Differential Risk Taking Implications of Performance Incentives from Stock and Stock Option Holdings

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Abstract

In this paper, we study the risk taking implications of managerial pay-for-performance incentives (delta). The extant empirical literature is built on the presumption that each unit of delta has an equal risk inducing effect regardless of its source. Instead, following the predictions of the principal-agent models of executive compensation, we differentiate between performance incentives from stock and option holdings. We show that while option delta is positively associated with firm riskiness, stock delta does not have a significant effect on risk taking. Consequently, the relationship between the total value of pay-for-performance incentives and firm risk strengthens as the relative contribution from option holdings increases. Our findings contribute to the debate on the executive pay reforms, stressing the need to consider the composition of stock-based pay when designing compensation packages to provide appropriate performance and risk incentives to the executives.

JEL classification: G32, G34

Keywords: executive compensation; risk taking; equity-based compensation; regulation

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1 Introduction

Stock and stock option grants form a significant portion of executive pay packages in the U.S.: stock-based pay amounted to 35 percent of a CEO's pay on average between 1993 and 2013. The main motivation for stock-based compensation is to provide managers with performance incentives. Equipped with these incentives, managers are expected to make value-generating financial decisions such as investing in high-risk high-return projects. However, since the onset of the 2007-2008 financial crisis, stock-based compensation is under scrutiny with the increasingly popular belief that it leads to excessive risk taking.

In the executive compensation literature, the impact of pay packages on managerial choices is largely analyzed within a principal-agent framework,[1] in which the contracting problem involves risk neutral shareholders (principals) and risk averse managers (agents). Shareholders design the managerial pay packages and managers in return undertake actions that would yield expected utility levels that are at least equal to their outside options. These models yield optimal compensation contracts, which include performance sensitive pay components such as stock and stock option grants[2], incentivizing managers to take value-maximizing actions. With regards to risk taking, if higher value projects are inherently riskier, then larger pay-for-performance incentives should implement riskier managerial actions. Yet, an important insight from the principal-agent analysis is that the relationship

[1] See Edmans and Gabaix (2015) for an extensive review of this literature.

[2] Armstrong et al. (2007) provides a detailed review of the optimal contracts suggested by the literature.

between stock-based pay and risk taking may not be positive, and even be negative because higher risk may be associated with a lower utility for a sufficiently risk averse manager (Lambert et al., 1991; Carpenter, 2000; Hall and Murphy, 2002; Ross, 2004; Lewellen, 2006). The risk-reducing effect of performance incentives are predicted to be more pronounced when provided primarily by stocks rather than options (Flor et al., 2014).

Despite the well-developed theoretical literature studying the risk taking effects of managerial performance incentives (delta), the number of empirical papers testing this relationship remains limited. Instead, the primary focus of the empirical work has been on testing the relationship between pay-for-risk sensitivity (vega) and firm risk, while delta has been treated as a control variable. Furthermore, while the theory distinguishes between the compensation plans that are linear (i.e. stock grants) and convex (i.e. stock option grants) in firm performance, the empirical studies so far do not distinguish between the pay-for-performance incentives from different pay sources. In the existing empirical literature, there is yet no consensus on the relationship between performance incentives and firm risk. For example, while Cohen et al (2004), Coles et al (2006), Armstrong and Vashishta (2012) and Savaser and Sisli Ciamarra (forthcoming) find that performance incentives lead to higher firm risk, other studies report no significant association between performance incentives and firm riskiness (Low, 2009; Hayes et al, 2012; Gormley et al, 2013 and Andersen and Core, 2014).

Given this background, in this paper we focus on the relationship between managerial performance incentives and firm risk. Specifically, we contribute to the literature by showing that differentiating between performance incentives provided by accumulated stock holdings and option holdings is crucial when analyzing the risk taking implications of stock-based

pay. In addition, disaggregating delta by its source leads to a more robust interpretation of its relationship to firm riskiness. Performance incentives from options are inherently coupled with risk taking incentives due to their convex payoff structure - the manager receives gains when stock price exceeds the exercise price, but her losses are capped when the stock price falls below the exercise price. However, performance incentives from stocks, which provide linear payoffs, are not accompanied by similarly strong risk taking incentives. Accordingly, we hypothesize that (i) performance incentives provided by option holdings are associated with higher firm risk compared to the performance incentives provided by stock holdings, and consequently (ii) the relationship between performance incentives and risk taking strengthens as the relative magnitude of incentives provided by options increases compared to the incentives from stocks.

In order to test these hypotheses, we assemble a panel dataset on the compensation packages of chief executive officers (CEOs) of U.S. public firms between 1992 and 2013. Our sample includes three distinct periods with regards to the relative importance of performance incentives from managerial stock holdings versus option holdings: 1992-1995, 1996-2007 and 2008-2013. At the beginning of our sample period, between 1992 and 1995, performance incentives have been mostly provided by stock grants. Yet, in the latter half of 1990s, option compensation has increased in popularity due to shareholder pressure for equity-based pay and accounting treatment advantages of option grants over other components of executive pay (Murphy, 2012). In consequence, the relative magnitude of performance incentives from option holdings has exceeded performance incentives from stock holdings during 1996-2007. Finally, the late 2000s witnessed another reversal in the composition of stock-based pay. In response to the change in the accounting treatment of option compensation under

FAS 123(R), option compensation has declined significantly (Hayes et al., 2012). As a result, between 2008 and 2013, performance incentives from stocks have once again begun to dominate incentives from options.

To measure the pay-for-performance incentives during this period, we follow the literature and calculate delta – the change in the dollar value of a CEO's wealth for a one percent change in stock price (Core and Guay, 1999). However, unlike prior studies, we further decompose total pay-for-performance incentives into two components: delta provided by accumulated stock holdings and delta from accumulated option holdings. Since stock-based pay also affects the risk appetite of managers by creating a pay-for-risk sensitivity, we directly control for risk taking incentives in all of our analyses. We measure risk taking incentives by vega – the change in the dollar value of a CEO's wealth for a 0.01 change in the annualized standard deviation of stock returns (Core and Guay, 1999).

We measure firm risk using realized stock return volatility, which is one of the standard measures of risk in the compensation literature (e.g., Guay, 1999; Low, 2009; Hayes et al. 2012). Stock return volatility reflects business decisions that affect the volatility of a firm's expected future cash flows and therefore represents the net effect of all managerial risk taking activities including those that are unobservable.

We find that while the relationship between delta from stock holdings and firm risk is insignificant, the relationship between delta from stock option holdings and firm risk is positive and statistically significant. This finding is in line with our first hypothesis: Performance incentives from option holdings are coupled with risk taking incentives due to their convex payoff structure, hence are associated with higher firm risk compared to the performance incentives provided by stocks that promise linear payoffs.

Our second hypothesis is that the relationship between total delta and risk taking strengthens as the relative magnitude of delta from option holdings increases compared to stock holdings. To test this prediction, we first separate the firms in our sample into quartiles according to the ratio of delta from options to delta from stocks (source ratio). We find that the relationship between delta and firm risk is negative for the firms that provide performance incentives mostly by stock grants: A one percent increase in delta is associated with a 1.8 percent reduction in firm riskiness for the firms in the lowest quartile of the source ratio. As the relative value of delta from stock option holdings increases, the relationship between firm risk and performance incentives becomes positive. A one percent increase in performance incentives is associated with a 2.1 percent increase in firm riskiness in the highest source ratio quartile. As an alternative approach, we also directly estimate the relationship between the source ratio (delta from options/delta from stocks) and the firm risk. The results are consistent with our quartile approach. A one percent increase in the source ratio is associated with a 1.9 percent increase in firm risk.

In order to ensure that the firms operating environment does not influence the structure of the compensation contracts of its managers (Murphy, 2012; Armstrong and Vashishtha, 2012), we explicitly account for the endogenous nature of the incentive contracts using instrumental variables estimation and find that our results are robust. In addition, to address endogeneity concerns further, we follow Hayes et al. (2012) and treat the FAS regulatory change regarding the expensing of options as an exogenous shock that led to a significant reduction in the source ratio. We show that the impact of delta on firm risk declines after the passage of FAS 123(R), which led to a sharp decline in option compensation. This result is in line with our prediction, which suggests that a decline in the source ratio is associated

with a depressive effect on firm risk.

To further test the robustness of our results, we investigate the differences between firms with high and low managerial control. The main cause behind the depressive effects of performance incentives on risk taking is the agency problem between managers and shareholders resulting from managerial risk aversion (Smith and Stulz, 1985; Amihud and Lev, 1981; Tufano, 1996). Risk averse managers may forgo some of the risky positive NPV projects to the detriment of the shareholders in order to preserve their firm-specific wealth and human capital. In firms where managers have more control over the firm's actions and hence have greater opportunities to shift from high risk to low risk projects, we expect to see more pronounced differences in the risk taking implications of the two components of performance pay. In particular, we expect the risk taking impact of performance incentives from stock grants to be more depressive for such firms. To test this conjecture, we use CEO tenure and product market competition, which are standard proxies for managerial control in the literature. Our results indicate that the source ratio (delta from options/delta from stock) matters only in firms with stronger managerial influence.

It has been shown that the relationship between performance incentives and firm risk depends on the state of the economy because individuals' risk appetite varies with the underlying macroeconomic conditions (Savaser and Sisli Ciamarra, forthcoming). Since our sample period covers two recessions, we also take into account the effect of economic conditions on managerial risk taking preferences by directly controlling for the level of macroeconomic activity. Our results are economically more significant once we control for the state of the economy: A one percent increase in performance incentives is associated with a 2.6 percent reduction in firm riskiness for the firms in the lowest quartile of the source ratio, and with

a 4.3 percent increase in firm riskiness in the highest quartile of the source ratio.

To conclude, our paper contributes to the literature on executive compensation by showing that not only the level but also the structure of executive pay packages matter for managerial risk taking. In the executive compensation literature, the standard practice has been to aggregate delta from managerial stock and option holdings into a single pay-for-performance measure. As a result, the extant literature is built on the presumption that each unit of delta has an equal risk inducing effect regardless of its source. Yet, our results clearly indicate that the performance incentives provided by options have significantly higher risk taking implications. Furthermore, the source ratio has a more robust explanatory power than the level of aggregate delta.

One of the main objectives of the recent regulatory changes has been to limit the excessive risk taking implications of executive compensation. As we have documented, the changes in the regulatory environment (e.g., Sarbanes Oxley Act of 2002, passage of FAS 123 (R) in 2006) have a direct impact not only on the level of executive incentives, but also on the source ratio. However, the impact of such changes in the source ratio has largely been overlooked in both academic and policy discussions. As such, our findings contribute to the debate on the executive pay reforms, stressing the need to consider the composition of stock-based pay when designing compensation packages to provide appropriate performance and risk incentives to the executives.

2 Hypothesis Development

We motivate our hypotheses by considering a manager's optimal response to the pay-for-performance sensitivity provided by her stock and stock option holdings following the standard assumptions in the principal-agent models of executive pay. Managerial preferences are customarily represented by a general utility function that incorporates the utility from her compensation contract and the disutility from costly managerial actions:

$$U(w, e) = V(w(e)) - C(e)$$

The executive's utility from her compensation contract (w) is typically increasing and concave, characterizing managerial risk aversion[3]. The compensation contract includes not only the current stock-based pay, but also the accumulated stock and stock option holdings, the sum of which captures the total pay-for-performance sensitivity. In a more general sense, the compensation contract represents managerial wealth, which consists of firm-related wealth (stock and option holdings) and outside wealth, which is often assumed to be a fixed amount (Armstrong et al., 2007).

The effort parameter, e, represents managerial actions that increase expected firm value (thus the value of the compensation contract that includes stock-based pay) but are costly to the managers themselves. It generally represents managerial effort in the literature, but it may also represent other costly actions of the managers (Edmans and Gabaix, 2015). In the context of our study, it represents project choice - high e involves creating and funding high-risk high-return projects, but doing so is costly to a risk-averse manager since high return projects are at the same time riskier (Guay, 1999; Ross, 2004).

[3] Managerial risk aversion is caused mainly by managers' organization-specific human capital and/or undiversified wealth portfolios (Smith and Stulz, 1985; Amihud and Lev, 1981; Tufano, 1996).

Given her compensation contract and general preferences, the manager chooses actions that maximize her utility. While firm risk is not a parameter that directly affects manager's utility in the standard principal-agent models, it has an indirect impact through its effect on stock price and hence the manager's utility from her firm-related wealth. An important result that emerges from the analysis of the manager's problem is that pay-for-performance incentives do not necessarily lead to the selection of high-risk high-return projects as intended. This is because for a sufficiently risk averse manager, convexity of the compensation plan generated by stock and stock option holdings may not be sufficient to overcome the concavity of her utility function (Lambert et al., 1991; Carpenter, 2000; Hall and Murphy, 2002; Ross, 2004; Lewellen, 2006).

The key theoretical argument that derives our hypothesis is that the depressive effect of performance pay is expected to be greater for stock grants than for stock option grants. The performance incentive implicit in stock options is inherently convex since the manager receives gains when stock price exceeds the exercise price, but her losses are capped when price falls below the exercise price. On the other hand, the performance incentives provided by stock grants are linear, subjecting the manager to both upside and downside risk. When executives receive rewards for upside risk, but are not penalized for downside risk, they will take greater risks than if they faced symmetric consequences in both directions (Murphy, 2012). Hence, risk taking incentives are primarily provided by stock option grants. Flor et al., (2014) formalize this argument in their theoretical framework and show that CEOs who receive option-based compensation invest in risky assets more and increase stock return volatility when compared to the CEOs who are compensated by common stock. Accordingly, the two main hypotheses of our paper are as follows:

H1: Performance incentives provided by option grants are associated with higher firm risk compared to the performance incentives provided by stock grants.

H2: The relationship between performance incentives and risk taking becomes stronger (more positive) as the relative magnitude of such incentives from option holdings increases compared to stock grants.

3 Data and Variables

To conduct our analysis, we use a sample of the U.S. companies that are included in the Standard and Poor's ExecuComp database and examine the period between fiscal years 1992 and 2013. Consistent with prior studies, we exclude the financial (SIC codes between 6000 and 6999) and utility firms (SIC codes between 4900 and 4999) from our dataset.

For each CEO, we gather compensation data including salary, bonus, stock option grants, restricted stock grants, and total pay[4]. For the majority of the firm-years, ExecuComp identifies CEOs with a lag. For firm-years when there is no CEO flag in the ExecuComp database, we identify the CEOs based on the dates when they assumed and quit office following Coles et al. (2006).

The Securities Exchange Commission (SEC) changed the compensation disclosure requirements for equity-based compensation with the implementation of FAS 123(R) in 2006. Thus, for fiscal years between 2006 and 2013, the ExecuComp variables reflect the post FAS 123(R) reporting standards. We follow Hayes et al. (2012) and perform the required

[4] If option grants (option_awards_blk_value) or stock holdings (shrown_excl_opts_pct) are missing in ExecuComp, we set their value to zero. Furthermore, there are some observations with negative bonus values, and we replace these figures with zero. Tenure is missing for some firm- years. We replace the missing tenure variables with zero and create indicator variables for missing tenure observations following Coles and Li (2011).

adjustments to the compensation variables for the 2006-2013 period.

The company financials data we use are from Compustat and the stock price data are from the Center for Research in Security Prices (CRSP). We merge these datasets with the compensation variables from ExecuComp. Then, we restrict our sample to firms that have at least 3 years of consecutive financial data and whose stock trades for at least 100 days over our sample period. After these filters, the sample reduces to 25,434 firm-year observations.

Following Core and Guay (2002), we measure the sensitivity of a CEO's wealth from her employment to firm performance with delta - the change in the dollar value of a CEO's wealth for a one percentage point change in the stock price. To measure the sensitivity of a CEO's wealth from her employment to firm risk, we calculate vega, i.e. the change in the dollar value of a CEO's wealth for a 0.01 change in annualized standard deviation of stock returns. To make our results comparable with the previous literature, we winsorize delta, vega, bonus, and salary at the 1st and 99th percentiles (Core and Guay, 2002; Coles et al., 2006). In addition, we convert all dollar values to 1992 constant dollars using the urban-CPI from the Bureau of Labor Statistics (BLS).[5]

We present the summary statistics on the compensation variables and firm financial characteristics in Table 1. Mean (median) total assets is \$4,269 million (\$825 million). Mean (median) delta is \$511,000 (\$143,000), mean (median) vega is \$83,000 (\$30,000), and mean (median) cash compensation is \$1,105,000 (\$789,000). These figures are consistent with the prior literature and have the same order of magnitude with the descriptive statistics reported in Coles et al. (2006).

When we disaggregate the total performance incentives into its two components, we find

[5] http://www.bls.gov/cpi/

that the mean (median) value of delta from accumulated stock holdings is equal to $323,000 ($44,000) and the mean (median) value of delta from accumulated option holdings is equal to $167,000 ($57,000) over our sample period. The source ratio, which is equal to delta from option holdings divided by delta from stock holdings, has a median of 1.4, suggesting that the magnitude of performance incentives from options exceed the incentives from stocks for the median firm. Due to the presence of CEOs with very few stock holdings, there are extreme values for this variable as manifested in its high mean value (927) compared to the median (1.4), leading to a skewed the distribution. Therefore, we use the logarithmic form of this variable in our regressions.

We measure firm riskiness with the volatility of stock returns, which we estimate using the annualized variance of daily stock returns over a firm's fiscal year. This is a standard proxy for firm risk in the literature since business decisions that have a larger impact on firms' expected cash flow volatility lead to higher realized stock return volatility. Realized stock return volatility reflects the net effect of all managerial risk taking activities, including those that are unobservable (e.g. Low, 2009). While firm risk can also be inferred from financial and investment policies that influence the volatility of a firm's expected future cash flows, many aspects of the uncertainty regarding these policies such as changes in capital expenditures, R&D expenditures, leverage, or firm diversification are unobservable. For instance, not all research and development projects are similarly uncertain. Ideally, one would also estimate the risk of the firm's debt since total firm risk also includes the debt component. However, due to lack of readily available data on private and public debt prices, we are unable to incorporate debt risk in our analysis, but we do control for the effect of leverage on equity risk in all of our regressions.

In line with earlier research on executive compensation, we use a set of control variables including firm size, market-to-book ratio, research and development expenditures scaled by total assets, capital expenditures scaled by assets and leverage ratio (Coles et al., 2006). Finally, to make sure that our results are not driven by the changes in the aggregate economic activity, we also control for the real GDP in our analysis. We use the unrevised announcement values of the GDP advance release variable to capture the macroeconomic climate as perceived by the firms during a fiscal year (Savaser and Sisli Ciamarra, forthcoming). The seasonally-adjusted real GDP growth rates are announced quarterly by the Bureau of Economic Analysis (BEA). We use the minimum of the four quarterly GDP growth rates during a firm's fiscal year.

We provide the list of all variables used in the analysis along with their definitions and data sources in the Data Appendix.

4 Composition of the Pay-for-Performance Incentives over Time

The main focus of our paper is the relationship between the managerial pay-for-performance incentives (delta) and firm risk. In Figure 1, we plot the evolution of total delta for the median CEO in our sample. As this figure illustrates, the aggregate value of pay-for-performance incentives (in 1992 dollars) increases steadily between 1992 and 2003, then declines significantly between 2003 and 2008. In Figure 2, we plot the delta from accumulated stock and option holdings seperately to highlight the distinct patterns associated with each component. As this figure demonstrates, delta from stock holdings remained relatively stable over our sample period whereas delta from stock option holdings fluctuated considerably. In particular, there are three distinct periods with regards to the relative importance of performance

incentives from stock versus option holdings: 1992-1995, 1996-2007, and 2008-2013.

Between 1992 and 1995, performance incentives were mostly provided by stock grants. The escalation of option grants began with the enactment of Section 162m in 1993, which exempted equity-based performance pay (stocks and options) from the $1 million tax deductibility cap that was put on top executives' compensation.[6] In addition, the accounting treatment advantages associated with option compensation made stock option grants increasingly more popular. Over time, the gap between the magnitude of performance incentives from managerial stock option holdings and performance incentives from stock holdings grew and reached its peak in 2003, when the median value of performance incentives from options was more than double the amount of performance incentives from stock grants ($39,000 vs. $102,000).

The fiscal year 2003 marks an important turning point in executive pay with firms starting to shift away from option awards. This decline in the popularity of option grants has been attributed to a series of changes in the regulatory and institutional environment including the Sarbanes Oxley Act of 2002 (Cohen et al., 2008), the new NYSE and NASDAQ listing rules requiring shareholder approval for all option plans in 2003 (Murphy, 2012), the changes in the accounting treatment of stock-based compensation under FAS 123(R) (Hayes et al.,2012) and the negative public opinion about executive pay (Kuhnen and Niessen-Ruenzi, 2012). By 2007, performance incentives from stock holdings and stock option holdings were virtually equivalent. After 2008, the value of performance incentives from stock holdings once again began to dominate incentives from stock option holdings, a trend that continued at an

[6] In addition to the Clinton's $1 million deductibility cap, the shareholder pressure for equity-based pay; SEC holding-period and option disclosure rules, accounting rules for options; NYSE listing requirements also contributed to the sharp increase in stock option grants during this period. Murphy (2012) discusses each factor in detail.

increasing rate until the end of our sample period. Figure 3 plots the evolution of the source ratio, once again reflecting the declining role of options in providing performance incentives.

5 RESULTS

5.1 *Aggregate Performance Incentives and Firm Risk*

To conduct our baseline analysis, we estimate the relationship between managerial performance incentives and firm risk following Coles et al. (2006):

$$\text{Firm risk}_{i,t} = \alpha + \beta_1 \text{Delta}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t} \quad (1)$$

We measure total firm risk with the natural logarithm of annualized volatility of daily stock returns during the fiscal year, t. Our main variable of interest is the pay-for-performance sensitivity (delta). Following the literature, we use one-year lagged values of delta in all of our regressions due to the possibility that managerial incentives are endogenously determined along with firm risk (Coles et al. 2006). Although delta is the primary focus of this paper, we also control pay-for-risk sensitivity (vega) that is provided to managers via stock options.

Other control variables include CEO tenure, one-year lagged values of cash compensation (salary plus bonus), firm size, market-to-book ratio, research and development expenditures scaled by total assets, capital expenditures scaled by assets and leverage ratio. These are the standard controls employed in the literature. Armstrong and Vashishtha (2013) provide a detailed discussion of these control variables and their predicted signs in the firm risk equation.

We perform our analyses using industry, firm and firm-manager fixed effects.[7] Firm fixed

[7] We create a dummy variable for each unique combination of manager and firm (i.e. for each employment spell). In Execucomp data, each employment spell has a unique firm-executive ID: CO_PER_ROL. This approach has been used in the economics literature by Abowd, Kramarz and Margolis (1999), Schank, Schnable, and Wagner (2007), and Munch and Skaksen (2008). The "spell method" uses the full sample and

effects mitigate the concern that unobservable firm characteristics might be affecting both the structure of executive compensation and firm risk choices. We also estimate the equation using fixed effects for firm-manager pairs (employment spells). To apply this method, we construct a dummy variable for each unique combination of CEO and firm pairs using the firm-executive identifier (co_per_rol) available in ExecuComp. This specification, as suggested by Graham et al., (2012) takes into account the possibility that a given CEO might be compensated differently in similar firms due to the heterogeneity in unobservable firm characteristics such as corporate culture. It also accounts for the possibility that in a given firm, similar CEOs might be compensated differently due to the heterogeneity in their unobserved personal characteristics such as effort. In addition, this approach also mitigates the concern that CEO transitions might be accompanied by changes in CEO characteristics other than performance and risk incentives that the CEOs possess. All regressions also include year fixed effects to capture systemic variations in firm risk over time. We cluster the standard errors at the firm level when using industry and firm fixed effects and at the firm-manager level when using employment spell effects.

Table 2 presents the results of estimation of the relationship between total value of accumulated performance incentives and firm risk. In column 1, we run industry fixed effects regression and find a negative relationship between delta and firm risk at the ten percent level. That is, a one percent increase in delta is associated with a one percent decline in stock return volatility implying a depressive effect of pay-for-performance incentives on firm's riskiness. In columns 2 and 3, we run the same regression using firm and firm-manager fixed

addresses possible omitted variable bias, but it can only estimate the joint firm and manager effects and does not disentangle the two.

effects and find that the coefficient on log(delta) is virtually equal to zero.

Even though our emphasis in this paper is on performance incentives (delta), we briefly comment on the negative coefficient on risk incentives (vega) in our regressions. The theory stresses that the relationship between vega and risk may either be positive or negative depending on the risk aversion of the managers (Ross, 2004). Some of the earlier studies (Coles et al., 2006; Low, 2009) find a positive correlation between vega and firm risk, while some find no significant relationship (Hayes et al., 2012). Yet, more recent studies (Milidonis and Stathopoilos, 2014; Savaser and Sisli-Ciamarra, forthcoming) report a significant negative relationship between vega and risk, similar to our results. Milidonis and Stathopoilos (2014) attribute the negative relationship between vega and risk to managerial career concerns. Savaser and Sisli-Ciamarra (forthcoming) attribute the shift in the sign on the vega coefficient to the differences in sample periods – the expanded sample period includes the recession period when managerial risk aversion increased substantially (Guiso et al., 2014; Cohn et al., 2014). Since we have followed the specification in Coles et al. (2006), we reestimate the equation for the sample period of that study (1992-2002), and in line with their results we obtain a positive coefficient on vega.

5.2 Composition of the Pay-for-Performance Incentives

In this section, we test our first hypothesis, which suggests that performance incentives provided by option holdings are associated with higher firm risk compared to the performance incentives provided by stock holdings We regress firm risk on the two distinct sources of pay-for-performance incentives:

$$\text{Firm risk}_{i,t} = \alpha + \beta_1 \text{Delta from Stocks} + \beta_2 \text{Delta from Options}_{i,t-1} + \beta_3 \text{Vega}_{i,t-1} + \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t} \quad (2)$$

We present the results in Table 3. We find that the relationship between pay-for-performance incentives from options and firm risk is positive and statistically significant at the one percent level. More specifically, we show that a one percent increase in the value of delta from stock option grants is associated with a 5 to 9 percent increase in firm risk. On the other hand, our findings indicate that delta from accumulated stock holdings do not have an impact on firm riskiness – the coefficient on delta from stock is negative but statistically insignificant for firm and firm-manager fixed effects (columns 2 and 3).

To formally test our hypothesis, we calculate the significance of the difference between the coefficients on delta from stock and delta from options (b2-b1). This difference is positive and significant for all estimation methods at the one percent level. Overall, the results presented in Table 3 collectively support our first prediction - performance incentives from option holdings are accompanied by risk taking incentives due to the convex payoff structure of the options, hence they are associated with higher firm risk compared to performance incentives provided by stocks.

To test our second prediction that the relationship between total performance incentives and firm risk strengthens (i.e. becomes more positive) as the magnitude of such incentives from option holdings increases relative to stock holdings, we divide the firms in our sample into quartiles according to the ratio of delta from options to delta from stocks (source ratio). Then, we re-estimate the relationship between aggregate performance incentives and firm risk for each quartile separately using firm fixed effects. We present the results in Table

4, Panel A. Our results indicate that the relationship between performance incentives and firm risk is negative for firms that provide performance incentives mostly by stock grants. A one percent increase in performance incentives is associated with a 1.8 percent reduction in firm risk for the firms in the lowest quartile of the source ratio (column 1). The relationship between firm risk and performance incentives becomes positive as the relative value of delta from stock options increases. A one percent increase in performance incentives is associated with a 2.1 percent increase in firm risk in the largest quartile of the source ratio (column 4).[8]

Another way of testing our second hypothesis is to directly incorporate the source ratio (delta from options/delta from stocks) as a continuous variable into our regression framework:

$$\text{Firm risk}_{i,t} = \alpha + \beta_1 \text{Source Ratio}_{i,t-1} + \beta_2 \text{Vega}_{i,t-1} + \sum_j \gamma_j X_{i,t} + \varepsilon_{i,t} \qquad (3)$$

Our results in Table 4, Panel B suggest that a one percent increase in the source ratio is associated with a statistically significant 0.9 to 2.4 percent increase in firm risk. To state the economic significance of this result, we calculate the effect of increasing a CEO's source ratio from its 25th percentile value (0.23) to its 75th percentile value (4.55). Such an increase would be associated with a 36 percent increase in firm risk. This finding is consistent with the results associated with our quartiles approach - the relationship between total performance incentives and firm risk strengthens as the magnitude of such incentives from option holdings increases relative to stock holdings.

[8] When we re-estimate this relationship using industry and firm-manager fixed effects, our results remain unchanged. Results are not provided for brevity, but are available upon request.

6 Robustness

6.1 Endogeneity

A major concern in the executive compensation literature is that the firms' operating environment might influence the structure of the compensation contracts offered to the managers (Murphy, 2012) and therefore the analyses may be subject to the reverse causality problem. We try to mitigate the endogeneity concern in two ways: (i) using the passage of FAS 123(R) as an exogenous shock to the source ratio, and (ii) using the instrumental variables estimation method.

6.1.1 FAS 123(R) as an Exogenous Shock to the Source Ratio

In this section, we address the endogeneity problem by examining whether managers change firm risk in response to an exogenous shock that affected the source of performance incentives, but not firm riskiness, namely the passage and implementation of FAS 123(R). The aim of FAS 123(R) was to make the economic cost of stock options more transparent to the readers of financial statements. Before FAS 123(R), firms recorded compensation expenditures using the intrinsic values of the option grants. As there were no cash outlay when the options were granted and no expense when they were exercised, firms presumed the "perceived cost" of options to be lower than their "economic cost". This in turn encouraged firms to compensate their executives with options (Hall and Murphy, 2003).

On March 12, 2003, the Financial Accounting Standards Board (FASB) announced that it will re-examine whether stock options should be a charge against earnings. This decision was partly the result of an unfriendly environment toward high-level executives who realized substantial gains from their stock options over the past decade and the widespread belief

that companies would have made smaller option grants if options had been a charge against earnings. The new standard, known as FAS 123(R), required the expensing of employee stock options at fair value. The effective date of FAS 123(R) was the first accounting period after June 15, 2005. With the passage of the regulatory change, stock option grants became a less attractive tool for managerial compensation, and firms responded by significantly reducing managerial stock option grants (Carter et al., 2007; Feng and Tian, 2009; Hayes, et al., 2012). More importantly, as shown in Hayes et al. (2012), while the new accounting standard lead to a significant reduction in option compensation, firm risk remained unchanged following its implementation.

Using this regulatory change as an exogenous shock to the source ratio, we estimate the relationship between performance incentives and firm risk and report the results in Table 5. To capture the effect of the new accounting standard, we create a dummy variable that takes the value one for the fiscal years after 2005 (After FAS 123(R)).[9] We include this indicator variable along with its interactions with delta and vega in our regression specification.

Our results presented in Table 5 show that the effect of delta on firm risk is positive prior to the passage of FAS 123(R). More specifically, we find that a one percent increase in delta is associated with a one to two percent increase in stock return volatility prior to the passage of FAS 123(R).Supporting evidence for our hypothesis comes from the negative and significant interaction term (Delta * After FAS 123(R)). We find that a one percent increase in delta provided after FAS 123(R) is translated in a 4-6 percent lower firm risk

[9] The original effective date of FAS 123(R) was the first accounting period after June 15, 2005. However, more than 500 public companies did not wait for the regulation to go into effect and shifted from reporting intrinsic values to fair market values in 2003, shortly after the announcement by the FASB. Therefore, we create a dummy variable that takes the value one for the fiscal years after 2003 and repeat our analysis. Reassuringly, our results remain unchanged when we consider the announcement date as the effective start date of the regulatory change.

when compared to the pre-FAS 123(R) period. This result is in line with our prediction, which suggests that a decline in the source ratio is associated with a depressive effect on firm risk. Since this regulatory change was a negative shock to the source ratio that was exogenous to firm risk, our findings help mitigate the endogeneity concerns.

6.1.2 Instrumental Variables Regressions

In this section, we estimate the executive compensation and firm risk equations using the instrumental variables (IV) regressions. We first regress the equity incentives (delta and vega) on the list of instruments described below and the exogenous controls. Then, we regress the total firm risk on the predicted values of delta and vega and present the results in Table 6.

The IV estimation requires the use of instruments for delta and vega – the two components of the executives compensation packages that we treat as endogenous. To identify the list of instruments, we follow the prior literature. Our first set of instruments include cash-to-asset ratio, tax-loss carry forward (an indicator variable that is equal to one if a firm had a tax-loss carry forward in any of the past three years and zero otherwise) and the stock returns in the past two years. These variables have been identified by Armstrong and Vashistha (2012) as valid instruments for delta and vega.[10]

We also use the accounting cost of implementing FAS 123(R) as an additional instrument. As explained in the previous section, following the passage of FAS 123(R), firms reduced stock option grants to their executives. However, firms with higher accounting costs of options reduced their option grants more because they would have had a larger accounting impact on

[10] For a detailed explanation of these variables as instruments, we refer the reader to Armstrong and Vashistha (2012).

their profitability measures (Hayes et al., 2012). This non-uniform response to the regulation implies a positive relationship between vega and the accounting cost of FAS 123(R). However, there is no obvious reason to expect FAS cost to affect firm risk. In fact, Hayes et al. (2012) show that the passage of FAS 123(R) has not been accompanied by a similar decline in firm risk. We measure the accounting cost with the estimated market value of annual CEO option grants to reported net income – i.e. by how much the reported net income of a firm would decline if stock option grants were expensed at their fair value. This variable has also been employed as an instrument in Savaser and Sisli Ciamarra (forthcoming).

Our last instrument is the volatility of the monthly stock returns in the previous three years (years t-4 to t-1). In identifying this instrument, we use the property that the lagged values of time series data are natural IV candidates (Greene, 2003, pg. 79). Lagged stock return volatility is independent of the current shocks to stock returns. However, firms use 60-month stock return volatility in their option pricing as a component of Black-Scholes valuation and therefore the level of this variable is expected to have an effect on the value of option-based compensation, as well as delta and vega.

Our first stage regression results are in line with the prior research (Armstrong and Vashistha, 2012, Coles et al., 2006). The statistically significant partial F-statistics from these regressions suggest that, as a group, our instruments have a significant explanatory power in both the delta and vega regressions (Table 6, Panels B and C). In addition, to test the validity of our instruments, we use Hansen's (1982) test of overidentifying restrictions and report the J-statistics associated with the IV regressions. When the J- statistic is significantly different from zero, at least one of the assumptions of the test is violated suggesting the presence of endogenous instruments. We find that the J-statistics associated with our

regressions are not statistically different from zero for all source ratio quartiles (except the second quartile), hence support the validity of the instruments in our analysis.

We present the results for the second stage regressions for firms in different quartiles of the source ratio in Table 6, Panel A We obtain a statistically significant negative coefficient on delta for firms with low source ratios (Quartile 1) - the relationship between performance incentives and firm risk is negative for firms that provide performance incentives mostly by stock grants. On the other hand, the relationship between delta and firm risk is positive and statistically significant for the firms with high source ratios (Quartile 4), indicating that managerial performance incentives contribute to firm riskiness when they are provided mostly by stock options. In sum, the IV estimation results also confirm the robustness of our main finding to the endogenous treatment of contract design.

6.2 CEO Control

We have shown that when performance incentives are mostly provided by stock holdings, managers take on less risk. The main cause behind the depressive effects of performance incentives on risk taking is the agency problem between the managers and the shareholders: Managers are inherently more risk averse than shareholders due to their organization-specific human capital and/or undiversified wealth portfolios (Smith and Stulz, 1985; Amihud and Lev, 1981; Tufano, 1996) and would like to maintain the value of their stock-based holdings. In order to preserve their wealth, they may forgo some of the risky positive NPV projects to the detriment of the shareholders. To overcome this agency problem resulting from CEO risk aversion, firms provide stock options to their managers.

To the extent that agency problems that arise from managerial risk aversion are mitigated,

stock grants would be sufficient to induce managers to take on risk to increase firm value, and option grants would not be necessary. As such, one would not expect the source ratio to be a significant determinant of firm riskiness. Therefore, in order to further test the robustness of our results, we investigate the differences between firms with high and low managerial control. Powerful managers would have more opportunities to shift from high-risk to low-risk projects to preserve the value of their stock holdings. Hence, the differential risk taking implications associated with stock and option holdings should be more pronounced when managerial control is higher.

To test this conjecture, we use the CEO tenure and product market fluidity as proxies for managerial control. CEO tenure is a commonly used proxy for CEO control in the literature (e.g., Fahlenbrach, 2009; Agrawal and Nasser, 2009; Chava et al., 2010; Bebchuk et al., 2010, Ferreria et al., 2011; Pan et al., 2014). As CEOs become more seasoned in the firm, the board control over the executive's actions tends to decline. For example, the representation of independent outsiders on the board decreases with the tenure of the CEO (Baker and Gompers, 2003). Similarly, executives with longer tenure are more likely to capture the board of directors, which gives them substantial control over the firm, since directors that are appointed by a CEO exert less control over the manager (Shivdasani and Yermack, 1999; Baker and Gompers, 2003; Morse et al., 2011; Coles et al., 2014).

Pan et al. (2014) show that more seasoned CEOs (with a tenure exceeding 3 years) tend to have more power over the board of directors. Accordingly, in columns 1 and 2 of Table 7, we divide the firms into two categories: (i) firms whose CEOs have a tenure longer than 3 years, and (ii) firms whose CEOs have a tenure less than or equal to 3 years. We create an indicator variable that takes the value one for firms whose managers have a long tenure and

zero otherwise. In line with our prediction, we find that the effect of source ratio on firm risk is positive and significant only for the firms that are managed by more seasoned CEOs. For such firms, a one percent increase in the source ratio is associated with a one percent increase in firm risk. These results show that the composition of delta matters only in firms with stronger managerial influence.

As an alternative proxy for CEO control, we use the product market fluidity index, which is developed by Hoberg et al. (2014). This measure captures the emerging product market threats from other firms. In particular, low product market fluidity identifies instances of low product market competition, which enables the CEO to exert more control over firm's policies including its riskiness. This is because product market competition is an important external governance device that limits the managers' ability to use firms' resources according to their own personal preferences. For example, product market competition may serve as a substitute for internal governance mechanisms (Giroud and Mueller, 2010; Chhaochharia et al., 2012); reduce managerial indiscipline (Giroud and Mueller, 2010; Giroud and Mueller, 2011; Grullon and Michaely, 2012) or improve management practices (Bloom and Van Reenen, 2007, Masulis et al., 2007; Bloom et al., 2015).

In columns 3 and 4, we divide the firms into two categories according to their product market fluidity: (i) firms with a fluidity index above the sample median, and (ii) firms with a fluidity index less than or equal the sample median. A high fluidity index reflects high product market competition, which tends to be a disciplining force on managers. Therefore, we expect managers that operate in such a high market competition environment to be less able to adjust firms' operations to alter firm risk according to their own preferences. Once again, in line with our main hypothesis, the effect of source ratio on firm risk is positive and

significant only for the firms that have a low fluidity score (implying more CEO control over firm policies). In particular, for such firms, we find that a one percent increase in the source ratio is associated with a 1.4 percent increase in firm risk. For firms that operate in a highly competitive market environment where managers have limited control over firm policies, the coefficient on source ratio is statistically insignificant. These results further show that the source of delta matters only in firms with stronger managerial influence.

6.3 Impact of the Macroeconomic State

Previous research documents a pro-cyclical relationship between performance incentives and firm risk (Savaser and Sisli Ciamarra, forthcoming). That is, the relationship between delta and firm risk weakens as the economic conditions deteriorate. This is because during recessions, managers are less willing to take risk primarily due to the state-dependent nature of the risk aversion parameter that defines the concavity of the manager's utility function. To control for the effect of the economic conditions on the managerial risk taking preferences, we directly incorporate the level of macroeconomic activity in our regression analysis in Table 8.

To capture the level of macroeconomic activity, we use the GDP growth rate as a proxy. The regression equation in Table 8, Panel A augments the baseline regression specification (Equation 1) with the measure of economic activity itself as well as its interactions with delta and vega. Columns (1) – (4) present the estimation results for each quartile of the source ratio (delta from option holdings/delta from stock holdings). Confirming prior research, we find that the relationship between delta and firm risk strengthens as the economic conditions improve. Most importantly, we find the relationship between total performance incentives

and firm risk to be more positive for managers' whose performance incentives mostly come from options. More specifically, we show that a one percent increase in performance incentives is associated with a 2.6 percent reduction in firm risk for the companies that are in the lowest quartile of the source ratio, while the same increase in delta is associated with a 4.3 percent increase in firm risk for firms in the largest quartile of the source ratio. This result indicates that our coefficient estimates become economically more significant when we control for the effect of macroeconomic conditions.

As an alternative test, we incorporate the source ratio as a continuous variable into our regression analysis and include the GDP growth rate variable itself along with its interactions with source ratio and vega. As the results in Table 8, Panel B indicate, a one percent increase in the source ratio is associated with a 1 to 2.5 percent increase in firm risk confirming the validity of our main hypothesis and our earlier results.

7 Conclusion

Stock-based pay has come under scrutiny with the popular belief that it induces excessive risk taking following the onset of the 2007-2008 financial crisis. In this paper, we argue that in order to understand the effect of stock-based pay on managerial risk taking, we need to take into account the source of the performance incentives. In particular, we show that while performance incentives from managerial stock option holdings are associated with increased firm riskiness, performance incentives from stock holdings are not. Furthermore, we present evidence that stock holdings may actually limit managerial risk appetite if managers do not hold a significant amount of stock options. These results suggest that regulators and compensation committees may find it useful to consider the composition of stock-based

pay when designing compensation structures to provide appropriate performance and risk incentives.

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Data Appendix. Variable definitions and sources

Variable	Description	Source
CEO Incentive Measures		
Salary ($000s)	Base salary of the CEO	Execucomp
Bonus ($000s)	Bonus payments to the CEO. Calculated as "Bonus + Nonequity Incentives" after the fiscal year 2006	Execucomp
Cash compensation ($000)	Salary plus bonus	Execucomp
Delta ($000s)	Dollar change in the CEO stock and option portfolio for a 1% change in stock price. We use log(1+delta) in our regressions.	Authors' calculations
Delta from stock holdings ($000s)	Dollar change in the CEO stock portfolio for a 1% change in stock price. We use log(1+delta from stocks) in the regressions.	Authors' calculations
Delta from stock option holdings ($000s)	Dollar change in the CEO option portfolio for a 1% change in stock price. We use log(1+delta from options) in the regressions.	Authors' calculations
Source ratio	Delta from Stock Option Holdings / Delta From Stock Holdings . We use log(1+delta from stocks) - log(1+delta from options) in the regressions.	Authors' calculations
Vega ($000s)	Dollar change in the CEO stock and option portfolio for a 1% change in stock return volatility. We use log(1+Vega) in the regressions.	Authors' calculations
Tenure as CEO (years)	Number of years as CEO	Execucomp
Firm Financial Characteristics		
Total risk	Annualized variance of daily stock returns during a firm's fiscal year.	CRSP
R&D Expenditures / Assets	Research and development expenditures scaled by total assets	Compustat
Capital Expenditures / Assets	Capital expenditures net of sales of plant, property and equipment scaled by total assets	Compustat
Leverage ratio	Ratio of long-term debt and debt in current liabilities to book value of assets.	Compustat
Size	Natural logarithm of net sales	Compustat
Market value	Sum of market value of common stock, liquidating value of preferred stock, and book value of total debt	Compustat, CRSP
Market-to-book ratio	Market value divided by book value of total assets	Compustat
Return on assets (ROA)	Earnings before interest, taxes, depreciation and amortization (EBITDA) scaled by total assets	Compustat
Stock return	Annual stock return over a firm's fiscal year	Compustat
FAS Cost	Ratio of Black-Scholes value of CEO stock option grants to net income. This variable serves as a proxy for accounting cost associated with the implementation of FAS 123R.	Compustat
Cash / Assets	Ratio of cash and marketable securities to total assets	Compustat
Past Volatility	Annualized variance of daily stock returns between t-4 and t-1.	CRSP
Total Loss Carry Forward	An indicator variable that takes the value one if a firm has tax-loss-carry-forwards in any of the past three years and zero otherwise	Compustat
Other Variables		
Gross Domestic Product (GDP) growth rate	Advance release values for real GDP growth rate (percentage changes from a year ago), seasonally adjusted. We calculate the minimum GDP growth rate over a fiscal year as the GDP measure	Bureau of Economic Analysis / Action Economics
After FAS 123(R)	An indicator variable that takes the value one for fiscal years 2006-2013 and zero otherwise.	

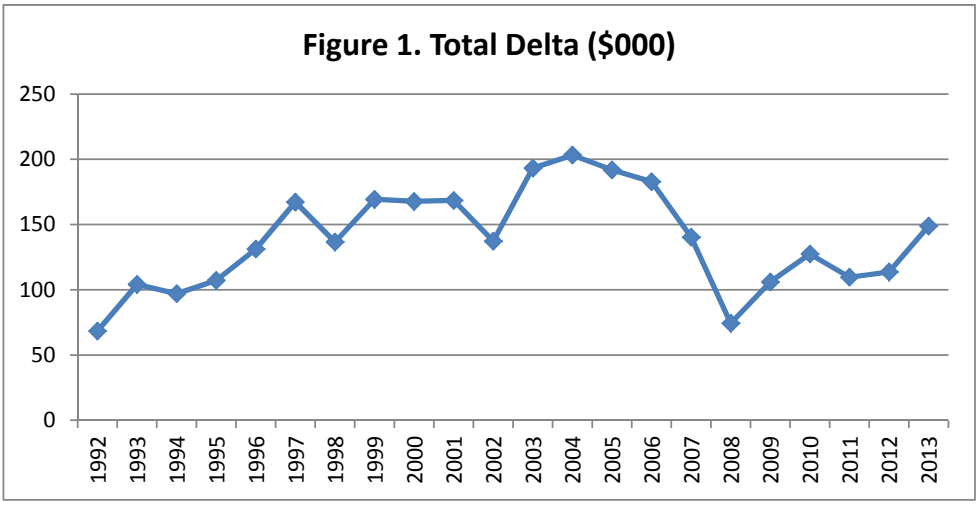
Figure 1. Total Delta ($000)
250
200
150
100
50
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

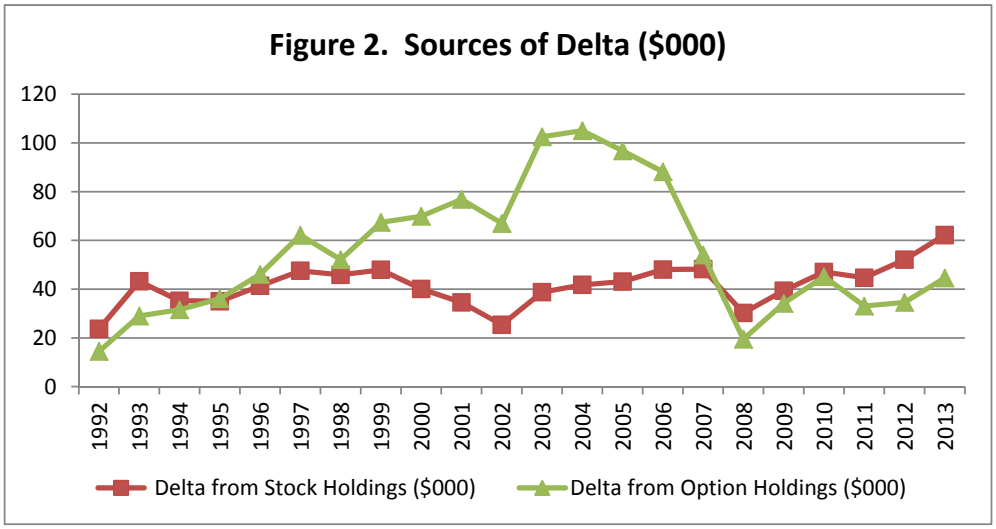
Figure 2. Sources of Delta ($000)
120
100
80
60
40
20
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Delta from Stock Holdings ($000)
Delta from Option Holdings ($000)

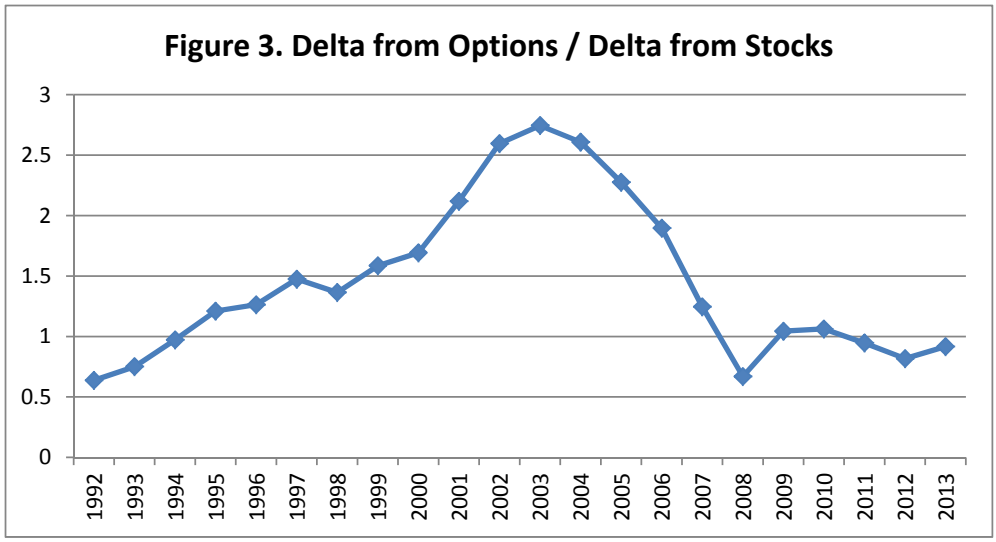
Figure 3. Delta from Options / Delta from Stocks
3
2.5
2
1.5
1
0.5
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

Table1. Summary Statistics

This table presents the summary statistics for the variables used in the analyses. The definition of the variables and the relevant data sources are provided in the Data Appendix.

	Mean	Standard Deviation	p25	p50	p75
CEO Compensation Measures					
Cash Compensation ($000)	1,105	1,007	476	789	1,380
Vega ($000s)	83	143	7	30	91
Delta ($000s)	511	1,276	52	143	404
Delta from Stock Holdings ($000s)	323	1,057	11	44	152
Delta from Stock Option Holdings ($000s)	167	306	13	57	171
Source Ratio	927	79,473	0.23	1.42	4.55
Tenure as CEO (years)	8	8	3	6	11
Firm Financial Characteristics					
Standard Deviation of Daily Stock Returns (annualized)	0.029	0.015	0.019	0.025	0.035
Total Assets ($mn.)	4,269	17,299	314	825	2,568
Net Sales ($mn.)	3,763	12,109	316	849	2,559
Sales Growth	0.07	0.26	-0.02	0.06	0.15
Market-to-book Ratio	1.77	1.37	0.94	1.34	2.06
Leverage Ratio	0.21	0.20	0.04	0.19	0.32
R&D Expenditures / Assets	0.04	0.07	0.00	0.00	0.05
Capital Expenditures/ Assets	0.06	0.06	0.02	0.04	0.07
FAS Cost	0.06	2.70	0.00	0.00	0.01
Cash / Assets	0.21	0.24	0.03	0.12	0.32
Return on Assets (ROA)	0.14	0.13	0.09	0.14	0.19
Stock Return	0.13	1.12	-0.23	0.02	0.29
Past Volatility	0.446	0.221	0.298	0.396	0.539
Total Loss Carry Forward Dummy	0.44	0.50	0.00	0.00	1.00

Table 2: Total Managerial Performance Incentives and Firm Risk

This table presents the results of the estimation of Equation 1 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm level in regressions that control for industry and firm fixed effects, and at the manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Sample Period	1992-2013		
Fixed Effects	Industry	Firm	Firm-Manager
Log(Delta $_{-1}$)	-0.010	0.005	0.005
	[0.089]*	[0.327]	[0.394]
Log(Vega $_{-1}$)	-0.036	-0.035	-0.030
	[0.000]***	[0.000]***	[0.000]***
Log(Cash Compensation$_{-1}$)	-0.084	-0.074	-0.052
	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.000	-0.007
	[0.400]	[0.725]	[0.556]
Log(Sales)	-0.168	-0.166	-0.094
	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.023	0.011	-0.001
	[0.001]***	[0.059]*	[0.851]
R&D Expenditures / Assets	1.858	0.215	0.335
	[0.000]***	[0.076]*	[0.009]***
Capital Expenditures / Assets	0.310	0.340	0.341
	[0.040]**	[0.009]***	[0.013]**
Leverage Ratio	0.298	0.340	0.415
	[0.000]***	[0.000]***	[0.000]***
Constant	-0.440	-0.600	-1.126
	[0.017]**	[0.000]***	[0.000]***
N	25434	25434	22781
Year Fixed Effects	Yes	Yes	Yes
R-sq	0.541	0.509	0.544
adj. R-sq	0.539	0.508	0.544

Table 3: Decomposed Managerial Performance Incentives and Firm Risk

This table presents the results of the estimation of Equation 2 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variables of interest are the logarithm of the lagged value of delta from stocks and delta from options and represent the managerial performance incentives from stock and option holdings respectively. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at firm level in the regressions that control for industry and firm fixed effects, and at the manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Fixed Effects	Industry	Firm	Firm-Manager
Log(Delta from Stocks $_{-1}$)	-0.014	-0.001	-0.007
	[0.001]***	[0.759]	[0.123]
Log(Delta from Options $_{-1}$)	0.087	0.054	0.053
	[0.000]***	[0.000]***	[0.000]***
Log(Vega $_{-1}$)	-0.128	-0.087	-0.081
	[0.000]***	[0.000]***	[0.000]***
Log(Cash Compensation$_{-1}$)	-0.099	-0.084	-0.063
	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.000	-0.007
	[0.634]	[0.788]	[0.566]
Log(Sales)	-0.162	-0.169	-0.097
	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.031	0.005	-0.005
	[0.000]***	[0.378]	[0.398]
R&D Expenditures / Assets	1.857	0.230	0.352
	[0.000]***	[0.057]*	[0.006]***
Capital Expenditures / Assets	0.233	0.285	0.294
	[0.120]	[0.029]**	[0.031]**
Leverage Ratio	0.308	0.352	0.429
	[0.000]***	[0.000]***	[0.000]***
Constant	-0.413	-0.519	-1.035
	[0.020]**	[0.000]***	[0.000]***
N	25434	25434	22781
Year Fixed Effects	Yes	Yes	Yes
R-sq	0.545	0.511	0.546
adj. R-sq	0.544	0.510	0.546
F-value (p-value) for difference in coefficients of Log(Delta from Stocks $_{-1}$) and Log(Delta from Options $_{-1}$)	84.39 (0.0000)	35.70 (0.0000)	31.82 (0.0000)

Table 4. Composition of Performance Incentives and Firm Riskiness
Panel A. Total Managerial Performance Incentives and Firm Risk for Different Quartiles of the Source Ratio

This table presents the results of the estimation of Equation 1 in the text for different quartiles of the source ratio (Delta from Option Holdings/Delta from Stock Holdings). The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for firm and year fixed effects. Robust standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

	Quartiles according to the Source Ratio (Delta from Options / Delta From Stock)			
	Q1	Q2	Q3	Q4
Log(Delta $_{-1}$)	-0.018	0.013	0.026	0.021
	[0.012]**	[0.268]	[0.059]*	[0.039]**
Log(Vega $_{-1}$)	-0.015	-0.048	-0.065	-0.046
	[0.106]	[0.000]***	[0.000]***	[0.000]***
Log(Cash Compensation$_{-1}$)	-0.062	-0.062	-0.092	-0.068
	[0.006]***	[0.006]***	[0.000]***	[0.002]***
CEO Tenure	-0.002	-0.006	0.001	-0.002
	[0.316]	[0.026]**	[0.829]	[0.511]
Log(Sales)	-0.139	-0.152	-0.128	-0.119
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	0.017	0.021	0.024	-0.021
	[0.137]	[0.076]*	[0.012]**	[0.038]**
R&D Expenditures / Assets	1.107	0.143	0.659	-0.165
	[0.017]**	[0.465]	[0.041]**	[0.181]
Capital Expenditures / Assets	0.156	0.315	0.819	0.191
	[0.449]	[0.163]	[0.001]***	[0.452]
Leverage Ratio	0.510	0.353	0.314	0.270
	[0.000]***	[0.001]***	[0.001]***	[0.005]***
Constant	-0.754	-0.808	-0.871	-0.723
	[0.003]***	[0.000]***	[0.000]***	[0.000]***
N	6274	6273	6274	6273
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-sq	0.519	0.539	0.539	0.536
adj. R-sq	0.517	0.536	0.537	0.533

Table 4. Composition of Performance Incentives and Firm Riskiness (cont'd)
Panel B. Source Ratio as an Explanatory Variable

This table presents the results of the estimation of Equation 3 in the text. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of the source ratio, calculated as log(1+delta from stocks) - log(1+delta from options). The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm level in regressions that control for industry and firm fixed effects, and at the manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Fixed Effects	Industry	Firm	Firm-Manager
Log(Source Ratio $_{-1}$)	0.024	0.009	0.019
	[0.000]***	[0.019]**	[0.000]***
Log(Vega $_{-1}$)	-0.065	-0.045	-0.050
	[0.000]***	[0.000]***	[0.000]***
Log(Cash Compensation$_{-1}$)	-0.088	-0.073	-0.048
	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	0.001	0.000	-0.010
	[0.362]	[0.746]	[0.366]
Log(Sales)	-0.159	-0.156	-0.082
	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.024	0.013	-0.001
	[0.000]***	[0.037]**	[0.796]
R&D Expenditures / Assets	1.850	0.200	0.318
	[0.000]***	[0.101]	[0.015]**
Capital Expenditures / Assets	0.300	0.356	0.348
	[0.051]*	[0.008]***	[0.012]**
Leverage Ratio	0.295	0.356	0.409
	[0.000]***	[0.000]***	[0.000]***
Constant	-0.472	-0.645	-1.187
	[0.012]**	[0.000]***	[0.000]***
N	24705	24705	22159
Year Fixed Effects	Yes	Yes	Yes
R-sq	0.544	0.514	0.551
adj. R-sq	0.542	0.513	0.550

Table 5: FAS 123(R) as an Exogenous Shock to the Composition of Performance Incentives

This table presents the results for the estimation of Equation 1 incorporating the variables associated with the implementation of FAS123(R). The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for firm and year fixed effects. Robust standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Fixed Effects	Industry	Firm	Firm-Manager
Log(Delta $_{-1}$)	0.010	0.019	0.013
	[0.152]	[0.000]***	[0.034]**
Log(Vega $_{-1}$)	-0.028	-0.027	-0.025
	[0.000]***	[0.000]***	[0.000]***
After FAS 123(R)	0.316	0.031	-0.035
	[0.000]***	[0.576]	[0.886]
Log(Delta $_{-1}$)* After FAS 123(R)	-0.064	-0.056	-0.044
	[0.000]***	[0.000]***	[0.001]***
Log(Vega $_{-1}$) * After FAS 123(R)	-0.012	-0.010	-0.010
	[0.171]	[0.303]	[0.379]
Log(Cash Compensation$_{-1}$)	-0.085	-0.070	-0.050
	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.000	0.000	-0.009
	[0.869]	[0.775]	[0.482]
Log(Sales)	-0.166	-0.158	-0.089
	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.022	0.011	-0.001
	[0.001]***	[0.059]*	[0.833]
R&D Expenditures / Assets	1.868	0.216	0.345
	[0.000]***	[0.074]*	[0.007]***
Capital Expenditures / Assets	0.308	0.337	0.338
	[0.040]**	[0.009]***	[0.013]**
Leverage Ratio	0.298	0.335	0.409
	[0.000]***	[0.000]***	[0.000]***
Constant	-0.539	-0.749	-1.214
	[0.002]***	[0.000]***	[0.000]***
N	25434	25434	22781
Year Fixed Effects	Yes	Yes	Yes
R-sq	0.545	0.513	0.547
adj. R-sq	0.543	0.512	0.546

Table 6. Instrumental Variables Estimation

This table presents the results of the estimation of Equation 1 in the text for different quartiles of the source ratio (Delta from Option Holdings/Delta from Stock Holdings) using two-stage regressions. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for firm and year fixed effects. Robust standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Panel A: Second Stage Regressions, Dependent Variable: Firm Risk				
	Quartiles according to the Source Ratio (Delta from Options / Delta From Stock)			
	Q1	Q2	Q3	Q4
Log(Delta $_{-1}$)	-1.325	0.470	0.623	0.986
	[0.019]**	[0.133]	[0.215]	[0.016]**
Log(Vega $_{-1}$)	0.231	-0.991	-0.854	-0.635
	[0.178]	[0.000]***	[0.054]*	[0.041]**
Log(Cash Compensation$_{-1}$)	-0.053	-0.107	-0.249	-0.301
	[0.476]	[0.181]	[0.101]	[0.005]***
CEO Tenure	0.063	0.002	-0.000	-0.036
	[0.028]**	[0.918]	[0.988]	[0.041]**
Log(Sales)	0.297	0.059	-0.056	-0.219
	[0.155]	[0.699]	[0.550]	[0.039]**
Market-to-book	0.423	-0.086	-0.127	-0.276
	[0.017]**	[0.445]	[0.443]	[0.019]**
R&D Expenditures / Assets	-3.102	0.252	0.978	0.565
	[0.109]	[0.575]	[0.228]	[0.191]
Capital Expenditures / Assets	2.048	0.045	0.420	-0.232
	[0.045]**	[0.922]	[0.278]	[0.619]
Leverage Ratio	-0.826	0.427	0.484	0.594
	[0.181]	[0.059]*	[0.019]**	[0.006]***
N	5207	5840	5871	5867
Hansen Statistics	7.277	21.118	3.77	0.778
Chi-sq, p-value	0.1219	0.003	0.4367	0.9414

Table 6. Instrumental Variables Estimation

This table presents the results of the first stage of the two-stage least squares (2SLS) estimation of Equation 1 for different quartiles of the source ratio. Log(Delta) and Log(Vega) are treated as endogenous. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects and firm fixed effects. The standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Panel B. First Stage Regressions, Dependent Variable: Log(Delta)

	Quartiles according to the Source Ratio (Delta from Options / Delta From Stock)			
	Q1	Q2	Q3	Q4
Log(Cash Compensation)	0.047	0.227	0.389	0.333
	[0.417]	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	0.051	0.052	0.063	0.052
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Sales)	0.425	0.497	0.263	0.286
	[0.000]***	[0.000]***	[0.000]***	[0.001]***
Market-to-book	0.299	0.376	0.370	0.321
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
R&D Expenditures / Assets	-3.061	-1.165	-1.913	-1.219
	[0.002]	[0.000]***	[0.000]***	[0.000]***
Capital Expenditures / Assets	1.665	0.958	0.450	0.885
	[0.000]***	[0.001]***	[0.156]	[0.057]*
Leverage Ratio	-1.000	-0.601	-0.340	-0.551
	[0.000]***	[0.000]***	[0.004]***	[0.000]***
Instruments				
Cash / Assets	0.317	0.304	-0.113	-0.052
	[0.087]*	[0.013]**	[0.292]	[0.701]
Total Loss Carry Forward	-0.077	0.017	0.014	0.001
	[0.246]	[0.690]	[0.685]	[0.977]
FAS Cost	0.589	0.013	0.003	0.044
	[0.000]***	[0.614]	[0.000]***	[0.053]*
Return	-0.385	-1.224	-0.115	-0.316
	[-0.528]	[0.006]***	[0.759]	[0.420]
Past Return	-0.470	-0.432	-0.552	0.262
	[0.405]	[0.226]	[0.117]	[0.533]
Past Volatility	-0.166	0.165	0.014	0.133
	[0.000]***	[0.146]	[0.867]	[0.292]
N	5207	5840	5871	5867
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm-manager Fixed Effects	Yes	Yes	Yes	Yes
Test of excluded instruments:				
F Statistic	3.580	2.610	7.020	1.250
Prob > F	0.002	0.016	0.000	0.278

Table 6. Instrumental Variables Estimation

This table presents the results of the first stage of the two-stage least squares (2SLS) estimation of Equation 1 for different quartiles of the source ratio. Log(Delta) and Log(Vega) are treated as endogenous. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects and firm fixed effects. The standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Panel C. First Stage Regressions, Dependent Variable: Log(Vega)

	Quartiles according to the Source Ratio (Delta from Options / Delta From Stock)			
	Q1	Q2	Q3	Q4
Log(Cash Compensation)	0.105	0.111	0.161	0.196
	[0.030]	[0.002]***	[0.000]***	[0.000]***
CEO Tenure	0.007	0.032	0.045	0.026
	[0.250]	[0.000]***	[0.000]***	[0.000]***
Log(Sales)	0.390	0.424	0.242	0.255
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.002	0.056	0.075	0.082
	[0.937]	[0.003]***	[0.000]***	[0.000]***
R&D Expenditures / Assets	-0.239	-0.421	-0.820	-0.771
	[0.764]	[0.095]	[0.022]	[0.000]***
Capital Expenditures / Assets	0.424	0.363	0.073	0.924
	[0.342]	[0.281]	[0.820]	[0.027]
Leverage Ratio	-0.270	-0.186	0.024	-0.268
	[0.224]	[0.219]	[0.851]	[0.014]
Instruments				
Cash / Assets	-0.218	0.274	-0.048	-0.017
	[0.253]	[0.031]*	[0.682]	[0.894]
Total Loss Carry Forward	-0.062	0.047	0.007	0.000
	[0.430]	[0.320]	[0.867]	[0.997]
FAS Cost	2.430	0.038	0.002	0.059
	[0.000]***	[0.238]	[0.000]***	[0.038]
Return	-0.280	-0.790	0.000	-0.179
	[0.627]	[0.079]*	[1.000]	[0.629]
Past Return	-0.864	0.049	-0.341	-0.186
	[0.166]	[0.9000]	[0.420]	[0.618]
Past Volatility	-0.344	-0.463	-0.701	-0.671
	[0.021]**	[0.000]	[0.000]***	[0.009]
N	5207	5840	5871	5867
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Test of excluded instruments:				
F Statistic	3.950	3.720	9.250	1.910
Prob > F	0.001	0.001	0.000	0.076

Table 7. Managerial Control

This table presents the results for the estimation of Equation 3 in the text for firms with higher and lower levels of managerial control. Long CEO Tenure and Low Product Fluidity proxies high managerial control. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of the source ratio, calculated as log(1+delta from stocks) - log(1+delta from options). The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm level in regressions that control for industry and firm fixed effects and at the manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

	Long CEO Tenure	Short CEO Tenure	Low Product Fluidity	High Product Fluidity
Log(Source Ratio $_{-1}$)	0.010	0.005	0.014	0.007
	[0.050]*	[0.325]	[0.013]**	[0.195]
Log(Vega $_{-1}$)	-0.046	-0.042	-0.052	-0.038
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
Log(Cash Compensation$_{-1}$)	-0.082	-0.059	-0.072	-0.067
	[0.000]***	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	-0.001	-0.026	0.003	-0.000
	[0.382]	[0.001]***	[0.057]*	[0.910]
Log(Sales)	-0.143	-0.161	-0.224	-0.072
	[0.000]***	[0.000]***	[0.000]***	[0.001]***
Market-to-book	0.023	-0.014	-0.008	0.013
	[0.000]***	[0.229]	[0.565]	[0.064]*
R&D Expenditures / Assets	0.153	0.034	-0.153	0.248
	[0.275]	[0.909]	[0.711]	[0.038]**
Capital Expenditures / Assets	0.471	0.278	-0.158	0.332
	[0.003]***	[0.195]	[0.508]	[0.091]*
Leverage Ratio	0.366	0.357	0.475	0.270
	[0.000]***	[0.000]***	[0.000]***	[0.001]***
Constant	-0.690	-0.596	-0.147	-0.745
	[0.000]***	[0.002]***	[0.508]	[0.000]***
N	17523	7182	10230	10165
R-sq	0.522	0.484	0.553	0.552
adj. R-sq	0.521	0.482	0.552	0.551

Table 8. Removing the Impact of the Macroeconomic Conditions

Panel A. Total Managerial Performance Incentives and Firm Risk for Different Quartiles of the Source Ratio

This table presents the results for the estimation of Equation 1 in the text for different quartiles of the source ratio (Delta from Option Holdings/Delta from Stock Holdings) controlling for the macroeconomic state. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of delta and represents the managerial performance incentives. The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects and firm fixed effects. Robust standard errors are clustered at the firm level. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

	Quartiles according to the Source Ratio (Delta from Options / Delta From Stock)			
	Q1	Q2	Q3	Q4
Log(Delta $_{-1}$)	-0.026	-0.004	0.041	0.043
	[0.003]***	[0.765]	[0.031]**	[0.017]**
Log(Vega $_{-1}$)	-0.012	-0.043	-0.075	-0.080
	[0.250]	[0.000]***	[0.000]***	[0.000]***
GDP Growth	-0.111	-0.129	-0.125	-0.041
	[0.000]***	[0.000]***	[0.000]***	[0.040]**
Log(Delta $_{-1}$)* GDP Growth	0.008	0.020	0.015	0.005
	[0.001]***	[0.000]***	[0.014]**	[0.469]
Log(Vega $_{-1}$) * GDP Growth	-0.002	-0.010	-0.003	-0.004
	[0.381]	[0.013]**	[0.646]	[0.512]
Log(Cash Compensation$_{-1}$)	-0.073	-0.081	-0.099	-0.064
	[0.004]***	[0.001]***	[0.000]***	[0.009]***
CEO Tenure	-0.002	-0.006	-0.001	-0.002
	[0.323]	[0.072]*	[0.791]	[0.494]
Log(Sales)	-0.115	-0.119	-0.123	-0.120
	[0.004]***	[0.001]***	[0.000]***	[0.000]***
Market-to-book	0.017	0.027	0.021	-0.023
	[0.153]	[0.019]**	[0.026]**	[0.033]**
R&D Expenditures / Assets	1.063	0.174	0.761	-0.125
	[0.019]**	[0.427]	[0.022]**	[0.270]
Capital Expenditures / Assets	0.285	0.334	0.954	0.137
	[0.172]	[0.161]	[0.000]***	[0.606]
Leverage Ratio	0.494	0.352	0.259	0.274
	[0.000]***	[0.002]***	[0.014]**	[0.013]**
Constant	-0.663	-0.722	-0.739	-0.685
	[0.014]**	[0.001]***	[0.001]***	[0.003]***
N	5854	5736	5616	5280
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-sq	0.524	0.544	0.551	0.550
adj. R-sq	0.521	0.541	0.549	0.547

Table 8. Removing the Impact of the Macroeconomic Conditions
Panel B. Source Ratio

This table presents the results for the estimation of Equation 3 in the text controlling for the macroeconomic state. The dependent variable is firm risk, calculated as the logarithm of the annualized variance of the daily stock returns. The main variable of interest is the logarithm of the lagged value of the source ratio (Delta from Option Holdings/Delta from Stock Holdings). The definitions of the rest of the variables are provided in the Data Appendix. All regressions control for year fixed effects. Robust standard errors are clustered at the firm level in regressions that control for industry and firm fixed effectss, and at the manager level in regressions that control for firm-manager pair fixed effects. P-values are provided in brackets. *, **, *** mark the 10%, 5% and 1% statistical significance for the estimated coefficients.

Fixed Effects	Industry	Firm	Firm-Manager
Log(Source Ratio $_{-1}$)	0.025	0.010	0.020
	[0.000]***	[0.035]**	[0.000]***
Log(Vega $_{-1}$)	-0.069	-0.051	-0.053
	[0.000]***	[0.000]***	[0.000]***
GDP Growth	-0.075	-0.078	-0.074
	[0.000]***	[0.000]***	[0.000]***
Log(Source Ratio $_{-1}$) * GDP Growth	-0.002	-0.001	-0.001
	[0.084]*	[0.280]	[0.343]
Log(Vega $_{-1}$) * GDP Growth	0.006	0.005	0.003
	[0.000]***	[0.002]***	[0.029]**
Log(Cash Compensation$_{-1}$)	-0.085	-0.080	-0.048
	[0.000]***	[0.000]***	[0.000]***
CEO Tenure	0.001	0.001	-0.011
	[0.234]	[0.641]	[0.323]
Log(Sales)	-0.160	-0.148	-0.080
	[0.000]***	[0.000]***	[0.000]***
Market-to-book	-0.018	0.018	0.000
	[0.005]***	[0.002]***	[0.985]
R&D Expenditures / Assets	1.763	0.195	0.316
	[0.000]***	[0.106]	[0.016]**
Capital Expenditures / Assets	0.380	0.400	0.344
	[0.013]**	[0.003]***	[0.013]**
Leverage Ratio	0.304	0.363	0.407
	[0.000]***	[0.000]***	[0.000]***
Constant	0.360	-0.551	-1.090
	[0.050]**	[0.000]***	[0.000]***
N	22159	22159	22159
Year Fixed Effects	Yes	Yes	Yes
R-sq	0.545	0.522	0.555
adj. R-sq	0.543	0.521	0.555