CEO Incentives and Downside Risk

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Abstract

We examine whether CEO equity incentives are related to firm risk. Our study differs from prior research in that we distinguish between upside and downside firm risk. Our study is prompted by the simple observation that variance is a symmetric and unconditional risk measure that may not capture how CEOs judge risk. For a sample of about 2,600 firms from 1992 to 2008, we find that CEO incentives reflect both the asymmetry and the conditional nature of firm risk. In particular, CEO incentives are negatively related to downside risk but positively related to upside risk, consistent with the notion that CEOs perceive potential losses as riskier than potential gains. We also find that CEO incentives reflect upside and downside systematic risk. Our results hold after we control for other firm-specific and CEO characteristics known to affect incentives. One conclusion from our findings is that CEO equity incentives reflect risk asymmetrically, consistent with psychology research. To the extent that they are not already doing so, compensation committees might tailor contracts to reflect the differential importance of downside and upside risk. From a research perspective, failing to consider these richer risk measures could lead to false inferences about the efficacy and efficiency of CEO incentives and compensation contracts.

CEO Incentives and Downside Risk

Introduction

This study investigates whether certain previously unexplored firm-risk characteristics are empirically related to CEO equity-based incentives. Our study differs from prior research in that we consider firm-risk measures other than variance. We are motivated by the simple observation that variance is a symmetric and unconditional risk measure that may not capture how CEOs judge their firms' risk (Slovic 1987; Henderson 2005; Koonce, McAnally and Mercer 2005) and therefore, may not be solely relevant in structuring optimal incentives. Our study reconsiders the oft-documented relation between incentives and risk by disaggregating firm risk. Consistent with prior studies, we define incentives as the degree to which CEO wealth is linked to stock-market performance (i.e. pay-performance sensitivity or PPS). We explore the differential impact of downside versus upside firm risk on pay-performance sensitivities. Our tests control for other CEO characteristics and firm-specific operating, investing, and financing factors known to affect optimal CEO incentives.

Much of the theoretical and empirical literature on CEO incentives measures firm risk as stock-price variance (or volatility, or standard deviation, or some other variant of a second-moment measure).[1] However, variance may be an incomplete risk proxy for two inter-related reasons. First, psychology research finds that people's risk judgments are asymmetric (Libby and Fishburn 1977; Kahneman and Tversky 1979). People (including CEOs) are more sensitive to economic losses relative to economic gains. Therefore, because variance is a symmetric risk measure, it might not fully capture the perceived risk of equity-based holdings for risk-averse CEOs. Our study overcomes this issue by including a number of downside risk proxies.

[1] Hereafter, we use the term variance to refer to these various second-moment risk measures.

Consistent with the notion that CEOs are averse to potential losses, we expect that CEO incentives are decreasing in downside risk.

Second, total firm risk comprises market risk and firm-specific risk and CEOs with equity-based holdings are exposed to both types of risk. Intuitively, we might expect that these two types of risk matter differently to CEOs and thus, have differential impact on optimal incentives. All investors are exposed to idiosyncratic risk, but unlike other investors, CEOs may be unable to completely diversify their exposure to their firm's market risk because of personal wealth constraints and the excessive cost (and routine prohibition) of short-selling. A number of studies (e.g., Jin 2002 and Garvey and Milbourn 2003) disaggregate firm risk and find that CEO incentives are related to idiosyncratic risk but largely unrelated to beta. This latter result may owe to the fact that these studies are silent on the potential asymmetric effect of upside versus downside beta (Bawa and Lindenberg 1977; Estrada 2003). Thus, we extend this stream of research by disaggregating beta into upside and downside betas as a further refinement of market risk. Consistent with the notion of CEO loss aversion, we expect CEO incentives are decreasing in downside beta.

We use OLS regressions to test the relation between CEO incentives and firm-risk measures including: downside and upside semivariance, relative semivariance (i.e., upside relative to downside semivariance), and downside and upside beta. To enhance our study's comparability to a broad swath of extant CEO incentive research, we measure CEO incentives as the ex ante sensitivity of CEO wealth to shareholder percent returns (Core and Guay 1999). Consistent with prior studies, we capture CEO wealth by combining the value of the CEO's holdings of both stock and options. Importantly, our regressions include the variance of the company's stock return to control for overall firm risk.[2] We also control for firm-specific factors known to affect CEO compensation (size, leverage, potential agency conflict, and investment opportunities) as well as for CEO-specific factors.

For a sample of 21,139 firm-year observations from 1992 to 2008, we find that downside risk is negatively associated with CEO incentives. Consistent with Core and Guay (1999), we find that stock-price variance is positively related to CEO pay performance sensitivity even after including our downside risk metrics, which implies that compensation contracts impound both total risk and downside risk incrementally.

To further explore the relation between incentives and asymmetric risk, we disaggregate total CEO incentives into PPS from options versus stock. Confirming our expectations, incentives relating to the CEO's options are positively related to upside risk but unrelated to downside risk. This is consistent with the economics of options, which provide the CEO incentives on the upside and protection on the downside. In contrast, and as expected, both upside and downside risk are strongly related to CEO incentives from stock.

When we disaggregate market risk, we find that both idiosyncratic risk and market risk (beta) are significantly related to CEO incentives. This result contrasts with prior research that finds weaker results for beta (Jin 2002).[3] However, the hypothesized negative relation between downside beta and incentives only obtains during bear markets. This suggests that CEOs are most concerned with downside systematic risk when the market is down.

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[2] Following Core and Guay (1999), we use variance of percent returns. This is consistent with our dependent variable, sensitivity to a one percent change in stock price (i.e. percent return). We discuss this empirical choice more fully in the research design section. In untabulated results, we also use the Jensen and Murphy (1990) measure of ex ante sensitivity to a $1,000 change in firm value. Our inferences are largely unaffected by the choice of the dependent PPS variable.

[3] Differences in our research design compared to Jin (2002) might explain our stronger results. As Core and Guay (2002) demonstrate, dollar-return variance as used by Jin (2002) fails to properly control for the effect of firm size on variance.

Our study contributes to the debate on whether or not incentives created by equity-based compensation incent managers to act in the best interests of shareholders. Specifically, we find that CEO pay-performance sensitivities seem to impound risk characteristics identified by prior psychology, finance, and accounting research as important to risk assessment. While we do not claim that compensation committees specifically consider asymmetric and conditional risk measures in setting CEO compensation, CEO pay-performance measures seem to reflect more than variance. In addition, our results suggest that using variance to generalize about the effects of risk on equity-based compensation or incentives is incomplete.

In the next section, we expand on our motivation for the study and present our hypotheses. We then describe our sample and present our empirical results before we conclude in the final section.

Hypothesis Development

A common theoretical underpinning for compensation research is the principal-agency (PA) framework that predicts optimal compensation contracts under certain modeled conditions, including firm risk (Holmstrom 1979; Holmstrom and Milgrom 1987). PA models are equilibrium models: they predict the effect of firm risk on the optimal compensation contract, including any equity-based compensation. In general, firm risk affects the optimal contract because the expected payoff from equity-based compensation depends on future stock price or return, which is uncertain at the contract's inception.[4] Hemmer (2007) points out that the basic PA models do not unambiguously predict either a negative or positive relation between firm risk and optimal incentives. In particular, because firm risk is endogenous, changes in the agent's effort level can (and do) affect equilibrium risk levels. Thus, the PA model, "predicts a positive

[4] PA models also predict what action (or effort) the CEO will choose given both firm risk and the incentives created by the compensation contract. Our study does not consider how CEO's actions affect ex post firm risk.

relation between risk and incentives if achieving the higher effort level requires stronger incentives. A negative relation is predicted only if the higher effort can be achieved with weaker incentives." (Hemmer 2007 page 126).

Not surprising therefore, empirical tests of PA models report mixed results with respect to the relation between firm risk (i.e. variance) and incentives created by equity-based compensation.[5] Many studies document a *negative* relation between variance and incentives (e.g., Garen 1994; Aggarwal and Samwick 1999; and Lambert and Larcker 2004), whereas other studies propose (and/or find) a *positive* relation (e.g., Demsetz and Lehn 1985; Core and Guay 1999; Prendergast 2002; Campbell 2003; and Dodonova and Khoroshilov 2006). This conflicting evidence on the direction of the relation between firm risk and incentives might be explained by different empirical specifications, the most significant of which is the treatment of firm size. For example, Aggarwal and Samwick (1999) define variance in terms of dollar returns. Core and Guay (2002) point out that dollar returns are highly correlated with firm size (which itself is highly correlated with CEO compensation and firm-related wealth). Core and Guay (2002) correct econometrically for the effect of size in dollar-return variance by disaggregating dollar-return variance into percent-returns variance (risk) and market capitalization (size); and report that CEO incentives are negatively related to size and positively related to variance.

Theoretical predictions and empirical findings aside, we posit that the variance measure itself may not fully capture firm risk. Variance is a symmetric, unconditional risk measure that puts equal weight on observations above and below the mean. Prior research shows that both asymmetry and the conditional nature of risk affect individuals' risk assessment. Clearly, CEOs

[5] The PA work we cite above generally considers optimal compensation contracts. Empirical tests of PA models use as their dependent measure periodic compensation as well as equity ownership levels (i.e., firm-related wealth). We follow the latter stream of literature, consistent with the notion in Core and Guay (1999) that periodic incentive grants respond to the deviation between optimal incentive levels and CEOs' existing incentives that arise from firm-related wealth.

weigh upside potential and downside risk differently and, we maintain that it is a CEO's assessment of firm risk that affects the compensation contract he is willing to accept and the optimal level of incentives he continues to hold. Consequently, in equilibrium, it is CEO's assessed firm risk and not firm risk as depicted in theoretical models, that is of interest. Failing to either model or control for the asymmetry and the conditional nature of firm risk may lead to erroneous inferences about optimal CEO incentives.

Downside risk and CEO incentives

That investors place different importance on downside losses relative to upside gains is not a new idea: early theoretical finance research acknowledged the notion. For example, Markowitz (1956 and 1959) considered mean-semivariance portfolio optimization. Markowitz (1959) shows that, with normal distributions, both the downside semivariance and the variance provide appropriate portfolio allocations. However, if distributions are not normal, only the downside risk measure yields appropriate allocations. Nonetheless, "after proposing the semivariance measure, Markowitz (1959) stayed with the variance measure because it was computationally simpler. The optimization models using a … semicovariance (matrix) require twice the number of data inputs than the variance model. With the lack of cost-effective computer power and the fact that the variance model was already mathematically very complex, this was a significant consideration…" (Nawrocki 1999, page 4) While less prominent than the mean-variance CAPM, semivariance continues to inform theoretical asset-pricing models (see for example, Markowitz 1987; Markowitz, Todd, Xu and Yamane 1993; and Estrada 2003).

Theoretical psychology research also acknowledges that people do not have a symmetrical view of risk. In their influential piece on risky decision making, Kahneman and Tversky (1979) introduce a "value function" to individuals' expected utility calculations. The value function assigns higher values to loss outcomes than to gain outcomes so that for a given variation in absolute value, there is a bigger (negative) impact to utility of losses than of gains. Ensuing research concludes that the value function explains oft-witnessed loss aversion among investors as well as seemingly incongruous behavior, such as people who buy both insurance policies and lottery tickets. The takeaway from this psychology research is that individuals (including CEOs) are more sensitive to economic losses relative to economic gains and risk. Risk measures that ignore asymmetric risk weighting underestimate the significance of downside exposure to CEOs.

More recent empirical research in both accounting and finance confirms the theoretical findings discussed above: investors view risk asymmetrically and investment decisions and asset prices reflect an asymmetric notion of risk (e.g. Shefrin and Statman 1985; Rom and Ferguson 1997/98; Odean 1998; Koonce, McAnally, and Mercer 2005). The upshot from these various streams of empirical research is that variance is not completely descriptive of how investors (including CEOs) judge firm risk because variance captures risk on the downside as well as opportunity on the upside. Clearly, upside potential is valuable to CEOs and thus, as variance increases so does opportunity. But downside exposure is costly to CEOs and thus, as variance increases so does risk of loss. This leads to our first prediction, that holding variance (or upside potential) constant, CEO incentives are incrementally decreasing in downside risk.

That variance fails to capture upside potential and downside risk separately would not pose a problem for stock-based compensation if stock returns were symmetrically distributed. In that event, a CEO would understand that downside observations (for example, those below the mean) are just as likely as those above and select a value function consistent with features documented in Kahneman and Tversky (1979). But stock returns are not symmetrical; they are positively skewed (Harvey and Siddique 2000), and this skewness directly affects the CEO's assessed firm risk.[6] Because a positively skewed distribution has a greater likelihood of positive outcomes, it is less risky to the CEO than a symmetric distribution with the same variance. Consequently, contracts denominated in stock price or stock returns are implicitly affected by skewness.

People prefer skewness (Chiu 2005) and a number of empirical studies report skewness preference in gambling settings (Golec and Tamarkin 1998; Garret and Sobel 1999). In the financial domain, there is theoretical support for the notion that skewness plays a role in the CEO's equity-based compensation: Hemmer, Kim and Verrecchia (2000) develop a PA model that explicitly incorporates stock-price skewness. A key finding in Hemmer et al. (2000) is that holding mean stock price constant, optimal convexity in CEO compensation is decreasing in stock-price skewness. In particular, Hemmer et al. (2000) show that the relative level of stock options to stock grants is decreasing in skewness. The intuition is that, holding mean stock price constant, higher skewness implies the stock-price distribution has more probability mass on higher outcomes; and thus, the CEO is exposed to less downside risk.[7]

Surprisingly, the analytical predictions in Hemmer et al. (2000) have not been examined empirically. Thus, our second prediction concerns the effects of skewness on optimal incentives. Because the sensitivity of options to stock-price changes (i.e., the option delta) is less than the sensitivity of stock, ceteris paribus, incentives are higher when the CEO holds relatively fewer options (or relatively more stock). Thus, the finding in Hemmer et al. (2000) that pay convexity is *decreasing* in skewness (relative to pay linearity) is synonymous with equity incentives

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[6] Skewness also has a technical implication in calculating "Value at Risk" and some argue that ignoring skewness introduces serious flaws in the Black–Scholes model and CAPM (Mandelbrot 1963).

[7] It is important to note that Hemmer et al.(2000) holds constant the mean of the outcome distribution but allows the variance to increase with the skewness. That is, skewness induces more downside loss and more dispersion because Hemmer et al.(2000) envision a distribution with a longer upside tail.

increasing in skewness.[8] This leads to our second prediction that CEO incentives are increasing in stock-return skewness.

Conditional risk and CEO incentives

Apart from concerns about asymmetry, a second potential problem with using variance to capture firm risk from the CEO's perspective is that variance is an unconditional risk measure: it is independent of the distribution of any other random variable. Prior psychology, finance, and accounting research all call into question the descriptive validity of unconditional risk measures. Theoretical psychology provides a richer depiction of risk, one where people assess risk relative to the distribution of some other random variable (Libby and Fishburn 1977; Weber and Bottom 1990; Veld and Veld-Merkoulova 2007). The view of risk as conditional also underlies the CAPM, which holds that the market prices differently the portion of firm risk that is conditional on the market portfolio and the portion that is unrelated (Sharp 1964; Lintner 1965).[9]

Holding firm-related wealth (i.e. the stock and options of his/her own firm) exposes the CEO to systematic and idiosyncratic risk. To deal with idiosyncratic risk, empirical evidence suggests that CEOs can and do adjust their portfolios in response to their personal firm-related wealth (Bettis et al. 2001). However, unlike other investors, CEOs cannot completely diversify away their exposure to idiosyncratic risk because of personal wealth constraints and the excessive cost (and routine prohibition) of shorting their firms' stock. Thus, CEOs are exposed to idiosyncratic risk as a number of prior studies document (Core and Guay 1999, 2002; Jin 2002; Garvey and Milbourne 2003; Henderson 2005).

[8] Pay convexity relative to pay linearity assumes that options (convex pay) are replaced by stock (linear pay) and not cash, consistent with the equilibrium depicted in Hemmer et al. (2000).
[9] The arbitrage pricing model and the Fama-French three factor model also view the risk of a particular asset as conditional on the distribution of one or more other random variables.

Prior research is mixed on the role of systematic risk for incentives. Accepted portfolio theory would lead us to conclude that CEOs, like other investors, should be able to appropriately align their portfolios to reflect an acceptable level of market risk. Thus, CEOs' compensation incentives should be invariant to their firms' market risk. Henderson (2005) nonetheless concludes that market risk may decrease incentives depending on other parameters; but it should be noted that these analytical results do not involve an equilibrium model. Garvey and Milbourn (2002) find that the average CEO's equity-based pay is invariant to market risk. However, their lack of results might derive from the fact that they consider annual pay, which reflects risk with a lag and captures only the periodic adjustment necessary to move the CEO to an optimal level of firm-related equity holdings. To overcome this issue, Jin (2002) considers CEO incentives (rather than compensation) and shows theoretically that when CEOs cannot trade the market portfolio, the effect of systematic risk on the optimal incentive level is ambiguous. Jin (2002) empirically tests the theoretical result and finds that after controlling for idiosyncratic risk, there is no significant relation between systematic risk and CEO incentives. But, the lack of findings may owe to the fact that Jin (2002) follows the empirical approach of Aggarwal and Samwick (1999) which does not directly control for the effects of firm size on CEO incentives.[10] More important however, is that prior work on the link between systematic risk and incentives fails to consider that, similar to variance, systematic risk is asymmetric, which might impact CEO's perceived risk. Consequently, the question of the relation between incentives and systematic risk is not completely answered.

Bawa and Linderberg (1977) develops downside beta as an alternate market risk metric. A downside beta measures the covariation of the firm's return with the market return when the

[10] A further econometric issue is that Jin (2002) measures total risk as the variance of *dollar* stock returns but defines both systematic risk and idiosyncratic risk using the market model and *percent* stock returns. It is unclear how this inconsistency affects Jin's results.

market return is below a specific target.[11] Ang et al. (2006) finds that market risk is not uniformly priced – they document a six percent premium for firms with higher downside beta after controlling for other documented risk factors. This higher return suggests that, on average, a higher downside beta indicates more risk.

We extend this prior research by disaggregating market beta into upside and downside beta. Consistent with the notion that CEOs are more averse to potential outcomes below a salient benchmark, our last prediction is that CEO incentives will be decreasing in downside beta.

Research Design

In this section, we define our measure of CEO incentives, risk variables, and control variables, and present our empirical specifications. We also discuss alternate research designs used in other studies and justify our research design choices against these alternatives.

Pay-performance sensitivity (PPS)

We define CEO incentives as the sensitivity of CEO's firm-related wealth to shareholder returns. We focus on CEOs' total firm-related wealth (e.g., stock, stock options, and restricted stock) as opposed to annual compensation because prior research demonstrates that firm-related holdings are far larger than periodic stock and option grants and thus, create a far stronger incentive (Jensen and Murphy 1990; Yermack 1995, Hall and Leibman 1998).[12] In particular, our sensitivity measure is the dollar change in CEO wealth for a one percentage change in stock price (Core and Guay 1999). Other studies base sensitivities on the dollar change in stock price. Our use of the percent change assumes a positive relation between the CEO's dollar ownership

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[11] Common targets include the mean market return, the risk-free return, and zero return. We estimate downside betas for each of these targets. Our primary tests report downside beta with respect to zero return and in our discussion of sensitivity tests, we note that inferences are largely unchanged by betas calculated with mean or risk-free return.

[12] To be consistent with prior research, we label our incentive variable "pay-performance sensitivity" (PPS) even though we don't explicitly consider periodic pay.

of the firm and his equity-based incentives (Core and Guay 1999), and is consistent with strong managerial incentives arising from relatively small fractional ownership in the firm (Haubrich 1994; Hall and Liebman 1998).

CEO equity holdings in the firm typically include both stock and options. Therefore, we calculate two separate sensitivities. We compute the sensitivity of the stock component (*PPS_Stock*) as the change in the market value of the CEO's stock and restricted stock holdings (both vested and unvested) to a one percent change in the stock price. Note that this is equivalent to one percent of the CEO's stock holdings in the firm.

While the stock sensitivity calculation is straightforward, calculating the option sensitivity requires a number of assumptions because the average CEO holds numerous individual option grants. To aggregate across the various grants, we adopt the approach in Core and Guay (2002). In particular, we proxy the average exercise price and time-to-maturity for the option portfolio based on the portfolio's intrinsic value and number of options (both vested and unvested) as reported in Execucomp. We then use these proxies as inputs to the Black-Scholes model to estimate the average *delta* for the CEO's option portfolio. This delta is the partial derivative with respect to stock price of the Black-Scholes value of the CEO's option portfolio. We define *PPS_Options* as the option-portfolio delta multiplied by one percent of firm stock price. This simple transformation of the traditional option-portfolio delta yields an option sensitivity that is analogous to the one percent sensitivity to stock price changes impounded in *PPS_Stock*.[13] See the Appendix for additional details on how we calculated *PPS_Options*.

We measure the stock and option sensitivities at the end of each firm's fiscal year and compute the CEO's total pay-performance sensitivity (*PPS_Total*) as the sum of the stock and option sensitivities. We use a logarithmic transformation of these variables (Core and Guay1999;

[13] See Baker and Hall (2004) for a discussion of the appropriateness of the transformed option-PPS measure.

Himmelberg et al. 1999) and, in order to preserve values of *PPS_Total* that are equal to zero, our tests use the natural log of *PPS_Total* + 1.

Risk variables

To explore the effect of risk on CEO incentives, we calculate a number of variables that capture the asymmetric and conditional nature of firm risk. We calculate each of these risk variables using monthly returns over the 36 months prior to our estimation date for *PPS_Total*. Additionally, we require at least 12 return observations and use percent returns to avoid heteroskedasticity induced by dollar returns. We measure *Variance* as the second moment of the returns distribution. Consistent with other studies that use the same variable specifications as we do, we predict a positive relation between CEO incentives and *Variance*.

To measure downside risk, we appeal to Nawrocki (1999), "Markowitz provides two suggestions for measuring downside risk: a semivariance computed from the mean return or below-mean semivariance (SV_m) and a semivariance computed from a target return or below-target semivariance (SV_t)." In an experimental setting, Veld and Veld-Markoulova (2007) find that investors consider their original investment to be the most important benchmark in assessing risk. This prompts us to calculate our downside risk measures relative to a zero return because absolute gains and losses are the salient target for CEOs. We compute our first downside risk measure, downside semivariance (*Down_Semi*), as:

$$Down\_Semi = \frac{1}{I}\sum_{i=1}^{I} \min(\mathrm{Ret}_i\,, 0)^2 \qquad (1)$$

where, Ret_i is the firm's return in month *i* and $\min(\mathrm{Ret}_i\,, 0)^2$ equals Ret_i^2 when Ret_i is negative and equals zero otherwise; *i* is the number of months in the estimation period and we require at least 12 monthly return observations. *Down_Semi* gives a positive weight only to returns below zero and captures the dispersion of negative returns. We expect that the sensitivity of the CEO's existing firm-related wealth (options, stock, restricted shares) will be negatively related to downside risk.

To fully disaggregate *Variance* and capture the dispersion of positive returns, we calculate upside semivariance (*Up_Semi*) as:

$$Up\_Semi = \frac{1}{I}\sum_{i=1}^{I} \max(\mathrm{Ret}_i\,,\,0)^2 \qquad (2)$$

Up_Semi gives a positive weight only to returns above zero and thus captures the dispersion of positive returns, which we expect to be positively related to CEO incentives.

We posit that CEOs are differentially sensitive to asymmetric distributions. Thus, to capture the notion that relative downside risk is differentially weighted by risk-averse CEOs, we define a measure of the skewness of firm returns. We do not use the traditional skewness metric (third moment) to measure relative downside firm risk because as Chiu (2005, p. 1817) notes, "an increase in downside risk implies (but is not implied by) a lower third moment." Thus, we use a ratio of downside semivariance to upside semivariance (*Ratio_Semi*) to proxy for the relative downside risk. Specifically, we estimate our second downside risk measure as:

$$Ratio\_Semi = Down\_Semi \,/\, Up\_Semi. \qquad (3)$$

Note that *Ratio_Semi* is a measure of inverse skewness, which we expect will be negatively related to CEO incentives.

We also include idiosyncratic risk and variants of systematic risk in our tests. We estimate these using the same 36 month window as above and calculate systematic risk, *Beta*, as the market-model regression beta and idiosyncratic risk, *I_risk*, as the standard deviation of the residuals obtained from the market-model regression, where market return is the CRSP Value-

Weighted return. Additionally, we calculate our asymmetrical and conditional downside risk measure, *Down_β*, as the firm's market-model beta using only those observations in our 36 month estimation window with a negative market return. Again, we choose zero as the return on which to condition our betas because losses are salient to all investors, and perhaps moreso to CEOs. For completeness, we also calculate *Up_β*, the firm's market-model beta using only those observations in our 36 month estimation window with a non-negative market return.

We also examine whether the general market environment moderates the association between CEOs incentives and market risk. In particular, we test whether the association between *PPS_Total* and *Down_β* is stronger during bear markets. To capture bear markets we use an indicator variable, *Down_Mkt,* which equals one if the compounded CRSP Value-Weighted market return over our 36 month estimation window is negative, and zero otherwise.

We normalize each of our risk measures according to its empirical cumulative density function (CDF) for all of our tests. This transformation, which results in ranked risk measures that range between zero and one, is common in the PPS literature (e.g. Aggarwal and Samwick 1999; Bertrand and Mullainathan 2000; Jin 2002; Milbourn 2003; Garvey and Milbourn 2003, 2006) and facilitates the interpretation of regression coefficients The magnitude of the coefficient on each of our risk measures represents the difference in the natural logarithm of PPS between firms with largest and smallest values of the respective risk measure.

Control variables

Our econometric models include a number of firm-level and CEO-specific control variables suggested by prior research. We describe these variables below with Compustat, CRSP, or Execucomp data names in parentheses, where applicable.

Existing studies find that managers of larger firms have higher equity incentives (Jensen and Murphy 1990; Core and Guay 1999; Bryan et al. 2000) but that CEO portfolio incentives increase at a decreasing rate with firm size (Demsetz and Lehn 1985; Baker and Hall 2004;). Thus, we include *MVE*, which we measure as the market value of equity in millions of dollars [(PRC×SHROUT)/1000], and use a logarithmic transformation to capture the decreasing positive association between equity incentives and size.

Following prior research, we expect that firms with greater growth opportunities will tie managers' wealth more closely to firm value. We proxy for growth opportunities using *BTM* , defined as the book value of assets (AT) divided by the market value of assets (LT + *MVE*), and expect that growth opportunities and *BTM* are negatively related. We expect a negative relation between *BTM* and *PPS_Total* consistent with Smith and Watts (1992), Core and Guay (1999) and Bryan et al. (2000).

We include a leverage variable, *Lev*, to control for the agency cost of debt. We use the book value of total long-term debt (DLTT + DLC) divided by total assets (AT). Prior research documents a negative relations between leverage and pay convexity (see for example, Graham, Lang, and Shakelford 2004). Recall that pay convexity and our measure of pay-performance sensitivity are negatively associated and thus, we expect a positive association between *PPS_Total* and *Lev*..

We control for the effect of agency problems on managers' incentives (Jensen, 1986). Firms with low growth opportunities face more potential agency conflicts, especially in the presence of free cash flows. Following Lang et al. (1991) and Core and Guay (1999) we measure this free cash flow problem (*FCFP*) as the prior three year average of operating cash flows (OANCF) minus total dividends (DVT), divided by total assets (AT) if the firm's *BTM* is greater than one (which is a proxy for low growth opportunities), and zero otherwise. We expect that low growth opportunity firms will use equity incentives at a rate increasing with free cash flows and, thus, we predict a positive relation between *FCFP* and *PPS_Total*.

To control for additional risk imposed on the CEO from poor operating performance, we include *Loss5*, which we measure as the number of consecutive years the firm has had negative annual income before extraordinary items (IB) over the previous five years. Because firm losses impose additional risk on the CEO, we expect a negative coefficient on *Loss5*.

Finally, we control for CEO specific factor by including a variable related to CEO tenure. Prior studies document a CEO "horizon" problem (Dechow and Sloan, 1991; Gibbons and Murphy 1992). In addition, Garvey and Milbourn (2003) find that younger managers are less able to hedge market risk; therefore, greater pay-performance sensitivity can be imposed on older managers. Core and Guay (1999) argue that over time, the uncertainty about a CEO's ability and talent is resolved, and it is possible to impose more risk on an older (more experienced) manager. For all of these reasons, we include *Tenure*, the number of years the manager has been the CEO. We identify the date the manager became CEO using the ExecuComp variable BECAMECEO. We use a logarithmic transformation of *Tenure* and expect it is positively related to *PPS_Total*.

Empirical Specification

We estimate the following four models to test our hypotheses.

$$log\ (PPS\_Total_{it}) = \alpha_0 + \theta_1 Up\_semi_{it} + \theta_2 Down\_semi_{it} + Controls_{it} + \varepsilon_{it} \qquad (4a)$$

$$log\ (PPS\_Total_{it}) = \alpha_0 + \theta_1 Ratio\_semi_{it} + \theta_2 Variance_{it} + Controls_{it} + \varepsilon_{it} \qquad (4b)$$

$$log\ (PPS\_Total_{it}) = \alpha_0 + \theta_1 Down\_semi_{it} + \theta_2 Up\_\beta_{it} + \theta_3 Down\_\beta_{it} + \theta_4 Down\_\beta_{it} \times Down\_Mkt_{it} + \theta_5 Down\_Mkt_{it} + \theta_6 I\_risk_{it} + Controls_{it} + \varepsilon_{it} \qquad (4c)$$

$$\log(PPS\_Total_{it}) = \alpha_0 + \theta_1 Ratio\_semi_{it} + \theta_2 Up\_\beta_{it} + \theta_3 Down\_\beta_{it} + \theta_4 Down\_\beta_{it} \times Down\_Mkt_{it} + \theta_5 Down\_Mkt_{it} + \theta_6 I\_risk_{it} + Controls_{it} + \varepsilon_{it} \quad (4d)$$

where all variables are as previously defined. *Controls* include log(*MVE*), *BTM*, *Lev*, *FCFP*, *Loss5*, and log(*Tenure*). We also include indicator variables for year and industry (based on the Fama-French 48 classifications). As noted above, we normalize each of the risk measures according to its empirical CDF. Additionally, we winsorize the dependent variables and the non-ranked continuous independent variables, at the bottom and top percentile of their distributions.

Sample and Data

We use Standard& Poor's Execucomp database to obtain our initial sample of 27,665 firm-quarter observations over the 1992-2008 period.[14] Table 1 presents our sample selection process. We delete 3,325 observations for financial firms (SIC 6000–6400). We lose 1,448 and 248 observations because of missing price and return data from CRSP and missing financial data from Compustat, respectively. Finally, we delete 1,505 observations because of insufficient data to measure our dependent variables (pay-performance sensitivities). Our final sample comprises 21,139 firm-quarter observations for 2,612 unique firms from 1992 to 2008.

Table 2 presents descriptive statistics for pay-performance sensitivities (PPS) and control variables. The median (mean) change in CEO wealth for a 1% change in stock price, *PPS_Total*, of $203,911 ($717,256) suggests that this variable is significantly skewed, consistent with the findings in Core and Guay (1999) using an earlier sample period (1992-1995). We also observe a larger mean PPS related to the CEO's stock holdings, relative to the options held. However this difference is almost entirely due to large positive values of *PPS_Stock* in its top quartile. Our logarithmic transformations remove virtually all of the skewness in *PPS_Total* and yield

[14] ExecuComp coverage begins in fiscal 1992 using COMPUSTAT fiscal-year conventions.

sensitivities due to the stock and option components of CEOs' portfolios with similar means and medians.

The median of our three variants of *Beta* are all close to 1, as we would expect, and approximately 23% of our observations follow a bear market (measured by *Down_Mkt*). On average, firms have downside semi-variance of percent returns (*Down_Semi*) of 0.64 percent and upside semi-variance of 1.18 percent, and these are statistically different. Thus, disaggregating *Variance* into upside and downside components suggests that return volatility due to positive price movements is nearly 50 percent larger than return volatility due to negative price movements. Our measure of skewness (inverse), *Ratio_Semi*, has a mean (median) of 0.70 (0.57), which confirms the prior comments on the relative size up downside risk to upside potential.

Table 3 presents Pearson and Spearman correlations for pay-performance sensitivities (*PPS*), control variables and unranked risk measures. Of particular note is that the downside and upside semi-variance measures are very highly correlated with their symmetric counterpart, *Variance* (0.93 and 0.95 respectively) but the correlation between the downside and upside market risk measures with *Beta* are much smaller (0.46 and 0.55 respectively).

The central tenet of our study is that, compared to variance, downside exposure and upside gain together are more descriptive of firm risk for CEOs. The near perfect pairwise correlations between *Variance* and *Down_Semi* and *Up_Semi*, discussed above, might suggest that disaggregating downside and upside risk is not instructive. To explore this possibility, we create portfolios based on a double sort of return variance and downside semi-variance deciles, and calculate mean *PPS* for each portfolio. If *Variance* is a sufficient statistic for *Down_Semi*, we will find no statistical significance in the mean *PPS* across *Down_Semi* deciles, holding

Variance constant. Table 4 shows mean *PPS* for each portfolio, displayed for small, medium and large firms (formed on MVE). Holding variance constant, we see a striking pattern – mean *PPS* decreases as downside risk increases. This pattern is statistically significant: t-statistics for the difference in *PPS* between high and low deciles of *Down_Semi* are nearly all significant at conventional levels. This suggests that variance alone does not explain CEO's incentives and that downside risk plays an important role. Next we test this notion with multivariate models (equations 4a through 4d).

Results

Multivariate tests of asymmetric risk measures

Our first hypothesis focuses on the relation between CEO incentives and downside risk while holding total risk constant. Our second hypothesis predicts a positive relation between CEO incentives and stock-return skewness, as generally predicted in Hemmer et al. (2000). Our variable *Ratio_Semi* is the ratio of downside semivariance to upside semivariance and thus is an inverse proxy for skewness. We report in Table 5 tests of these hypotheses.

The first column in Table 5 provides a benchmark regression estimation where we include only the traditional measure of risk in the literature, stock-return variance (*Variance*). These results allow us to compare our findings with prior research, and assess how inferences will change as we incrementally add other risk metrics to the model. The coefficient on *Variance* in Table 5 is significantly positive (0.738, $p < 0.01$), suggesting that CEO incentives are increasing with firm risk. As previously discussed, the extant research finds conflicting results with respect to the relation between CEO incentives and firm risk, but our result is consistent with studies that similarly define firm risk as stock-return variance (e.g., Core and Guay, 2002). The results for the control variables are consistent with prior research. That is, we find that CEO incentives increase with firm size and tenure. CEO incentives decrease with a firm's book-to-market ratio and history of negative operating performance. We do not find a significant result for a firm's free cash flow or for leverage.

In the second column of results in Table 5, we examine how estimated relations change when we decompose *Variance* into downside and upside semivariance (equation 4a). Consistent with our expectations, we find that the relation between CEO incentives and downside semivariance is negative and opposite from upside semivariance. These results are intuitive and capture the opposite forces of firm risk on CEO incentives. While CEOs consider upside potential as an attractive feature of their firm-related wealth, they also consider downside exposure as costly and thus are willing to hold less equity which reduces incentives.

Given how we normalize the variable *Down_Semi*, its coefficient magnitude of -0.312 indicates that for every decile increase in firm downside semivariance, the CEO's level of *PPS_Total* decreases by 3.07 percent (calculated as $e^{(-0.312 \times 0.1)} - 1$). To provide some economic intuition, consider the median CEO whose wealth changes by $203,911 given a one percent change in stock price. For this CEO, a one decile rank change in downside semivariance reduces pay-for-performance sensitivity by $6,260. Alternately, the CEOs of firms with downside semivariance in the highest decile have a PPS that is 26.8 percent lower (calculated as $e^{-0.312} – 1$), than CEOS of firms with downside semivariance in the lowest decile.

An interesting finding in Table 4 is that the absolute magnitude of the coefficient for *Down_Semi* is significantly less than the coefficient for *Up_Semi*, which indicates it is the upside potential of firm risk that drives the positive coefficient on *Variance* in the first column. This finding contrasts with the notion that CEOs are more sensitive to economic losses than economic gains, at least as it is manifested in their equity-based endowments. However, much of

PPS_Total is driven by options-based compensation, which largely protects CEOs from downside exposure (until the options become deep in-the-money). Thus, we predict that our downside risk measures are only relevant for CEO incentives derived from stock holdings. We examine this notion in subsequent tests.

The third column of Table 5 reports our test of our second hypothesis (equation 4b). Consistent with our prediction, we find that CEO incentives are increasing in stock-return skewness, as measured by *Ratio_Semi*, after controlling for overall firm risk. Recall that *Ratio_Semi* is an inverse measure of skewness and, thus our finding is that incentives are decreasing in downside risk. This result is consistent with the theoretical model in Hemmer et al. (2000) that when skewness is high, the firm relies less on options (convex pay) and more on stock (linear pay) to incent its CEO.

Tests of conditional risk measures

We next investigate the relation between CEO incentives and conditional risk (that is, systematic risk), as measured by equity beta. Specifically, we hypothesize that CEO incentives will be decreasing in downside beta. We estimate regression equation 4c and 4d to test our hypothesis. Table 6 reports the results from these tests, but we first estimate a benchmark model that includes only the conditional risk measure equity beta (*Beta*) and idiosyncratic risk (*I_Risk*). These results are displayed in the first column of Table 6. Consistent with prior research (Jin 2002, Garvey and Milbourne 2003), we find a positive relation between CEO incentives and idiosyncratic risk but no significant relation between CEO incentives and systematic risk.[15]

A premise of this paper is that the insignificant result on *Beta* could be due to the asymmetric sensitivities that individuals have for upside and downside risk. The remaining

[15] The extremely high correlation between *Variance* and *I_Risk* (displayed in Table 3) precludes us from including both variables in the model.

columns of Table 6 explore this possibility by disaggregating equity beta into its upside (*Up_β*) and downside (*Down_β*) components. In the second column, we continue to find insignificant results when only these variables replace equity beta. This result is inconsistent with our prediction of a negative coefficient for *Down_β*. In the third column, we examine whether this result persists as we add another risk measure to the model, specifically downside semivariance, which we found to be significant in our prior tests. When we include *Down_Semi* in the model, we continue to document a significantly negative coefficient for this variable. The coefficients for *Up_β* and *Down_β* become significantly positive. Again, this result is not consistent with our expectations.

Finally, columns 4-6 in Table 6 examine various specifications that include an indicator variable for bear markets (*Down_Mkt*), as previously defined. We interact this indicator variable with *Down_β* to assess whether a down market changes the relation between CEO incentives and downside beta. The differences in specifications across columns 4 through 6 are that the regression equations include downside semivariance in column 4, both downside and upside semivariance in column 5, and our inverse skewness measure in column 6. For each of these specifications, we find a significantly negative interaction between *Down_β* and *Down_Mkt*, indicating that the effect of downside beta is significantly more negative on CEO incentives during a bear market relative to its effect in a bull market. Given that the main effect of *Down_β* is generally positive over our regression specifications, we also test whether or not the full effect of *Down_β* in a bear market is significantly different from zero. This test is determined by summing the main effect of *Down_β* and the interaction *Down_β*×*Down_Mkt*. This test, as presented in the table, shows statistical significance in columns 5 and 6. Results for the other risk variables and controls across all specifications are qualitatively equivalent.

While we do not predict a sign for the association between bear markets and incentives, we find that *Down_Mkt* is positively associated with CEO incentives in each of the specifications in Table 6. This result makes intuitive sense when we also consider the negative association between downside beta ($Down\_\beta + Down\_\beta \times Down\_Mkt$) and CEO incentives during bear markets. In particular, a CEO with the smallest value for $Down\_\beta$ in our sample has an incentive portfolio value that is negatively correlated with negative market returns (i.e. a downside beta < 0; see Table 2), suggesting that this CEO's portfolio would perform well during a bear market. Thus, the CEO is more willing to have his personal wealth tied to firm performance during bear markets, as indicated by the positive coefficients on *Down_Mkt*. As $Down\_\beta$ increases, and becomes positive, the upside to holding equity incentives decreases (during a bear market) as the firm's stock performance becomes positively correlated with the market.

In sum, the results from tests of our three hypotheses indicate that stock price variance does not fully capture the relation between CEO incentives and firm risk, variance is symmetric and unconditional and inconsistent with the way risk is judged. While we find, consistent with several prior studies, a positive relation between CEO incentives and variance, we show that separating variance into upside semivariance and downside semivariance more completely captures the opposing effects of risk on CEO incentives. We also show that skewness is positively associated with CEO incentives, consistent with theoretical research by Hemmer et al. (2000). With respect to equity beta, we do not find a similar effect when it is disaggregated into upside and downside components; however, we do find that downside beta is decreasing in CEO incentives during bear markets. These results provide a potential explanation for conflicting evidence in prior research, and they present a richer framework to interpret the sometimes countering effects of risk on CEO incentives.

Distinguishing incentives from stock versus option holdings

Our primary motivation for exploring the differential effects of upside versus downside risk on CEO incentives stems from the theory that CEO's have asymmetric sensitivities to gains and losses. However, CEO incentives are also affected by specific equity instruments the CEO holds. While stock exposes the CEO to both downside and upside risk, options provide protection from downside risk, at least until the option becomes so far in the money that it essentially becomes equivalent to stock. The different risk exposures of stocks and options, prompt us to examine whether upside and downside risk have different effects on CEO incentives related to stock as compared to options.

To examine this issue, we disaggregate total pay-performance sensitivity (*PPS_Total*) into the portion that derives from the CEO's stock holdings (*PPS_Stock*) and the portion that derives from his / her options (*PPS_Options*). We then separately estimate the regressions from Table 3 with *PPS_Stock* and *PPS_Options* as the dependent variables, and report the results in Table 7.

In the first three columns of Table 7, *PPS_Stock* is the dependent variable. In general, these results look very similar to what we report in Table 5 (*PPS_Total*). However, we find two substantive differences. First, the coefficient magnitude for *Down_Semi* is significantly larger in when *PPS_Stock* is the dependent variable, indicating that downside risk is most salient for CEOs stock holdings.[16] Second, the magnitude of the coefficients for *Down_Semi* and *Up_Semi* are not significantly different from each other. This indicates that upside potential and downside risk have an equivalent, and opposite, impact on CEO incentives related to their stockholdings and is consistent with stock's symmetric linear payoff to both positive and negative price

[16] In untabulated results, we use seemingly unrelated estimation (SUE) to test for a significant difference between the coefficient on *Down_Semi* when *PPS_total* and *PPS_stock* are the dependent variables. We obtain a Chi-sq = 24.24 ($p < 0.001$).

movements. All other results in the first three columns are qualitatively similar, except we find a marginally significant coefficient for leverage.

The second set of results in Table 7 when *PPS_Options* is the dependent variable, show some differences relative to the *PPS_Total* regressions in Table 5. In particular, we find that downside semivariance is unrelated to CEO incentives. This makes intuitive sense because options offer protection against downside risk, and thus, CEO's wealth attributable to options is not sensitive to downside risk. The effect of upside semivariance remains significantly positive, indicating that higher upside potential induces CEOs to hold larger option portfolios.

We find other significant differences when we examine results for the control variables. That is, we no longer find a significant coefficients for *BTM*, *log(Tenure),* and *Loss 5*, but we do find a significantly positive relation for *Lev*, contrary to other studies (Lang and Shakelford). Thus, when assessing the incentives related to options only, our results suggest that other than size, the positive effect of upside potential along with the magnification of this effect via leverage are the primary determinants, while other control variables tend to lose their significance.

We run several robustness tests, which we describe below. All results yield similar inferences. Our tabulated results use zero return as the target; that is, we calculate upside and downside semivariance (upside and downside beta) relative to zero returns (market return). For robustness tests, we compute these risk measures using 1) the firm's mean return (mean market return) over the estimation window and 2) the monthly risk-free rate as alternative target returns. We also use unranked versions of each of the risk measures instead of their ranked (cdf) version. Finally, we use the Jensen and Murphy (1990) PPS measure, the sensitivity of CEO wealth to a

$1,000 change in the value of the firm, as an alternative dependent variable instead of a 1 percent change.

Conclusion

A considerable body of both of theoretical and empirical accounting and finance research confirms that investors view risk asymmetrically and conditionally (e.g. Shefrin and Statman 1985; Odean 1998; Koonce, McAnally, and Mercer 2005; Barberis et al. 2001; Kraus and Litzenberger 1976; Estrada 2003; Ang, Chen and Xing 2006). It is easy to imagine that CEOs too view risk asymmetrically and relative to important benchmarks when they judge compensation contracts such that, in equilibrium, CEO incentives reflect both upside and downside risk. We explore the applicability of these notions and test the relation between upside and downside risk and CEO pay for performance sensitivity by defining firm risk to include asymmetric risk measures (downside semivariance and relative semivariance) and conditional, asymmetric risk measures (downside beta).

We find that CEO incentives reflect both the asymmetry and the conditional nature of firm risk. We conclude that, in equilibrium, it is the CEO’s risk perception that affects the level of firm-related wealth a CEO is willing to hold. Prior research has tested only whether CEO incentives reflect stock-price variance. By assuming that outcomes are symmetrically distributed and that any asymmetry is irrelevant to CEO’s risk assessment, compensation research studies could come to erroneous conclusions. For example, because the variance and skewness of stock returns are highly correlated, CEOs may appear to prefer variance when it is skewness that determines the level of firm-related wealth they are willing to hold.

Consistent with prior research that empirically “test” PA-model predictions, our study has several limitations. First, empirical tests of PA models make assumptions about the agent’s utility function, which is unobservable to empirical researchers. To overcome this obstacle, we have assumed that CEOs have largely similar utility functions and are risk averse. Second, it is difficult to develop empirical proxies that accurately capture the variables in the PA models and some of our proxies are noisy. Thus, as Hemmer (2007) concludes, our empirical evidence might yield descriptive insights but does not shed any light on the validity of PA theory.

Appendix

We estimate the option component of CEO pay-performance sensitivity (*PPS_Options*) following the approach in Core and Guay (2002). In particular, we assume that the Black-Scholes (1973) value, as modified by Merton (1973), is the appropriate measure of the CEO's option portfolio value:

$$\text{Option value} = [Se^{-dT}N(Z) - Xe^{-rT}\mathrm{N}(Z - \sigma T^{(1/2)})], \tag{5}$$

where $Z = [\log(S/X) + T(r - d + \sigma^2/2] / \sigma T^{(1/2)}$, N is the cumulative probability function for the normal distribution, S the price of the underlying stock, X the exercise price of the option, σ the expected stock-return volatility over the life of the option, r the risk-free interest rate, T the time-to-maturity of the option in years, and d is the expected dividend rate over the life of the option.

The partial derivative of the Black-Scholes value with respect to stock price is:

$$\delta(\text{option value}) / \delta(\text{price}) = e^{-dT}N(Z), \tag{6}$$

and the sensitivity of stock option value with respect to a one percent change in stock price is:

$$\text{Sensitivity of option value to stock price} = e^{-dT}N(Z)\times(\mathit{price}/100). \tag{7}$$

We obtain data for CEO stock and option holdings from Execucomp. We compute the average exercise price of exercisable and unexercisable options in the CEO's portfolio using the current realizable value from Execucomp. We estimate the average exercise price as [year-end price - (current realizable value/number of options)]. We set the time-to maturity of unexercisable (exercisable) options equal to 10 (7) years and approximate the appropriate risk free rate using 10 (7) year treasury rates, respectively. We follow the Execucomp convention for estimating the expected dividend yield and expected stock-return volatility. Specifically, we compute the firm's average dividend yield over the prior three years and annualized return volatility over the prior 60 months. We winsorize both variables at 95% of their distributions and the resulting measures have correlations of 92% (99%) with non-missing Execucomp measures of dividend yield (stock return volatility). We obtain fiscal year end stock prices from CRSP.

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Table 1
Sample Selection

	N
Initial Sample of CEO observations from ExecuComp (1992-2008)	27,665
Financial firms (SIC 6000-6400)	(3,325)
	24,340
Missing price and return data from The Center for Research in Security Prices (CRSP)	(1,448)
	22,892
Missing financial statement data from Compustat	(248)
	22,644
Missing neccessary data to measure *Total_PPS*, *Stock_PPS* and *Option_PPS*	(1,505)
Final Sample	**21,139**

Table 2
Descriptive Statistics

Variables	Mean	Std. Dev.	1%	Q1	Median	Q3	99%
PPS_Total	717,256	1,750,904	0	74,870	203,911	564,350	13,348,717
PPS_Options	232,662	439,826	0	22,872	81,368	230,448	2,909,286
PPS_Stock	465,069	1,496,433	0	16,922	65,202	230,878	11,678,431
log (PPS_Total)	12.19	1.74	0	11.22	12.23	13.24	16.41
log (PPS_Options)	10.39	3.59	0	10.04	11.31	12.35	14.88
log (PPS_Stock)	10.86	2.59	0	9.74	11.09	12.35	16.27
log (MVE)	7.21	1.57	3.66	6.13	7.08	8.20	11.40
BTM	0.65	0.27	0.12	0.45	0.65	0.84	1.39
FCFP	0.01	0.02	-0.01	0.00	0.00	0.00	0.11
Lev	0.23	0.18	0.00	0.07	0.22	0.35	0.75
Loss5	0.37	1.00	0	0	0	0	5.00
log (Tenure)	1.58	0.97	-0.62	0.92	1.63	2.29	3.57
Beta	1.17	0.83	-0.28	0.60	1.02	1.58	4.08
Down_β	1.17	1.73	-3.40	0.19	1.00	1.98	7.35
Up_β	1.12	1.57	-2.87	0.19	0.95	1.90	6.29
Down_Mkt	0.23	0.42	0	0	0	0	1
Down_Semi (%)	0.64	0.68	0.04	0.19	0.39	0.82	3.64
Up_Semi (%)	1.18	1.57	0.09	0.33	0.64	1.30	9.66
Ratio_Semi	0.70	0.50	0.10	0.37	0.57	0.88	2.96
I_Risk	0.11	0.06	0.03	0.07	0.09	0.13	0.32
Variance (%)	1.81	2.14	0.14	0.56	1.07	2.13	12.73
N	21,139						

The sample comprises 21,139 firm-year observations over the period 1992-2008. *PPS_Total* is the pay-performance sensitivity of the CEO's wealth to firm-related equity returns and is measured as the sum *of PPS_Options* and *PPS_Stock*. *PPS_Options* is the option-portfolio delta multiplied by one percent of firm stock price. *PPS_Stock* equals the change in the market value of the CEO's stock holdings to a one percentage change in stock price. *MVE* equals the fiscal year end market value of equity. *BTM* equals fiscal year end book value of total assets divided by market value of equity plus book value of total liabilities. *FCFP* equals the prior three year average of the ratio OCF – DIV / TA if the firm's *BTM* is greater than one, and zero otherwise; where OCF equals operating cash flows, DIV equals total dividends, and TA equals total assets. Lev is equal to fiscal year end book value of long-term debt divided by total assets. Loss5 equals the number of consecutive years over the past five years that the firm has realized negative earnings before extraordinary items. Tenure equals the number of years the manager has been CEO. Risk measures are calculated using 36 months of returns data prior to our measurement of PPS_Total (with a minium of 12 monthly return observations. *Beta* is the market-model regression beta. *Down_β* (*Up_β*) is the firm's market-model beta using only those observations in our 36 month estimation window with a negative (non-negative) market return. *Down_Mkt* equals one if the compounded CRSP Value-Weighted market return over our 36 month estimation window is negative, and zero otherwise. *Down_Semi* (*Up_Semi*) = $\frac{1}{I}\sum_{i=1}^{I} \min(Ret_i , 0)^2$ where, Ret_i is the firm's return in month *i* and $\min(Ret_i , 0)^2$ equals Ret_i^2 when Ret_i is negative (non-negative) and equals zero otherwise. *Ratio_Semi = Up_Semi* / *Down_Semi*. *I_risk* is the standard deviation of the residuals obtained from the market-model regression. Variance is the second moment of the returns distribution.

Table 3
Pearson and Spearman Correlations between Dependent and Independent variables

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	*log (PPS_Total)*		**0.65**	**0.83**	**0.58**	**-0.43**	**-0.16**	**-0.10**	**-0.23**	**0.33**	**0.02**	**-0.04**	**0.07**	**0.01**	**-0.15**	**0.02**	**-0.23**	**-0.09**	**-0.07**
2	*log (PPS_Options)*	**0.36**		**0.29**	**0.60**	**-0.35**	**-0.15**	**-0.02**	**-0.15**	**0.09**	**0.03**	**-0.03**	**0.05**	**0.06**	**-0.10**	0.01	**-0.17**	**-0.08**	**-0.05**
3	*log (PPS_Stock)*	**0.74**	**0.06**		**0.40**	**-0.28**	**-0.11**	**-0.05**	**-0.23**	**0.39**	**-0.02**	**-0.05**	**0.04**	**-0.02**	**-0.17**	**-0.04**	**-0.18**	**-0.12**	**-0.11**
4	*log (MVE)*	**0.56**	**0.32**	**0.38**		**-0.33**	**-0.18**	**0.09**	**-0.28**	0.00	**-0.12**	**-0.11**	0.01	-0.01	**-0.44**	**-0.33**	**-0.18**	**-0.44**	**-0.41**
5	*BTM*	**-0.41**	**-0.18**	**-0.23**	**-0.36**		**0.37**	**0.37**	**0.18**	**-0.05**	**-0.10**	0.00	**-0.10**	**0.11**	**0.09**	**-0.19**	**0.42**	**-0.06**	**-0.06**
6	*FCFP*	**-0.18**	**-0.08**	**-0.11**	**-0.22**	**0.46**		**0.07**	**0.09**	**0.01**	**-0.01**	**0.02**	**-0.04**	**0.08**	**0.13**	**-0.01**	**0.21**	**0.06**	**0.06**
7	*Lev*	**-0.10**	-0.01	-0.01	**0.04**	**0.31**	**0.03**		**0.06**	**-0.04**	**-0.20**	**-0.07**	**-0.14**	**0.02**	**-0.16**	**-0.25**	**0.11**	**-0.20**	**-0.21**
8	*Loss5*	**-0.20**	**-0.04**	**-0.22**	**-0.27**	**0.09**	**0.03**	**0.08**		**-0.07**	**0.24**	**0.16**	**0.08**	**0.12**	**0.42**	**0.27**	**0.20**	**0.36**	**0.36**
9	*log (Tenure)*	**0.32**	**0.01**	**0.36**	0.00	**-0.05**	0.00	**-0.04**	**-0.06**		**0.03**	0.00	**0.04**	-0.01	0.00	0.03	**-0.05**	**0.01**	**0.02**
10	*Beta*	**0.01**	**0.04**	**-0.06**	**-0.14**	**-0.09**	-0.01	**-0.16**	**0.29**	**0.01**		**0.46**	**0.55**	**-0.06**	**0.48**	**0.49**	**-0.01**	**0.40**	**0.51**
11	*Down_β*	**-0.04**	-0.01	**-0.06**	**-0.12**	-0.01	**0.01**	**-0.05**	**0.17**	**-0.01**	**0.43**		**0.15**	**-0.02**	**0.26**	**0.23**	**0.03**	**0.20**	**0.26**
12	*Up_β*	**0.05**	**0.02**	**0.01**	-0.01	**-0.10**	**-0.03**	**-0.12**	**0.12**	**0.03**	**0.57**	**0.14**		**-0.12**	**0.20**	**0.24**	**-0.04**	**0.17**	**0.24**
13	*Down_Mkt*	**0.02**	**0.06**	**-0.02**	**-0.01**	**0.12**	**0.09**	**0.02**	**0.08**	-0.01	**-0.03**	**-0.03**	**-0.10**		**0.29**	**0.17**	**0.18**	**0.21**	**0.24**
14	*Down_Semi*	**-0.17**	**-0.02**	**-0.22**	**-0.38**	**0.11**	**0.13**	**-0.07**	**0.47**	**-0.04**	**0.54**	**0.26**	**0.22**	**0.29**		**0.78**	**0.35**	**0.90**	**0.93**
15	*Up_Semi*	-0.01	**0.03**	**-0.09**	**-0.23**	**-0.16**	**-0.02**	**-0.15**	**0.35**	-0.01	**0.53**	**0.24**	**0.23**	**0.15**	**0.73**		**-0.26**	**0.94**	**0.95**
16	*Ratio_Semi*	**-0.22**	**-0.08**	**-0.15**	**-0.19**	**0.42**	**0.27**	**0.13**	**0.15**	**-0.05**	**-0.02**	**0.02**	**-0.05**	**0.18**	**0.23**	**-0.25**		-0.01	**0.02**
17	*I_Risk*	**-0.09**	0.01	**-0.16**	**-0.40**	**-0.06**	**0.06**	**-0.15**	**0.41**	**-0.01**	**0.47**	**0.22**	**0.19**	**0.21**	**0.85**	**0.89**	**-0.07**		**0.98**
18	*Variance*	**-0.07**	0.01	**-0.15**	**-0.30**	**-0.07**	**0.03**	**-0.13**	**0.42**	**-0.02**	**0.57**	**0.26**	**0.24**	**0.22**	**0.87**	**0.97**	**-0.09**	**0.94**	

Pearson correlations are presented below the diagonal and Spearman correlations are presented above the diagonal. Our sample is from 2002-2009. See table 2 for variable descriptions. Bold values indicate significance at the p < 10% level.

Table 4

Mean *PPS_Total* Portfolios Based on Firm Size, Return Variance and Downside Semivariance

Panel A: Small MVE

Variance	*Down_Semi*: Low	2	3	4	5	6	7	8	9	High	High − Low	t-stat
Low	106	144	168	149	186	109	158	249	165	121	15	0.37
2	263	386	236	232	251	224	238	156	178	90	-173	-3.47
3	253	238	220	271	214	162	111	154	180	83	-169	-3.72
4	326	280	225	206	179	262	169	154	169	110	-216	-3.57
5	230	328	226	139	225	210	198	179	115	71	-159	-4.12
6	240	245	192	257	222	133	193	166	154	85	-155	-4.00
7	234	195	188	159	131	128	159	140	90	38	-195	-6.19
8	299	243	194	174	124	215	118	104	135	84	-215	-4.01
9	231	188	155	123	110	129	155	187	113	68	-163	-4.02
High	254	233	146	189	116	109	128	62	172	95	-159	-3.17

Panel B: Medium MVE

Variance	*Down_Semi*: Low	2	3	4	5	6	7	8	9	High	High − Low	t-stat
Low	88	194	276	167	281	284	303	657	232	309	221	2.49
2	353	388	377	474	424	289	326	490	461	432	78	0.74
3	810	511	377	649	319	460	714	462	309	235	-575	-3.17
4	646	638	408	355	635	567	382	305	331	323	-324	-2.07
5	590	484	489	393	618	507	507	531	285	322	-268	-2.41
6	754	619	612	637	468	315	388	596	433	529	-225	-0.91
7	632	682	708	626	653	406	737	507	523	249	-383	-3.89
8	776	693	601	662	536	506	502	395	536	214	-562	-3.76
9	1,016	704	679	652	714	678	577	426	440	367	-649	-4.02
High	980	578	444	587	504	455	563	448	398	493	-487	-2.00

Panel C: Large MVE

Variance	*Down_Semi*: Low	2	3	4	5	6	7	8	9	High	High − Low	t-stat
Low	1,208	883	1,170	705	809	890	779	872	1,013	935	-272	-0.68
2	963	1,645	933	917	654	912	1,130	1,205	1,784	998	35	0.13
3	1,351	1,685	1,545	1,466	1,529	1,125	1,031	730	1,217	837	-514	-1.76
4	1,310	1,536	1,645	1,945	1,301	1,068	1,090	1,127	675	590	-720	-2.93
5	2,286	1,205	1,216	1,287	953	1,118	982	758	937	891	-1,396	-2.80
6	2,806	1,970	1,370	1,040	915	1,337	1,535	1,734	1,380	1,724	-1,082	-1.85
7	2,468	2,091	1,443	1,677	1,725	1,339	1,997	1,082	1,018	879	-1,589	-3.25
8	2,742	1,807	2,104	1,422	2,300	1,389	1,735	1,224	1,173	687	-2,055	-4.61
9	2,875	2,356	1,517	2,240	2,030	1,946	1,424	2,012	3,363	834	-2,041	-4.37
High	4,041	2,573	2,390	1,828	2,515	2,155	2,373	1,815	1,643	1,432	-2,609	-4.21

This table presents mean total pay-performance sensitivity (*PPS_Total*) reported in thousands for small (Panel A), medium (Panel B) and large (Panel C) MVE firms for portfolios based on deciles of return variance and return semivariance. Our sample period is 1992 to 2008. See Table 2 for variable definitions.

Table 5
Regression Analysis of Total PPS and Asymmetric Risk Measures

Dependent variable: log (*PPS_Total*)	(1)	(2)	(3)
Intercept	6.747***	6.632***	6.838***
	(0.175)	(0.177)	(0.174)
CDF (*Down_Semi*) **(1)**		-0.312***	
		(0.087)	
CDF (*Up_Semi*) **(2)**		1.040***	
		(0.081)	
CDF (*Ratio_Semi*)			-0.331***
			(0.047)
CDF (*Variance*)	0.738***		0.706***
	(0.091)		(0.092)
log (*MVE*)	0.613***	0.611***	0.611***
	(0.015)	(0.015)	(0.015)
BTM	-0.902***	-0.714***	-0.751***
	(0.084)	(0.091)	(0.093)
log (*Tenure*)	0.515***	0.510***	0.512***
	(0.018)	(0.018)	(0.018)
FCFP	-0.282	-0.184	-0.343
	(0.782)	(0.779)	(0.782)
Lev	-0.015	0.006	-0.004
	(0.121)	(0.120)	(0.121)
Loss 5	-0.108***	-0.096***	-0.102***
	(0.015)	(0.015)	(0.015)
Test of (1) + (2) = 0 (p-value)		**[0.00]*** **	
Fixed effect	Industry, Year	Industry, Year	Industry, Year
N	21,139	21,139	21,139
Adj Rsq	53.4%	53.8%	53.7%

The sample period ranges from 1992-2008 and comprises nonfinancial firm-year observations with sufficient data available on Execucomp, CRSP, and Compustat to measure pay-performance sensitivity measures. See Table 2 for definitions and distributional statistics for the regression variables. *, **, and *** represent statistical significance at the α = 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test.

Table 6
Regression Analysis of Total PPS and Conditional Risk Measures

	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	6.708*** (0.176)	6.691*** (0.178)	6.649*** (0.178)	6.635*** (0.177)	6.591*** (0.178)	6.764*** (0.177)
CDF(*Down_Semi*)			-0.784*** (0.107)	-0.773*** (0.107)	-0.380*** (0.123)	
CDF(*Up_Semi*)					0.937*** (0.163)	
CDF(*Ratio_Semi*)						-0.320*** (0.047)
CDF(*Beta*)	0.037 (0.051)					
CDF(*Up_β*)		0.027 (0.042)	0.079* (0.043)	0.086** (0.043)	0.002 (0.045)	0.041 (0.043)
CDF(*Down_β*) **(1)**		0.041 (0.042)	0.097** (0.042)	0.127*** (0.045)	0.067 (0.045)	0.086* (0.044)
CDF(*Down_β*)×*Down_Mkt* **(2)**				-0.192** (0.084)	-0.267*** (0.085)	-0.261*** (0.086)
Down_Mkt				0.210*** (0.070)	0.236*** (0.070)	0.234*** (0.070)
CDF(*I_Risk*)	0.742*** (0.092)	0.745*** (0.092)	1.371*** (0.113)	1.362*** (0.113)	0.171 (0.224)	0.702*** (0.093)
log (*MVE*)	0.620*** (0.015)	0.620*** (0.016)	0.620*** (0.016)	0.619*** (0.016)	0.613*** (0.015)	0.616*** (0.016)
BTM	-0.888*** (0.084)	-0.889*** (0.084)	-0.760*** (0.090)	-0.762*** (0.090)	-0.711*** (0.091)	-0.744*** (0.092)
log (*Tenure*)	0.515*** (0.018)	0.515*** (0.018)	0.512*** (0.018)	0.512*** (0.018)	0.511*** (0.018)	0.512*** (0.018)
FCFP	-0.263 (0.781)	-0.267 (0.781)	-0.257 (0.782)	-0.240 (0.781)	-0.173 (0.780)	-0.293 (0.781)
Lev	-0.020 (0.121)	-0.021 (0.121)	-0.017 (0.120)	-0.019 (0.120)	0.001 (0.120)	-0.011 (0.120)
Loss 5	-0.107*** (0.015)	-0.107*** (0.014)	-0.096*** (0.015)	-0.094*** (0.015)	-0.094*** (0.015)	-0.099*** (0.015)
Test of (1) + (2) = 0 (p-value)				**[0.42]**	**[0.01]****	**[0.03]****
Fixed effect	I, Y	I, Y	I, Y	I, Y	I, Y	I, Y
N	21,139	21,139	21,139	21,139	21,139	21,139
Adj Rsq	53.5%	53.5%	53.7%	53.7%	53.9%	53.7%

(continued)

Table 6, *Continued*

The sample period ranges from 1992-2008 and comprises nonfinancial firm-year observations with sufficient data available on Execucomp, CRSP, and Compustat to measure pay-performance sensitivity measures. See Table 2 for definitions and distributional statistics for the regression variables. I and Y represent industry and year fixed effects. *, **, and *** represent statistical significance at the $\alpha = 0.10$, 0.05, and 0.01 level, respectively, using a two-tailed test.

Table 7
Regression Analysis of Stock and Option PPS and Asymmetric Risk Measures

Dependent variable:	log (*PPS_Stock*)			log (*PPS_Options*)		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	5.754*** (0.300)	5.643*** (0.303)	5.885*** (0.300)	1.913*** (0.491)	1.803*** (0.496)	2.002*** (0.489)
CDF (*Down_Semi*) **(1)**		-0.830*** (0.145)			0.106 (0.238)	
CDF (*Up_Semi*) **(2)**		1.072*** (0.141)			0.787*** (0.221)	
CDF (*Ratio_Semi*)			-0.474*** (0.080)			-0.322** (0.127)
CDF (*Variance*)	0.343** (0.150)		0.296** (0.150)	0.821*** (0.247)		0.790*** (0.248)
log (*MVE*)	0.563*** (0.026)	0.558*** (0.026)	0.560*** (0.026)	0.796*** (0.042)	0.797*** (0.042)	0.793*** (0.042)
BTM	-0.885*** (0.141)	-0.613*** (0.149)	-0.668*** (0.150)	0.161 (0.226)	0.254 (0.244)	0.309 (0.248)
log (*Tenure*)	0.925*** (0.030)	0.919*** (0.030)	0.921*** (0.030)	0.001 (0.050)	-0.001 (0.050)	-0.002 (0.050)
FCFP	-0.811 (1.185)	-0.714 (1.182)	-0.898 (1.184)	-2.263 (1.941)	-2.199 (1.941)	-2.323 (1.943)
Lev	0.313 (0.196)	0.340* (0.195)	0.329* (0.195)	1.400*** (0.319)	1.414*** (0.320)	1.411*** (0.319)
Loss 5	-0.232*** (0.033)	-0.212*** (0.032)	-0.224*** (0.033)	-0.051 (0.039)	-0.048 (0.039)	-0.045 (0.039)
Test of (1)+(2)=0 (p-value)		**[0.14]**			**[0.00]*****	
Fixed effect	I, Y	I, Y	I, Y	I, Y	I, Y	I, Y
N	21,139	21,139	21,139	21,139	21,139	21,139
Adj Rsq	32.2%	32.5%	32.4%	19.7%	19.7%	19.8%

The sample period ranges from 1992-2008 and comprises nonfinancial firm-year observations with sufficient data available on Execucomp, CRSP, and Compustat to measure pay-performance sensitivity measures. See Table 2 for definitions and distributional statistics for the regression variables. I and Y represent industry and year fixed effects. *, **, and *** represent statistical significance at the $\alpha = 0.10$, 0.05, and 0.01 level, respectively, using a two-tailed test.