.21	0.1	0.2	0.34
CEO_Age	55.5	6.7	51.0	56.0	60.0
CEO_Tenure	7.7	6.8	3.0	6.0	10.0
CEO_Shrown	0.02	0.03	0.00	0.01	0.02

Panel B. Pre- and Post-FAS 123R Sample Periods

	Pre-FAS123R (2002-2004)		Post-FAS123R (2006-2008)		Difference	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Post - Pre*	
Fraction of CEO Compensation (%)						
Salary_pct	22%	15%	21%	14%	-1%	**
Bonus_pct	18%	14%	21%	15%	3%	***
Option_pct	44%	25%	26%	23%	-18%	***
Stock_pct	9%	16%	26%	23%	17%	***
Equity Incentives						
Delta (in $000s)	701	1,275	687	1,300	-14	
Vega (in $000s)	196	257	167	233	-29	***
Risk Variables						
Total_risk	0.02	0.01	0.03	0.02	0.01	***
Idiosync_risk	0.0004	0.0004	0.0009	0.0011	0.0004	***
System_risk	0.0001	0.0001	0.0005	0.0005	0.0004	***
Idiosync/Total_risk	0.78	0.11	0.63	0.16	-0.14	***
Control Variables						
σNI	0.05	0.06	0.05	0.05	-0.01	***
MVE (in $millions)	7,386	17,050	8,627	18,512	1,240	***

Annret	0.18	0.45	-0.04	0.38	-0.22	***
ROA	0.04	0.09	0.05	0.1	0.01	***
ΔNI	1.66	17.77	-6.32	34.15	-7.98	***
BTM	0.46	0.3	0.53	0.4	0.07	***
Lev	0.51	0.22	0.53	0.21	0.02	***
Instown	0.73	0.17	0.83	0.17	0.1	***
HHI	0.09	0.07	0.1	0.08	0.01	***
R&D	0.03	0.05	0.03	0.05	0.00	
PP&E	0.25	0.20	0.25	0.21	0.00	
CEO_Age	55.4	6.9	55.6	6.5	0.2	
CEO_Tenure	7.6	6.6	7.9	6.9	0.4	
CEO_Shrown	0.01	0.03	0.02	0.03	0.01	***

Panel B of Table 4-2 reports the descriptive statistics for the pre- and post-FAS 123R periods. The implementation of FAS 123R has affected CEO compensation structure. Although the proportion of salary and bonus compensation remain similar in magnitude between the pre- and post-FAS 123 periods, the composition of equity compensation has significantly changed. The average proportion of CEO option awards in total compensation decreased from 44% to 26% while the average proportion of CEO stock awards in total compensation increased from 9% to 26%. This is consistent with the findings in prior studies (e.g., Brown and Lee 2011; Hayes, Lemmon, and Qui 2012) that, after the adoption of FAS 123R, firms replaced stock option compensation with restricted stock, resulting in modest or no change in delta, but decreases in vega. My results confirm this. The average CEO portfolio delta decreased from $701,000 to $687,000 but the decrease is statistically insignificant. In contrast, the average CEO portfolio vega decreased from $196,000 to $167,000 and the decrease is statistically significant. I also document significant changes in my risk measures. The levels of the average total, idiosyncratic, and systematic risk increased after FAS 123R was adopted. However, the proportion of the average of idiosyncratic risk in total risk decreased.

4.4.2. Difference-in-differences Analysis

I employ a difference-in-differences (DiD) design that compares the changes in systematic risk and idiosyncratic risk of firms that were, ex ante, likely to be more affected by FAS 123R (treatment group) to those of firms that were, ex ante, less likely to be affected (control group). Importantly, this shock to CEO is not likely to affect the firm's risk-taking environment. Thus, the adoption of FAS 123R provides a quasi-natural experiment setting for testing the causal effect of option compensation on CEO risk-taking.

Following Hayes, Lemmon, and Qiu (2012), I define the perceived accounting costs of option expensing as the average value of the pro forma option expenses (deflated by fully diluted shares used to calculate earnings per share) the company reported in the pre-FAS 123R period of 2002-2004. This variable measures the amount by which earnings per share would be reduced if the option-based compensation had to be expensed at the fair market value. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact in the post-FAS 123R period and are expected to reduce option-based compensation relatively more than the control group.

The regression models take the following form:

$$Risk_{i,t+1} = \alpha_0 + \alpha_1 H\_Acct\_Impact * Post + \alpha_2 Post + \beta\ Controls_{i,t} + Firm\ FE + Time\ FE + \varepsilon_{it}, \quad (4.2)$$

where *Risk* is alternatively total risk, idiosyncratic risk, systematic risk, or idiosyncratic risk divided by the total risk. *POST* is one if year is in (2006, 2007, 2008), and zero if year is in (2002, 2003, 2004). I exclude fiscal 2005 as it is a transitory year for FAS 123R. Since I include firm-fixed effects, I omit *H_Acct_Impact* main effect to avoid the perfect multicollinearity problem. I control for firm characteristics that include the standard deviation of net income (σNI), firm size (*MVE*), past stock performance (*Annret*), past accounting performance (*ROA*), change in net income (ΔNI), growth opportunities (*BM*), financial leverage (*Leverage*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), R&D expenditures (*R&D*), and *PP&E*. I also include CEO characteristics that include CEO age (*Age*), CEO tenure (Tenure), and CEO share ownership (*Shrown*). All independent variables are lagged by one year. I also include time fixed effects to capture time variation and firm fixed effects to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

The positive coefficients on *Post* in Columns (1) – (3) in Table 4-3 indicate that the levels of total, idiosyncratic, and systematic risk have increased in the *L_Acct_Impact* firms during the post-FAS 123R period and the negative coefficient on *Post* in Column (4) indicates that the proportion of idiosyncratic risk in total risk has decreased. Since I employ DiD design, the variable of interest in Columns (1) – (4) is the interaction term of *H_Acct_Impact* * *Post*. The negative coefficients on the interaction term in Columns (1)

– (3) suggest that the *levels* of total, systematic, and idiosyncratic risk of firms that were, *ex ante*, more likely to reduce option-based compensation increase less than the control group after the implementation of FAS 123R. This indicates a positive relationship between stock options and the levels of total, systematic, and idiosyncratic risk. This is consistent with the prediction that vega is positively related to both systematic and idiosyncratic risk Armstrong and Vashishtha (2012). However, the positive coefficient on the interaction term in Column (4) indicate that the proportion of idiosyncratic risk over total risk of firms that were, *ex ante*, more likely to reduce option-based compensation increased relatively more than the control group after the implementation of FAS 123R. Reversely, *H_Acct_Impact* firms' decreased relatively more than *L_Acct_Impact* firms, suggesting positive association between CEO option compensation and the proportion of systematic risk over total risk.

Table 4-3. Difference-in-Differences (DiD) Analysis

This table presents results from difference-in-differences (DiD) analysis that estimates the effects of FAS 123R on total risk, idiosyncratic risk, systematic risk, and the proportion of idiosyncratic risk in total risk. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact in the post-FAS 123R period and, thus, to reduce option-based compensation more than the control group. *Post* is one if year is in (2006, 2007, 2008) and zero if year is in (2002, 2003, 2004). I require that all sample firms have at least one year of data in both the pre- and post-FAS 123R periods. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix E. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1)	(2)	(3)	(4)
	Total_risk	*Idiosync_risk*	*System_risk*	*Idiosync/Total_risk*
*H_Acct_Impact*Post*	-0.00460***	-0.00331***	-0.00304***	0.0171***
Post	0.0146***	0.00850***	0.0121***	-0.117***
σNI	0.0370***	0.0291***	0.0207***	-0.0758*
MVE	-0.00347***	-0.00446***	0.000274	-0.0304***
Annret	0.000416	0.000966**	-0.000467	0.0103***

ROA	-0.0130***	-0.0119***	-0.00436	-0.00849
ΔNI	-0.0000269**	-0.0000217**	-0.0000158**	-0.0000624
BTM	0.00410***	0.00371**	0.00212**	0.00561
Lev	0.00436	0.00463*	0.000188	0.0177
Instown	-0.00108	-0.000826	0.00300*	0.0228
HHI	0.0116	0.0119	0.000358	0.0268
R&D	-0.0591***	-0.0523***	-0.0241**	0.0223
PP&E	-0.00111	-0.00105	0.000494	0.00504
CEO_Age	0.00294	0.00226	0.00134	0.0105
CEO_Tenure	0.000141	0.000228	0.0000545	-0.000227
CEO_Shrown	0.00914	0.00605	0.00447	0.0186
Intercept	0.0337**	0.0405***	0.000319	1.019***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	3,546	3,546	3,546	3,546
Adj. R-sq	0.685	0.664	0.662	0.634

The volatility of accounting performance (σ*NI*) is positively associated with total, idiosyncratic, and systematic risk but is negatively associated with the proportion of idiosyncratic risk in total risk. Firm size (*MVE*) is negatively associated with total risk, idiosyncratic risk, and the proportion of idiosyncratic risk in total risk. Accounting performance measures (*ROA* and Δ*NI*) are, in general, negatively associated with the levels of each risk type but are not significantly associated with the proportion of idiosyncratic risk. Firm growth opportunities (*BTM*) has negative impacts on total, idiosyncratic, and systematic risk but has no impact on the proportion of idiosyncratic risk in total risk

Combined, my findings suggest that, although stock options create incentive to increase the levels of both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that CEOs prefer projects that are primarily characterized by systematic risk than by idiosyncratic risk when they are given risk-taking incentives (Acharya and Bisin 2009; Armstrong and Vashishtha 2012; Panousi and Papanikolaou 2012).

4.4.3. Difference-in-differences Analysis: Placebo Tests

An important assumption when using a difference-in-differences approach in a natural experiment framework is the parallel trends assumption—that is, in the absence of treatment, the treatment and control groups would have behaved similarly. One way to validify the parallel trends assumption suggested by Roberts and Whited (2013) is to conduct a placebo (falsification) test. I conduct two placebo tests.

In the first placebo test, I create a pseudo event and examine whether the pseudo event has similar effects on firm risk-taking as FAS 123R. Finding no effects of the placebo event on CEO risk-taking would provide validation on my baseline results. I randomly choose 1999 as my pseudo event year. Similar to the baseline research design, I define pre-pseudo event period as the prior three years before the event (i.e., 1997-1999) and post-pseudo event period as the following three years after the event (i.e., 2001-2003). I define H_*ACCT*_Impact as one if the firm's average pro forma option expense is above the sample median in the pre-pseudo event period, and zero otherwise. I require that all sample firms have at least one year of data in both the pre- and post-pseudo event periods. Table 4-4 reports the results for the pseudo event of 1999. The coefficients of *H_Acct_Impact * Post_psedu* is insignificant in (1), (2), and (4) and the coefficient in Column (3) is only marginally significant. This result suggests that the pseudo event has no or minimal effects on firm risk, weakening the possibility that my main results in Table 4-3 is driven by unparallel trends between the treatment and control groups.

Table 4-4. Difference-in-Differences (DiD) Analysis: Placebo Test – Pseudo Event

This table presents results from difference-in-differences (DiD) analysis that estimates the effects of pseudo event on total risk, idiosyncratic risk, systematic risk, and the proportion of idiosyncratic risk in total risk. I randomly choose 1999 as my pseudo event year. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-peudo event period (treatment group), and zero otherwise (control group). *Post_Pseudo* is one if year is in (2000, 2001, 2002) and zero if year is in (1996, 1997, 1998). I require that all sample firms have at least one year of data in both the placebo pre- and post-pseudo event periods. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix E. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Total_risk*	(2) *Idiosync_risk*	(3) *System_risk*	(4) *Idiosync/Total_risk*
*H_Acct_Impact*Post_Pseudo*	0.0000698	-0.000382	0.000779*	-0.00244
Post_Pseudo	-0.000445	-0.00142**	0.00203***	-0.0626***
σNI	0.0275***	0.0243***	0.00845*	0.0268
MVE	0.000217	-0.000282	0.000824**	-0.00689*
Annret	0.00150***	0.00165***	0.000138	0.00626**
ROA	-0.0153***	-0.0135***	-0.00524**	-0.00353
ΔNI	-0.0000207	-0.0000170	-0.00000359	0.0000580
BTM	0.00635***	0.00636***	0.00104*	0.0111*
Lev	0.00728***	0.00712***	0.000724	0.0104
Instown	-0.00677***	-0.00691***	0.000215	-0.0145
HHI	0.00548	0.00896	-0.00618	0.0650
R&D	-0.00624	-0.00353	-0.00244	0.0590
PP&E	-0.00432	-0.00223	-0.00570***	0.0318
CEO_Age	-0.00327	-0.00261	-0.00175	0.0196
CEO_Tenure	0.000604*	0.000477	0.000353*	-0.00225
CEO_Shrown	-0.0121	-0.0116	-0.000407	-0.0687
Intercept	0.0323**	0.0311**	0.00961	0.890***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	2,957	2,957	2,957	2,957
Adj. R-sq	0.732	0.732	0.650	0.591

In the second placebo test, I use the same pre-event (2002-2004) and post-event (2006-2008) periods as I do in my main test but randomly assign my sample firms to treatment and control groups. *H_Acct_Impact_Pseudo* is one if a firm is randomly assigned into the treatment group and zero otherwise. I find that none of the coefficients in Columns (1) – (4) in Table 4-5 is significant, indicating that the random treatment has no effects on firm risk. Combined together, the results from the placebo tests lend support my baseline results that FAS 123R causes differential risk-taking behavior for treated and control groups.

Table 4-5. Difference-in-Differences (DiD) Analysis: Placebo Test – Pseudo H_Acct_Imp

This table presents results from difference-in-differences (DiD) analysis that estimates the effects of pseudo *H_ACCT_Impact* on total risk, idiosyncratic risk, systematic risk, and the proportion of idiosyncratic risk in total risk. I use the same pre-event (2002-2004) and post-event (2006-2008) periods as I do in Table 3-3. *Post* is one if year is in (2006, 2007, 2008) and zero if year is in (2002, 2003, 2004). However, I randomly assign my sample to the treatment and control groups. *H_Acct_Impact_Pseudo* is one if a firm is randomly assigned into the treatment group and zero otherwise. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix E. All columns include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

	(1) *Total_risk*	(2) *Idiosync_risk*	(3) *System_risk*	(4) *Idiosync/Total_risk*
*H_Acct_Impact_Pseudo*Post*	-0.000504	-0.000250	-0.000340	0.00450
Post	0.0125***	0.00698***	0.0108***	-0.110***
σNI	0.0424***	0.0328***	0.0243***	-0.0970**
MVE	-0.00375***	-0.00466***	0.0000922	-0.0294***
Annret	0.000305	0.000886*	-0.000541	0.0107***
ROA	-0.0126***	-0.0116***	-0.00412	-0.00998
ΔNI	-0.0000268**	-0.0000216**	-0.0000157**	-0.0000640
BTM	0.00370**	0.00343**	0.00186*	0.00712
Lev	0.00314	0.00376	-0.000618	0.0224
Instown	-0.000550	-0.000451	0.00335*	0.0207
HHI	0.0169	0.0157	0.00384	0.00687
R&D	-0.0641***	-0.0560***	-0.0275**	0.0405
PP&E	-0.00165	-0.00147	0.000137	0.00631

CEO_Age	0.00161	0.00132	0.000456	0.0157
CEO_Tenure	0.000320	0.000354	0.000173	-0.000946
CEO_Shrown	0.00288	0.00159	0.000326	0.0427
Intercept	0.0410***	0.0456***	0.00509	0.992***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	3,546	3,546	3,546	3,546
Adj. R-sq	0.678	0.659	0.655	0.632

4.5. Conclusions

In this paper, I exploit the passage of Financial Accounting Standard (FAS) 123R to provide new evidence on how executive stock options differentially affect firm's systematic and idiosyncratic risk. I use this accounting regulatory change that removed the favorable accounting treatment of option-based compensation as an exogenous shock to CEO option compensation.

Although the impact of executive stock options on risk-taking has been extensively studied, prior studies focus on the firm's *total* risk. However, managers may perceive *systematic* and *idiosyncratic* risk differently than diversified shareholders. Even the studies that study the relation between option-based compensation and systematic and idiosyncratic risk differ in their predictions. Tian (2004) and Armstrong and Vashishtha (2012) both support the positive impact of stock options on systematic risk. However, Tian (2004) predicts negative relation between stock options and idiosyncratic risk but Armstrong and Vashishtha (2012) predict the positive relation. The mixed predictions in the literature about the relationship between stock options and idiosyncratic risk is potentially due to the difficulty of modelling the manager's utility function and due to the difficulty of establishing a causal relationship between executive stock options and managerial risk-taking in empirical studies.

Thus, providing new evidence on the causal relationship is meaningful. I find that the levels of total, systematic, and idiosyncratic risk of firms that were, ex ante, more likely to reduce option-based compensation decreased relatively more than the control group after the implementation of FAS 123R. This indicates a positive relationship between stock options and the levels of total, systematic, and idiosyncratic risk. This is consistent with the prediction that vega is positively related to both systematic and idiosyncratic risk Armstrong and Vashishtha (2012). In addition, I provide evidence that option-based compensation is negatively associated with the proportion of idiosyncratic risk over total risk and option-based compensation is positively associated with the proportion of systematic risk over total risk.

My findings suggest that, although stock options create incentive to increase both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that CEOs prefer projects that are primarily characterized by systematic risk than by idiosyncratic risk when they are given risk-taking incentives (Acharya and Bisin 2009; Armstrong and Vashishtha 2012). My findings are consistent with the idea that idiosyncratic risk is unwanted by under-diversified managers and systematic risk is preferred by CEOs since systematic risk is priced by the market and CEOs can hedge any unwanted systematic risk by trading the market portfolio.

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APPENDIX A
VARIABLE DEFINITIONS – CHAPTER 2

Incentive Variables	
LnCashComp	Natural logarithm of one plus the cash compensation received by the CEO during the fiscal year.
LnDelta	Natural logarithm of one plus the sensitivity of the CEO's stock and option holdings to a 1% change in stock price (Core and Guay 2002).
LnEquitySens	Natural logarithm of one plus the sensitivity of the CEO's stock and option holdings to a 1% change in firm volatility (Core and Anderson 2017).
LnExcessDelta	Residuals from the optimal delta model (see Appendix B).
LnExcessEquitySens	Residuals from the optimal equity sensitivity model (see Appendix B).
LnNewDelta	Natural logarithm of one plus the sensitivity of stock and options granted to the CEO in year *t* to a 1% change in stock price.
LnNewEquitySens	Natural logarithm of one plus the sensitivity of stock and options granted to the CEO in year *t* to a 1% change in firm volatility.
Earnings Management Variables	
DACC	Signed discretionary accruals (Kothari, Mizik, and Roychowdhury 2016; see Eq. (2.2)).
REM	Abnormal discretionary expenses, which are the sum of R&D, SG&A, and advertising expenses, multiplied by -1 (see Eq. (3.1)).
Control Variables	
LnMVE	Natural logarithm of market value of equity.
BTM	Book-to-market value of equity.
Leverage	Total liabilities divided by total assets.
LnFirmAge	Natural logarithm of the number of years the firm appears on Compustat.
R&D	Research and development expenses scaled by total assets.
Investment	The three-year average of the sum of capital expenditures plus acquisitions
ROA	Net income before extraordinary items scaled by total assets.
Annret	Buy-and-hold annual return.
σ*CFO*	Standard deviation of cash flows from operations over the prior ten years scaled by total assets.
σ*Sales*	Standard deviation of sales over the prior ten years scaled by total assets.
LnCEOTenure	Natural logarithm of one plus CEO tenure.
LnCEOAge	Natural logarithm of one plus CEO age.
CF Shortfall	The three-year average of [(common and preferred dividends + cash flow from investing - cash flow from operations)/total assets].
σ*Ret*	Standard deviation of daily returns over the year.
σ*(Idio_Risk)*	Standard deviation of the residuals of the market model, estimated with daily returns, over the year.
Free CF Prob	1 if the book-to-market ratio is less than 1 and is the three-year average of [(cash flow from operations - common and preferred stock dividends)/total assets], otherwise.
Instown	The percentage of total intuitional ownership over common shares outstanding.
H_InstInvestor	1 if the percentage of institutional investor holdings in the firm is higher than the median of institutional investor holdings by fiscal year, and zero otherwise.

APPENDIX B
OPTIMAL CEO EQUITY INCENTIVES

This table presents results from OLS regressions that estimate the optimal level of CEO equity incentives in terms of delta and equity sensitivity. I estimate the following regression models: $LnDelta_{it-1}$ (or $LnEquitySens_{it-1}$) = $\beta_0 + \beta_1\ LnCashComp_{it-1} + \beta_2\ Annret_{it-1} + \beta_3\ LnMVE_{it-1} + \beta_4\ BTM_{it-1} + \beta_5\ Leverage_{it-1} + \beta_6\ R\&D_{it-1} + \beta_7\ Investment_{it-1} + \beta_8\ \sigma(Idio\ Risk)_{it-1} + \beta_9\ LnTenure_{it-1} + \beta_{10}\ Age_{it-1}$ + *Firm Fixed Effects* + *Year Fixed Effects* + u_{it-1} (or v_{it-1}). The residual, u_{it-1} (v_{it-1}), is $ExcessDelta_{it-1}$ ($ExcessEquitySens_{it-1}$). All dependent and independent variables are measured one year prior to new equity incentive grants (year *t-1*). All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix A. All columns include firm fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses. Sample includes a total of 10,727 firm-years (1,168 firms) from 1995 to 2015.

	(1) *LnDelta*	(2) *LnEquitySens*
LnCashComp	0.102***	0.165***
Annret	0.146***	-0.0315
LnMVE	0.692***	0.258***
BTM	-0.430***	0.0202
Levearge	-0.173	0.752***
R&D	-0.544	-2.116**
Investment	0.139	0.0868
σ(Idio Risk)	2.114	-3.088
LnCEOTenure	0.439***	0.310***
LnCEOAge	0.207	-1.004***
Intercept	-3.095***	2.469**
Firms Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
N	10,727	10,727
adj. R-sq	0.845	0.709

APPENDIX C
ASYMMETRIC PAYOFF OF STOCK OPTIONS

The following illustrate the point that stock options do not provide downside protection. Consider the following case. A CEO is granted $1,000,000 worth of either at-the-money stock options or restricted stock. I assume that the exercise price equals the stock price at grant = $30, estimated volatility = 0.2, maturity = 10 years, the risk-free rate = 0.03, and dividend yield = 0%. Assuming the company uses the Black-Scholes model, the CEO will receive either 90,467 shares of stock options or 33,333 shares of restricted stock. If stock price increases by 90% at maturity[28], the final payoffs of stock options and restricted stock are $2,442,614 and $1,900,000, respectively. In contrast, if stock price decreases by 90% at maturity, the final payoffs of stock options and restricted stock are $0 and $100,000, respectively. This numerical example demonstrates the asymmetric payoff of stock options with respect to downside risk versus upside potential.

Annual increase/decrease in stock price	Value of options after 10 years ($)	Value of shares after 10 years ($)
-6.6%	0	100,000
0%	0	1,000,000
6.6%	2,442,614	1,900,000

[28] Annual return of 6.6% will generate stock return of 0.9 if it is yearly compounded for 10 years.

APPENDIX D
VARIABLE DEFINITIONS – CHAPTER 3

Dependent variables	
Cash_Awards	Natural logarithm of one plus the cash compensation received by the CEO during the fiscal year.
Option_Awards	Natural logarithm of one plus the option compensation received by the CEO during the fiscal year.
Stock_Awards	Natural logarithm of one plus the restricted stock compensation received by the CEO during the fiscal year.
Equity_Awards	Natural logarithm of one plus the restricted stock and option compensation received by the CEO during the fiscal year.
Cash_Awards (%)	Percentage of the cash compensation over the total compensation received by the CEO during the fiscal year.
Option_Awards (%)	Percentage of the option compensation over the total compensation received by the CEO during the fiscal year.
Stock_Awards (%)	Percentage of the restricted stock compensation over the total compensation received by the CEO during the fiscal year.
Equity_Awards (%)	Percentage of the restricted stock and option compensation over the total compensation received by the CEO during the fiscal year.
Option/Equity	Option compensation over the sum of option and restricted stock compensation.
Asymmetric risk variables	
$Rel\beta^-$	Downside beta minus beta (Ang, Cheng, and Xing 2006; see Eq. (3.1)).
$Rel\beta^+$	Upside beta minus beta (Ang, Cheng, and Xing 2006; see Eq. (3.1)).
$\beta^- - \beta^+$	Downside beta minus upside beta (Ang, Cheng, and Xing 2006; see Eq. (3.1)).
DUVOL	Natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the ‘‘down’’ days to the standard deviation of firm-specific daily returns in the ‘‘up’’ days (Chen, Hong, and Stein 2001; Kim, Li, and Zhang 2011; see Eq. (3.2)).
Control variables	
β	Market beta estimated from the market model.
σIR	Standard deviation of the residuals of the market model, estimated with daily returns, over the year.
σRet	Standard deviation of daily returns over the year.
σNI	Standard deviation of net income before extraordinary items over the prior five years ending in year *t*. Minimum of 3 observations required.
MVE	Natural logarithm of market value of equity.
Annret	Buy-and-hold annual return.
ROA	Net income before extraordinary items scaled by total assets.
ΔNI	Change in net income before extraordinary items divided by fiscal year-end stock price.
BTM	Book-to-market value of equity.
Leverage	Total liabilities divided by total assets.
BigN	An indicator for big N auditor.
Instown	The percentage of total intuitional ownership over common shares outstanding.

HHI	Herfindahl-Hirschman Index. Sum of the squares of the net sales of each firm in an industry.
Free_CF	Operating cash flow minus capital expenditures divided by market value of equity
R&D	Research and development expenses scaled by total assets.
PP&E	Net property, plant, and equipment scaled by total assets.
CEO_Age	Natural logarithm of one plus CEO age.
CEO_Tenure	Natural logarithm of one plus CEO tenure.
CEO_Shrown	The number of shares of the firm owned by the CEO divided by the total number of shares of the firm.
Duality	An indicator for CEO-Chairman duality.
Male	One if the CEO is male, zero otherwise.

APPENDIX E
VARIABLE DEFINITIONS – CHAPTER 4

Risk (dependent) variables	
Total_risk	Standard deviation of daily returns over the year.
Idiosync_risk	Market beta multiplied by the annualized standard deviation of market return.
System_risk	Annualized standard deviation of the error term in the market model.
Idiosync/Total_risk	*Idiosync_risk* divided by *Total_risk*.
CEO compensation	
Salary_pct	Percentage of the salary compensation over the total compensation received by the CEO during the fiscal year.
Bonus_pct	Percentage of the bonus compensation over the total compensation received by the CEO during the fiscal year.
Option_pct	Percentage of the option compensation over the total compensation received by the CEO during the fiscal year.
Stock_pct	Percentage of the stock compensation over the total compensation received by the CEO during the fiscal year.
CEO equity incentives	
Delta	The sensitivity of the CEO's stock and option holdings to a 1% change in stock price (Core and Guay 2002).
Vega	The sensitivity of the CEO's option holdings to a 1% change in the standard deviation of daily stock return (Core and Guay 2002).
Test variables	
H_Acct_Impact	One if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group)
Post	One if year is in (2006, 2007, 2008), and zero if year is in (2002, 2003, 2004).
Control variables	
σRet	Standard deviation of daily returns over the year.
σNI	Standard deviation of net income before extraordinary items over the prior five years ending in year *t*. Minimum of 3 observations required.
MVE	Natural logarithm of market value of equity.
Annret	Buy-and-hold annual return.
ROA	Net income before extraordinary items scaled by total assets.
ΔNI	Change in net income before extraordinary items divided by fiscal year-end stock price.
BTM	Book-to-market value of equity.
Leverage	Total liabilities divided by total assets.
Instown	The percentage of total intuitional ownership over common shares outstanding.
HHI	Herfindahl-Hirschman Index. Sum of the squares of the net sales of each firm in an industry.
R&D	Research and development expenses scaled by total assets.
PP&E	Net property, plant, and equipment scaled by total assets.
CEO_Age	Natural logarithm of one plus CEO age.
CEO_Tenure	Natural logarithm of one plus CEO tenure.

CEO_Shrown	The number of shares of the firm owned by the CEO divided by the total number of shares of the firm.