Why do some CEOs hold so much equity?

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Abstract: We find that US CEOs hold a large amount of equity that is not explicitly constrained by ownership guidelines or vesting requirements. There is considerable debate as to why CEOs might hold seemingly unconstrained equity, particularly given that executives are widely assumed to be risk averse and poorly diversified. We explore several potential explanations for these unconstrained holdings. We begin by showing that the average CEO receives a pay premium for holding a substantial portion of this equity, suggesting that what might at first appear to be unconstrained equity, may in fact, be implicitly required by the board for incentive contacting purposes. Most CEOs, however, hold more equity than one would expect given the magnitude of the risk premium in their pay. We explore reasons why these CEOs appear to hold equity voluntarily, including subjective or objective beliefs about undervalued share price, or comparatively low risk aversion. We estimate models that allow for heterogeneity in the determinants of equity holdings across CEOs. Our estimates indicate that there is considerable variation in the determinants of holdings across CEOs. In particular, we find that CEOs tend to hold more equity when they are more risk-tolerant and when they have more power. We find little evidence that over-confidence or inside trading explains holdings. Overall, our results suggest that traditional OLS models of the conditional mean level of equity holdings fail to capture the significant variation that exists across CEOs.

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1. Introduction

By all accounts, US CEOs hold large quantities of equity in their firms. For example, the median CEO in our sample holds about $18 million in equity. When compared to CEOs in other countries, these portfolio holdings are very large. Conyon, Core, and Guay (2011) document that US CEOs hold more than five times the amount of equity that is held by UK CEOs and more than eight times the amount of equity held by CEOs in other European countries (using 2003 data and controlling for firm characteristics). The reasons why US CEOs hold so much equity, however, are an issue of considerable debate, particularly given that the majority of this equity is vested and seemingly readily saleable (in our sample, more than two-thirds of equity holdings are in the form of vested stock and vested in-the-money options). Throughout the paper, we refer to vested (and seemingly readily saleable) equity as being "unconstrained," and equity that cannot be divested because of vesting requirements, ownership guidelines, or other mechanisms as being "constrained." Our objectives in this paper are to provide insight into why US CEOs hold unconstrained equity, as well as to better understand heterogeneity in the reasons CEOs maintain these holdings.

Authors such as Demsetz and Lehn (1985) and Core and Guay (1999), argue that CEOs hold firm-specific equity because they are required to do so by the board of directors as part of an optimal incentive structure. As part of the reasoning for those arguments, a maintained assumption is that the optimal level of incentives represents a tradeoff between the benefits and costs of incentives. Because CEOs are risk averse they require a compensation risk premium for holding equity and therefore will not "voluntarily" hold more equity than required. And, for the same reason, boards will not require CEOs to hold more equity than is necessary for optimal contracting purposes, since larger equity requirements entail larger compensation costs. As

further support for the risk aversion assumption underlying this contracting hypothesis, a large and growing literature shows that executives' holdings of stock and options can serve to either mitigate or exacerbate agency conflicts with respect to executives' risk-taking incentives. Overall, the contracting explanation for CEOs' equity holdings suggests that equity holdings that appear to be vested and readily saleable are, in fact, likely to be constrained by *implicit* contracting mechanisms, perhaps via informal agreements or understandings between the board, investors, and management.

Other authors, however, argue that CEOs hold firm-specific equity for reasons beyond incentive contracting. Some hypothesize that CEOs' control over the timing of option exercise and stock sales provides them with incentives to induce or exploit an information advantage over less informed investors. For example, equity holdings have been predicted to provide CEOs and CFOs with incentives to manipulate both the timing and content of disclosures and financial reports in an attempt to inflate the stock price, and to then sell equity prior to investors' discovery of the price manipulation.[1] Such arguments imply that CEOs regularly, or at least periodically, hold more equity than required by the board for incentive contracting purposes, thereby allowing these executives to take advantage of "timing" their stock sales.

Another line of argument that has more recently gained currency is that some CEOs are optimistic (or overconfident) about the future return on the firm's investments, and as a result, consistently believe that their firm is undervalued (e.g., Malmendier and Tate, 2005). These CEOs are expected to voluntarily hold (or even buy additional) vested and saleable equity in their own firms, and thus the observed portfolio equity holdings for these CEOs will be larger than that required by the board for incentive contracting purposes. This explanation for

[1] A large literature that examines whether CEO equity holdings provide incentives for CEOs to manipulate earnings upward. Implicit in this literature is the assumption that CEOs hold excess equity that they intend to sell once the stock price has been inflated.

unconstrained CEO equity holdings differs from the informed trading argument above in that informed CEOs are expected to, on average, be correct about mispricing whereas optimistic CEOs hold an upwardly-biased view about their firm's stock price.

Still another possibility to explain relatively large equity holdings is that some CEOs may have very low risk aversion, or perhaps even be risk neutral. Labor market competition to become CEO of a publicly-traded firm can be viewed as a tournament, and the winners may well be both highly skilled and willing to take risk (as well as perhaps "lucky", which may also feed the overconfidence explanation discussed above). Low risk aversion is expected to manifest in a low compensation risk premium for a given amount of equity incentives, and boards may optimally impose greater incentive risk on such CEOs.

In a broad sample of US CEOs between the years 1994-2010, we begin our analysis by documenting that CEOs do, in fact, hold large quantities of seemingly unconstrained equity. To estimate constrained equity holdings, we collect data on CEO ownership guidelines, and unvested stock and options. Roughly 31% of the CEOs in our sample have an explicit ownership guideline requirement. For those CEOs with an ownership requirement, the guideline requires them to hold an average of about $3.6 million of equity. We also consider unvested restricted stock, unvested options, and out-of-the-money vested options to be constrained. The remainder of a CEO's equity portfolio (i.e., vested in-the-money options and vested stockholdings not covered by an ownership guideline) is considered to be unconstrained. Across all CEOs in our sample (i.e., both those with and those without ownership guidelines), the mean (median) CEO holds about $45 million ($18 million) of total equity, the mean (median) amount of constrained equity is about $12 million ($5 million), and the mean (median) amount of unconstrained equity is about $33 million ($10 million).

Given the prevalence and relative magnitude of unconstrained equity, we consider and explore several reasons why CEOs might hold equity beyond what is explicitly required. As a first step, we examine standard contracting determinants of CEO equity incentives (e.g., firm size, proxies for monitoring difficulty, free cash flow), and whether the importance of such determinants differs between constrained and unconstrained equity. We find that the standard determinants of CEO equity incentives appear to explain both constrained and unconstrained equity equally well. Thus, based on this first test, one might infer that unconstrained equity serves a similar purpose as constrained equity holdings, and that both types of holdings are monitored by the board of directors, and combine to mitigate CEO-shareholder agency conflicts.

If unconstrained CEO equity holdings are implicitly required by the board, however, one expects to observe that CEOs are paid a risk premium to hold both constrained and unconstrained equity. Using the framework developed by Cai and Vijh (2005) and extended by Conyon, Core and Guay (2011), we estimate compensation risk premiums that CEOs require to hold their constrained and unconstrained equity. We find that total annual CEO pay varies consistently with the estimated risk premiums, but does not vary sufficiently to compensate some of the CEOs for the risk borne through their equity holdings. This finding, however, is dependent upon the specific assumption made regarding CEO risk aversion. Within the executive compensation and incentives literature, CEOs are typically assumed to have relative risk-aversion with parameter 2 to 3. For an assumed relative risk aversion parameter (RRA) of 2, our analysis indicates that CEOs are more than fully compensated for holding the constrained amount of equity holdings, but are not fully compensated for holding about the conditional median amount of equity holdings. If CEOs are assumed to be less risk averse, with RRA of 1, CEOs appear to be compensated for equity holdings at about the conditional median. Overall, we

interpret these results as indicating that seemingly unconstrained CEO equity holdings are unlikely to be entirely explained by a contracting explanation, unless some CEOs are considerably less risk averse than has been previously assumed in the literature.[2] We therefore extend our analysis to consider a more expansive set of explanations beyond incentive contracting for why CEOs may "voluntarily" hold equity.

To explore some of these other reasons why CEOs might voluntarily hold equity in their own firms, we construct tests that simultaneously examine additional determinants of cross-sectional and time-series variation in CEO equity holdings. We conjecture that some CEOs may choose to hold equity when they have (or believe that they have) private information about the future stock price. To test this hypothesis, we examine whether CEOs systematically increase (decrease) their equity holdings prior to high (low) future excess returns. We find that, on average, future excess returns are not associated with the magnitude of unconstrained equity. However, allowing for heterogeneity in this relation across CEOs, we find a positive relation between unconstrained stock holdings and future returns for about 30%-45% of the CEOs in our sample (depending on the specification). This result suggests that some CEOs may successfully manage their equity holdings as a function of their information about future returns.

We examine the Malmendier and Tate (2005) hypothesis that overconfident CEOs over-estimate the future returns on their stock, and are therefore reluctant to make investments when the projects must be financed with external capital (due to their perception that investors will not pay fair value for their capital offerings). We find that, on average, the investment cash flow sensitivity is not higher for CEOs with large unconstrained equity holdings. However, similar to

[2] Our finding that a small coefficient of relative risk aversion is required to explain both the relatively high level of CEO equity holdings and the relatively small annual risk premium is analogous to, but opposite of, the "equity premium puzzle" in the asset pricing literature (e.g., Mehra and Prescott, 1985). In that case, investors must have a very high level of relative risk aversion to explain the return difference between equity and government bonds.

the informed trading analysis above, we find that about 25%-40% of CEOs appear to exhibit unconstrained stock holding behavior consistent with this perceived underpricing explanation.

Overall, we conclude that there is considerable heterogeneity in the reasons why CEOs hold seemingly unconstrained equity. A substantial portion of this equity is likely to be implicitly constrained by the board given that CEOs appear to receive a compensation risk premium for holding much of it. We find little evidence that the average CEO holds unconstrained equity to take advantage of private information or due to the perceived undervaluation of their firm's stock, although we do provide evidence of heterogeneity across CEOs, and that a minority of CEOs may be holding additional equity for these reasons. Finally, we find that CEOs tend to hold more equity when they are more risk-tolerant and when they have more power.

Section 2 describes our sample and variable measurement. Our research design and results are presented in Sections 3 and 4. Section 5 provides concluding remarks.

2. Sample and Variable Measurement

Our initial sample is all CEOs on Execucomp from 1994 to 2010. We require each CEO to have at least one year of tenure, data on beginning-of-the-year equity holdings, and data on stock returns, and total direct compensation. In addition, we exclude CEOs who hold more than 10% of their firms' stock in any year during their tenure as CEO (the level of equity holdings for these CEOs is likely to be explained by control considerations that we cannot readily measure). These requirements yield a sample of 13,635 CEO-years from 1994 to 2010 for 3,321 CEOs. We hand-collect ownership guideline requirements for these CEOs. For firms with guidelines, most are formulated as a dollar or share multiple of salary. Some guidelines allow CEOs to include vested options (or a fraction of such options) when determining whether the requirement is met,

and others do not. Our measure of constrained ownership under these guidelines incorporates these plan features.

Table 1 provides descriptive statistics on CEO equity holdings, compensation and firm characteristics (all variables are winsorized by year at the 1st and 99th percentiles). To simplify the interpretation of CEO equity holdings, we convert stock and option holdings into incentive equivalent units measured as the change in equity portfolio value for a 1% change in stock price ("delta"). *Total Delta* is the delta of the CEO's total equity portfolio of stock and options for a 1% change in the price of the underlying stock. As noted above, we also identify the portion of CEO equity holdings that is constrained by ownership guidelines and other explicit restrictions, such as vesting requirements. *Constrained Delta* is the delta of the CEO's equity portfolio of unvested restricted stock, vested stock that is subject to an ownership guideline, unvested options, and vested out-of-the-money options. Vested out-of-the-money options are categorized as constrained because CEOs would not rationally exercise these options in most states of the world. The delta that is not considered constrained is termed *Unconstrained Delta* (i.e., *Total Delta* less *Constrained Delta*).[3] We also report descriptive statistics on ownership guidelines.

The mean (median) CEO's equity portfolio increases by $383,000 ($171,000) for a 1% change in stock price. To partition a CEO's equity portfolios into a constrained and unconstrained portion, we first consider whether the CEO has an ownership guideline requirement that constrains a portion of his vested stock and option holdings. Although the prevalence of ownership guidelines has grown substantially in recent years, across our full sample period, 31% of the CEO-years have ownership guidelines. The mean guideline-

[3] We recognize that this definition of unconstrained delta may include some vested options that are only slightly in-the-money that the CEOs is likely to perceive as constrained because a large portion of the time value would be foregone if the CEO were to exercise the option. Future versions of the paper will consider whether the results are sensitive to this classification.

constrained delta is $11,000 (for the 31% of the CEO-years in which there is a guideline, it constrains delta of about $31,000, which is equivalent to roughly $3.1 million worth of stock holdings). We then compute the delta from unvested stock and options, and add that amount to the guideline-constrained delta to obtain an estimate of the total constrained delta (*Constrained Delta*). The mean (median) *Constrained Delta* is $123,000 ($52,000). Thus, the vast majority of constrained delta comes from unvested equity holdings rather than constraints placed on vested equity via an ownership guideline.

The remainder of a CEO's delta is considered to be unconstrained (*Unconstrained Delta*). Mean (median) *Unconstrained Delta* is $316,000 ($100,000), which is much larger than *Constrained Delta* for most CEOs. Specifically, for the mean (median) CEO, *Constrained Delta* comprises 38% (34%) of *Total Delta*. Further, because much of the theoretical and empirical agency literature argues that executive incentives should be considered within the context of executive wealth, we obtain an estimate of CEOs' outside wealth based on Dittmann and Maug (2007). *Delta-to-Wealth* is *Total Delta×100* divided by *(Total Delta×100* + outside wealth*)*, where outside wealth is based on the estimate by Dittmann and Maug (2007).

In panel B of Table 1, we show a correlation matrix for the independent variables. We note that there is a large positive correlation between *Log(Tenure)* and *Cumulative Return*. This relation is partially mechanical – longer serving CEOs compound returns over a longer period. Second, there is a large positive correlation between *Log(Tenure)* and *%Outside directors appointed by CEO$_{t+1}$*. To be able to appoint many outside directors, the CEO must have long tenure. However, *%Outside directors appointed by CEOt+1* varies across CEOs with the same amount of tenure, and we, following prior research, use this variation after controlling for tenure as a proxy for CEO power.

3. Results

3.1. Do agency-based, economic determinants explain unconstrained CEO equity holdings?

Given the prevalence of unconstrained equity in the data, we explore several reasons why CEOs might hold equity that is not explicitly required. As a first step, we examine previously documented agency-based, economic determinants of total CEO equity incentives, and whether the importance of such determinants differs from the determinants of constrained equity. Specifically, our regressions include proxies for firm size, idiosyncratic volatility, book-to-market, tenure, free cash flow, and cumulative stock return performance over the CEO's tenure.

The results, reported in Table 2, indicate that the standard determinants of CEO equity incentives explain total equity holdings much better than constrained equity, suggesting that unconstrained equity is an important component of the incentives examined by prior literature testing economic hypotheses about executive equity incentives. Consistent with prior findings, total delta increases with firm size, idiosyncratic volatility, CEO tenure, free cash flow, and cumulative stock returns, and decreases with the book-to-market ratio (as a proxy for growth options). Constrained equity, however, increases only with firm size and idiosyncratic volatility, and not the other determinants. The R-squared in the total delta model is roughly three times larger than the R-squared in the constrained delta model (69.4% versus 23.7%). Thus, based on this first test, one might infer that unconstrained equity is at least as important, and perhaps more important, than constrained equity holdings in mitigating CEO-shareholder agency conflicts.

The third column explores the determinants of our estimate of CEO *Wealth.* Not surprisingly, since equity delta is a large component of wealth, all of the coefficients on wealth have the same sign as the coefficients on delta.

The determinants of log(*Delta-to-Wealth*), which are equal to the difference in the determinants of Delta and the determinants of wealth, are somewhat different than the determinants of *Total Delta*. Similar to *Total Delta*, *Delta-to-Wealth* increases with firm size, growth options and cumulative historical returns, has no relation with free cash flow, and a modest negative association with tenure. Further, in sharp contrast to its relation with *Total Delta*, idiosyncratic volatility exhibits a negative relation with *Delta-to-Wealth*, consistent with the agency-theoretic prediction that CEOs are expected to hold less equity when there is more "noise" in stock price as a performance measure. This change in sign occurs because there is a much stronger relation between idiosyncratic volatility and wealth than there is between idiosyncratic volatility and delta. One potential reason for the differential relation that we discuss below is that idiosyncratic risk is compensated, so a manager who bears more idiosyncratic risk becomes wealthier.

3.2. Do CEOs receive a compensation risk premium for holding unconstrained equity?

As argued above, if CEOs hold firm-specific equity because they are required to do so by the board of directors as part of an optimal incentive structure, compensation levels will include a risk premium. Thus, under this hypothesis, we predict that CEO pay includes a risk premium for both constrained and unconstrained equity holdings. If, however, only a portion of observed unconstrained holdings are required for contracting purposes, and the remaining portion is held voluntarily, we expect that CEOs will only be compensated for holding the required portion of equity. To estimate the proportion of equity holdings for which CEOs are paid a risk premium, we calculate the annual dollar risk premium that a risk averse and undiversified CEO would demand if he were being required to hold his observed equity portfolio. We discuss this

estimation method in the next subsection, and the regression results using these risk premiums in the following subsection.

3.2.1. Estimating the risk premium for holding incentives

We estimate the risk premiums that CEOs would demand if they are required to hold various levels of equity for incentive contracting purposes. To do this, we use the framework developed by Cai and Vijh (2005) and extended by Conyon, Core, and Guay (2011). In this framework, the risk premium is calculated as the dollar amount that makes the CEO indifferent between (1) receiving the risk premium and holding the constrained equity position *for one year*, and (2) not receiving the risk premium, and holding his preferred portfolio instead. In other words, the risk premium answers the following question: How much would the CEO be willing to pay (in the form of lower annual compensation) to relax the constraint that he hold a substantial fraction of his wealth in firm stock?

We calculate the risk premium numerically by solving the following equality:

$$E[U(\textit{wealth unconstrained})] = E[U(\textit{wealth constrained to firm equity}, \textit{outside wealth}, \textit{risk premium})] \quad (1)$$

To parameterize Eq. (1), we assume that the CEO has constant relative risk aversion (power utility). We use estimates of the CEO's (1) inside wealth, (2) outside wealth, (3) risk-aversion, and (4) an estimate of the firm's idiosyncratic, non-diversifiable, risk.[4] We estimate the CEO's inside wealth as the stock equivalent value of the delta of the CEO's actual holdings (which is obtained by multiplying delta by 100). For example, as shown in Table 1, the average CEO in our sample has delta of $383 thousand, and multiplying this by 100 yields a stock equivalent value of $38.3 million. Second, we assume that CEOs have outside wealth equal to an estimate

[4] See Conyon at al. (2011) for more details on this calculation.

based on data calculated in Dittmann and Maug (2007).[5] Based on these estimates, the average CEO has 62% of his total wealth in firm equity. Third, we present results assuming a coefficient of relative risk aversion of either two or one. Finally, firms' idiosyncratic risk is calculated as described above.

We calculate risk premiums under three assumptions about how much equity the CEO is required to hold: (1) the CEO is only paid a risk premium for holding explicitly constrained delta (*Min(Constrained, Actual Equity*), (2) the CEO is paid a risk premium for holding the conditional median amount of delta (*Min(Median, Actual Equity*), (3) the CEO is paid a premium for holding the full amount of his actual holdings; that is, none of his holdings are considered voluntary (*Actual Equity*). The variable *Min(Constrained, Actual Equity* will equal constrained equity unless the CEO is not currently in compliance with the constraint implied by his ownership guideline. For *Min(Median, Actual Equity*), we compute conditional median holdings using a median regression of the specification shown in table 2, column 1. We assume that the CEO is only paid a risk premium for the amount of equity he actually holds. For example, if the CEO holds less equity than explicitly constrained delta (because he does not currently meet the ownership guideline), we assume that the risk premium is only paid on his actual holdings. Similarly, with respect to the conditional median delta, if the CEO holds less than the conditional median delta, we assume that the risk premium is only paid on actual holdings.

Descriptive statistics for these equity holding variables are presented in Panel A of Table 3, and are consistent with those reported in Table 1. In Panel B of Table 3, we show annual

[5] The Dittmann and Maug wealth estimate is an aggregate of past compensation and equity sales for each Execucomp executive. Because more data on past compensation is available based on length of time individual is executive at firm or other firm on Execucomp and length of time firm is in Execucomp, the wealth data is likely more accurate for more recent data (Execucomp begins in 1993) and for firms that appear in Execucomp more frequently. We attempt to obtain more accurate estimates by estimating the relation between wealth and CEO and firm characteristics for data after 2004 on a sample of firms that appeared in Execucomp at least 14 times, and using these estimates to impute wealth for our sample CEOs.

dollar risk premiums for the three holding levels assuming that CEOs have relative risk aversion of two. The mean (median) estimated annual risk premium required for holding explicitly constrained equity is $541 thousand ($109 thousand). Recall from Table 1 that mean constrained equity has a delta of $123 thousand per 1% change in stock price, which is the equivalent of $12.3 million in stock holdings (assuming the mean CEO held all of his constrained equity in stock).

The remaining rows of Table 3, Panel B present risk premium estimates assuming that CEOs are paid for holding more equity than just the explicitly constrained portion of their portfolio. Specifically, the next row considers the premium required by CEOs for a holding requirement set at the conditional median equity holdings for CEOs in our sample. In other words, assuming each CEO is paid a risk premium on the amount of delta held by the median CEO at a firm with similar characteristics. If a given CEO holds more than the conditional median delta, we assume that no risk premium is paid. If a given CEO holds less than this conditional median delta, we assume a risk premium is paid on only the actual amount of delta held by the CEO. The mean (median) estimated annual risk premium required for holding equity at the conditional median is $1.666 million ($660 thousand). As a reference point, the average delta for the minimum of the CEO's actual holdings and the conditional median equity holding is $325 thousand per 1% change in stock price, which is the equivalent of about $32.5 million in stock holdings. These risk premiums amount to roughly 35% of total annual compensation at the mean.

Our third set of risk premium estimates are computed under the assumption that all of the CEO's actual holdings are required by the board. That is, the CEO holds no equity voluntarily and therefore demands a risk premium for his full equity holdings. The mean (median) estimated

annual risk premium required for total equity holdings is $4.035 million ($1,162 thousand). Again, as a reference point, the delta for the mean CEO's equity holding is $383 thousand per 1% change in stock price, which is the equivalent of about $38.3 million in stock holdings. These risk premiums amount to roughly 86% of total annual compensation at the mean. When considering these total equity risk premiums, recall that our sample excludes CEOs who hold more than 10% of their firm's stock, and that we have winsorized delta holdings for the remaining CEOs. In Panel C of Table 3, we show risk premiums for the three required holding levels assuming relative risk aversion of one rather than two. This lower risk aversion assumption results in risk premiums that are approximately 50% lower than those in Panel B.

3.2.2. The relation between observed CEO compensation and risk premium estimates

Following Conyon at al. (2011), we expect that CEO annual pay is the sum of the risk premium required by the CEO for holding firm equity, compensation related to the CEO's skill and cost of effort, and any other pecuniary benefits such as rents that he may extract. Given this assumption, if we correctly identify the amount of equity the CEO is constrained to hold, and the associated risk premium, we expect that our estimates of CEOs' annual risk premium will have a coefficient of one in a regression of CEO annual pay. We conduct an exploratory analysis in which we estimate a model of the level of annual CEO pay on each of the three risk premium estimates, and include controls for economic determinants identified by prior research (e.g., Core, Guay, and Larcker, 2008; Core, Holthausen, and Larcker, 1999; Murphy, 1999; Smith and Watts, 1992). The purpose of this analysis is to identify the risk premium that is most closely associated with observed CEO compensation, as evidenced by a coefficient of one in the following regression:

$$Compensation_{i,t+1} = \gamma_0 + \gamma_1 Risk\ premium_{i,t} + \beta_1 Log(Tenure_{i,t}) + \beta_2 Log(Sales_{i,t}) + \beta_3 Book\text{-}to\text{-}market_{i,t} + \beta_4 RET_{i,t+1} + \beta_5 RET_{i,t} + \beta_6 ROA_{i,t+1} +$$

$$\beta_7 ROA_{i,t} + IndustryControls_{i,t} + \varepsilon_{i,t} \quad (2)$$

The economic controls are, respectively, the natural logarithm of the CEO's tenure (in years), firm size measured as the natural logarithm of the firm's annual sales revenue, the book-to-market ratio to capture growth opportunities and the previous two years' accounting and stock returns.

Because estimated annual risk premiums are likely to be noisy, we concentrate on CEOs with four or more years of data and use average observations for each CEO. The regression results are reported in Table 4, Panel A. Column 1 shows benchmark results with no risk premium, columns 2 to 4 show results including risk premiums based on relative risk aversion = 2, and columns 5 to 7 show results including risk premiums based on relative risk aversion = 1. The coefficient on *Min(Constrained, Actual Equity)* in Column 2 is 1.39, which is substantially larger than one and suggests that CEOs are more than fully compensated for being exposed to the risk associated with their explicitly constrained equity (assuming that RRA = 2 is the correct coefficient of relative risk aversion factor for CEOs, and that CEOs have outside wealth equal to the amount we described above). In Column 3, the coefficient of 0.55 on *Min(Median, Actual Equity)* implies that if the conditional median represents the required level of equity holdings, CEOs are compensated with about $0.55 of extra pay for holding incentives that are estimated to require one dollar of risk premium. This coefficient indicates that, on average, CEOs are less than fully compensated for holding the median amount of equity incentives, suggesting that a portion of CEO equity holdings may be voluntary (again, assuming RRA = 2 is an appropriate risk aversion factor). The coefficient on *Actual Equity* in Column 4 is 0.16, which indicates that, on average, CEOs are considerably less than fully compensated for holding their actual total equity, again suggesting that a portion of CEO equity holdings may be voluntary.

Columns 5 to 7 of Table 4 presents estimates of Eq. (2) using the RRA = 1 risk premiums. The coefficients on the risk premium estimates are roughly 75% greater than those in columns 2 to 4. In Column 6, the coefficient on *Min(Median, Actual Equity)* is 0.86, suggesting that if CEOs in fact have a RRA equal to 1, they are roughly fully compensated for the risk associated with holding equity up to the conditional median level. Even using this lower risk aversion parameter, however, the coefficient on *Actual Equity* in Column 4 is only 0.26, which is considerably less than one and indicates that CEOs are still less than fully compensated for holding their actual total equity. Based on this analysis, we infer either that CEOs are, on average, less risk averse than RRA = 1 (which would imply CEOs are much closer to risk neutral than previously assumed in the literature), or that many CEOs choose to hold considerably more equity than is required for contracting purposes.

4. Explanations beyond incentive contracting for CEO equity holdings

In this section, we consider reasons why some CEOs may "voluntarily" hold equity. Specifically, we include additional variables in the incentive regression specification in Table 2 to attempt to discriminate between the following four explanations for CEOs' unconstrained equity holdings: 1) informed trading motivations, 2) overconfidence that the firm's shares are undervalued, 3) differential tolerance of risk, and 4) CEO power. Further, we make our specifications more flexible than standard OLS estimates of equity holdings by allowing CEOs to exhibit different degrees of informed trading, overconfidence, risk aversion, and power. Specifically, as described more fully below, we model CEO equity holdings using both a random coefficients model and a specification that we refer to as a "between-within" model that simultaneously models cross-sectional variation *between* CEOs and time-series variation *within*

CEOs. These models allow us to test explanations related to cross-sectional differences between CEOs' equity holdings, as well as whether some CEOs exhibit behavior consistent with certain explanations but not others.

In the next subsection, we describe the variables and hypotheses we construct to discriminate between the various explanations for CEOs' unconstrained equity, and in the following two subsections, we describe our two econometric specifications and the related results.

4.1. Potential explanations for unconstrained equity holdings

Informed trading motivations. To assess whether some CEOs hold unconstrained equity when they have private information about stock under- or over-valuation, or perhaps when they expect to be able to manipulate the stock price, we include future size and book-to-market adjusted returns. To compute these returns, we match each firm by size and book-to-market to the 25 size and book-to-market portfolios created by Fama and French (1993). We use the return on the matched portfolio as the expected return, and compute buy-and-hold excess returns starting three months after the firm's fiscal year end in year t+1 (*Excess Return*). We begin return calculations three months after the fiscal year-end because proxy information on CEO holdings is generally disclosed a few months after the fiscal year-end. We predict that CEOs who hold unconstrained equity for informed trading reasons will hold more equity when they expect future excess returns to be higher.

CEO overconfidence. The private-information-about-future-returns explanation for equity holdings assumes that CEOs hold more stock when they believe it to be undervalued and less stock when they believe it to be overvalued. Somewhat similar to this explanation, Malmendier and Tate (MT, 2005) predict that some overconfident CEOs over-estimate the future returns on

their stock. These overconfident CEOs believe that investors undervalue their firm's stock, and are therefore reluctant to make investments when the projects must be financed with external capital (due to their perception that investors will not pay fair value for their capital offerings). MT test this prediction by examining the sensitivity of investment to internal operating cash flow, with the prediction that overconfident CEOs exhibit greater investment-to-cash-flow sensitivity (because they are less willing to invest in the absence of internal cash flow). To create a measure of the sensitivity of investment to cash flow that varies—and therefore captures differences—across CEOs, we estimate the following model following MT:

$$Investment_{i,t+1} = \gamma_0 + \gamma_{CEO}\, Cash\ Flow_{i,t+1} + \gamma_1\, Book\text{-}to\text{-}market_{i,t} + Controls_{i,t} + \varepsilon_{i,t} \quad (3)$$

We estimate Eq. (3) using a finite mixture model that allows γ_{CEO} to take on five different values. Each of the five estimated values corresponds to a different CEO-specific cash flow sensitivity (*Investment-to-Cash-Flow Sensitivity*). In other words, each CEO is assigned an estimate of the sensitivity of investment to cash flow that takes on one of five values.[6] To confirm that these estimates are associated with other proxies for CEO overconfidence found in the literature, we estimate the following regression:

$$Investment\text{-}to\text{-}Cash\text{-}Flow\ Sensitivity_i = \beta + \beta_1\, Holder67_{i,t} + u_{i,t}, \quad (4)$$

where *Holder67*, similar to MT's proxy for overconfidence, is equal to one if the CEO's option portfolio is more than 67% in-the-money. We find that the coefficient on *Holder67* is positively and significantly related to *Investment-to-Cash-Flow* sensitivity, indicating that our CEO-specific proxy for the sensitivity of investment to cash flow captures the same underlying variable as does MT's proxy for overconfidence.

[6] The finite mixture model assumes that the data is explained by a mixture of five models described by Eq. (3), where the only difference is the coefficient on *Cash Flow*. We estimate the model via maximum likelihood using the SAS procedure "FMM." See Larcker (2003) and Allen, Larson, and Sloan (2013) for other applications of this technique.

Variation in CEO risk aversion. Next, we consider the possibility that CEOs differ in their risk aversion and/or that some boards require their CEOs to hold more equity due to firm-specific monitoring difficulty (e.g., Himmelberg et al., 1999). Some CEOs may be quite risk averse, while others may be more tolerant of risk, and possibly even close to risk neutral. CEOs with lower risk aversion should demand less compensation for holding large equity positions and may appear to more hold unconstrained equity compared to other, more risk-averse CEOs who require much greater compensation for holding the same amount of equity. To capture this risk-aversion effect, we estimate a variant of Eq. (3) above using a finite mixture model:

$$Compensation_{i,t+1} = \gamma_0 + \rho_{CEO}\, risk\ premium(RRA=1, Min(Median, Actual\ Equity))_{i,t} + \beta_1 Controls_{i,t} + \varepsilon_{i,t} \quad (5)$$

In the finite mixture model, we allow the coefficient on the risk premium (ρ_{CEO}) to take on five different values, again allowing us to generate an estimate of risk aversion for each CEO. Recall that Table 4, column 6 showed that if CEOs are assumed to have RRA of one, then they appear to be compensated for holding the conditional median equity. Estimated values of ρ_{CEO} from Eq. (5) (*Risk-aversion*) less than one indicate lower levels of risk aversion, and estimated values greater than one indicate either greater risk aversion or greater required holdings. We multiply the estimate by negative one, so that higher values indicate greater levels of risk-tolerance (*Risk-tolerance*).

With respect to the effect of firm-specific monitoring difficulty on CEO equity holdings, we expect that CEOs at firms where monitoring by the board or shareholders is particularly difficult and/or costly (easy) will hold more (less) equity and receive more (less) of a risk premium. These firm-specific monitoring needs should result in a positive relation between excess holdings and excess compensation (as compared to a situation in which a CEO "voluntarily" holds excess holdings, for which no excess compensation should be paid).

CEO power. As a measure of CEO power, we compute the proportion of each firm's outside directors who were appointed after the CEO assumed the office (*%Outside directors appointed by* CEO_{t+1}). Prior studies (e.g., Core, Holthausen, and Larcker, 1999) suggest that directors who are appointed during the CEO's tenure are more likely to be beholden to the CEO, and therefore less independent. Consistent with Core et al., we find that *%Outside directors appointed by* CEO_{t+1} is positively and significantly associated with total compensation when included in the Eq. (2) model for total compensation. On one hand, because boards are not independent of CEOs, they impose less incentives, and powerful CEOs may own less equity. On the other hand, if stockholders anticipate less effective monitoring by boards, they may require the CEO to hold greater equity incentives as a substitute for direct monitoring. Alternatively, Bebchuk and Fried (2003) argue that powerful CEOs may extract rents in the form of higher equity compensation, but may not wish to draw attention to these rents by immediately divesting this excess equity.

4.2. Random coefficients model

In this section, we describe how we test the various explanations described above for why CEOs hold unconstrained equity. Our tests extend the analysis described in Section 3.1 and Table 2 by relaxing the implicit assumption in pooled OLS estimation that constrains the relation between CEO equity incentives and its determinants to be identical across CEOs. To better capture the predictions of theoretical and empirical work that emphasizes heterogeneity in both CEO characteristics and contracting environments, our remaining tests are based on a random coefficients model that relaxes the implicit constraint that the estimated coefficients are identical across CEOs.[7]

[7] Note that we could also relax the constraint that the coefficients are constant over time. However, in our particular research setting, most of the variation in a panel of CEO equity incentives is cross-sectional rather than time-series.

The simplest version of a random coefficient model is a random effects model, which, similar to a fixed effects model, allows for CEO-specific intercepts. In other words, rather than assuming that there is a single intercept that describes the population average, a random effects specification assumes that there is a distribution of intercepts in the population. In the context of our research setting, a CEO-specific random intercept for *Delta* means that there is some average *Delta* in the population, but that there is variability in the average between CEOs.

A random coefficients model generalizes the random effects model to allow for heterogeneity in not only the intercepts, but also the slope coefficients. Thus, the random coefficient specification allows for a CEO-specific slope coefficient on each independent variable. This, in turn, allows us to assess what fraction of our sample CEOs have a negative coefficient.[8] For example, what fraction of our sample CEOs exhibits a positive relation between delta and future excess returns, consistent with those CEOs taking a larger equity position when in possession of positive information about future returns?

Our random coefficient specification is given by the following equation:

$$\begin{aligned} \textit{Equity Holdings}_{i,t+1} = {} & \beta_{0,i} + \beta_1 \textit{Log(MVE}_{i,t}\textit{)} + \beta_2 \textit{IdioVol}_{i,t} + \beta_3 \textit{Book-to-market}_{i,t} \\ & + \beta_{4,i} \textit{Log(Tenure}_{i,t}\textit{)} + \beta_5 \textit{FreeCashFlow}_{i,t} + \beta_{6,i} \textit{Cumulative Return}_{i,t} \\ & + \beta_{7,i}\, \textit{Investment-to-Cash-Flow sensitivity}_i + \beta_{8,i} \textit{ExcessReturn}_{i,t+1} \\ & + \beta_{9,i} \textit{Risk tolerance}_{i,} + \beta_{10,i} \textit{\%Outside directors appointed by CEO}_{i,t+1} \\ & + \textit{YearControls}_{i,t} + \textit{IndustryControls}_{i,t} + \varepsilon_{i,t} \end{aligned} \qquad (6)$$

Accordingly, allowing the coefficients to vary across CEOs is more likely to be a first-order concern. In addition, our final empirical specification (i.e., the "between-within" model) allows for CEO-specific coefficients for certain time-series deviations.

[8] A random coefficients model allows for a distribution of coefficients in the population and estimates the parameters of the distribution (e.g., the mean and standard deviation in the case of a normal distribution). A standard OLS model can be viewed as a special case of a random coefficients model that estimates the mean of the population distribution but constrains the standard deviation to be zero. In this sense, by allowing a coefficient to vary across CEOs, the statistical significance of the population standard deviation can be viewed as a statistical test for heterogeneity in the population. If the standard deviation of the coefficients is not different from zero, the implication is that a single, fixed coefficient that describes the relation for each CEO is appropriate.

In addition to testing for heterogeneity in the relation for the population of CEOs as a whole, we can also test for differences in particular subgroups of CEOs (e.g., by industry). In the limit, we can test for the statistical significance of any particular CEO's estimated coefficients. We adopt this approach in our tests and report the fraction of CEO-specific coefficients that are statistically different from zero.

where *coefficients* that are subscripted with an *i* are assumed to follow a normal distribution in the population of CEOs and the i^{th} CEO has his own CEO-specific coefficient that belongs to the population distribution. Thus, rather than simply estimate a single coefficient that is assumed to be constant across all CEOs, we estimate the parameters of the normal distribution (i.e., the mean and standard deviation) that describe the population distribution of CEO-specific coefficients.

Table 5 reports estimates of Eq. (6) using three variations of CEO equity holdings as the dependent variable: 1) total delta from all equity holdings; 2) constrained delta as defined earlier (i.e., unvested stock, unvested options, out-of-the-money options, and vested equity constrained via an ownership guideline), and 3) total delta scaled by total wealth.

Our independent variables in these specifications are the same as in Table 2 (i.e., the economic determinants of equity incentives examined in prior literature), plus the additional explanatory variables described in Section 4.1 that are intended to proxy for reasons why some CEOs may hold additional equity beyond that required for incentive-contracting purposes.

Within the random coefficients framework, the researcher is given the choice to estimate CEO-specific coefficients for all or some subset of the independent variables. We choose to estimate CEO-specific coefficients for those independent variables that we believe provide insight into why a CEO might hold more or less unconstrained equity. Specifically, we estimate CEO-specific coefficients for tenure, cumulative stock returns, and the four additional variables that proxy for reasons that CEOs may hold additional equity (i.e., *Investment-to-Cash Flow Sensitivity, Excess Return, Risk Tolerance,* and *%Outside directors appointed by CEO*). We allow CEOs' coefficients for tenure and cumulative stock returns to vary because these variables are expected to capture dimensions related to CEOs' portfolio rebalancing behavior, wealth, risk aversion, overconfidence, etc. Specifically, CEOs that do not allow their equity holdings to grow

substantially during their tenure, or rebalance their firm-specific equity following stock price run-ups, are likely be characterized quite differently from CEOs that rarely sell stock regardless of the number of shares they accumulate during their tenure, and/or the stock price performance underlying those shares.

Table 5 presents the results for the random coefficients specifications. For each of our three dependent variables, we report three columns of estimates: the first column reports the mean of the population distribution of CEO-specific coefficients for each of the independent variables, and below this is a *t*-test for the significance of the mean coefficient. The second column reports the standard deviation of the population distribution of CEO-specific coefficients for those coefficients that are allowed to vary across CEOs and is blank if the coefficient is constrained to be identical for all CEOs in the population. The third column reports an estimate of the fractions of CEOs with positive coefficients based on the population mean and standard deviation reported in the first and second column, respectively.

The first three columns report results when the natural logarithm of total delta is the dependent variable. The signs of the coefficients on the six economic determinants of incentives are similar to those reported in Table 2. We also find that the two economic determinants that are allowed to vary across CEOs—*Log(Tenure)* and *Cumulative Return*—exhibit considerable heterogeneity in the population of CEOs as indicated by the statistical significance and economic magnitude of the population standard deviations. In particular, the respective means and standard deviations of these two distributions of coefficients indicate that 17% (13%) of CEOs have negative coefficients on the CEO's tenure (cumulative stock returns). CEOs with a negative coefficient on cumulative returns can be characterized as rebalancing their equity portfolios. In contrast, CEOs with coefficients that are one standard deviation above the population mean (i.e.,

CEO-specific coefficients of 0.47 on *Log(Tenure)* and 0.61 on *Cumulative Return*) have equity holdings that exhibit a strong relation with tenure and stock returns, respectively.

In terms of the four proxies for reasons why CEOs might hold additional equity, we find that the population average coefficients on *Excess Return* and *Investment-to-Cash-Flow Sensitivity* are not significantly different from zero. Both results suggest that the average CEO does not hold additional equity because they are attempting to earn positive excess returns on their equity holdings or because they are overconfident about the valuation of their own company's stock. Column (3) of Table 5 indicates, however, that beyond the inferences with respect to the average coefficients, there is statistically significant cross-sectional variation in the CEO-specific coefficients. For example, with respect to CEOs altering their equity holdings based on their views about stock price undervaluation or future returns, we find that about 49% of CEOs' equity holdings do appear to increase prior to positive excess returns, and that about 55% of CEOs have positive coefficients on *Investment-to-Cash-Flow Sensitivity* consistent with over-confidence. Few of the CEOs have positive and significant coefficients (untabulated).

The population average coefficient on *%Outside directors appointed by CEO* is significantly positive, which is at odds with the prediction that more powerful CEOs are able to use their influence to hold fewer incentives than other similarly-situated CEOs that have less power. Instead, the positive relation is consistent with CEOs who have gained control of board being more difficult to monitor and therefore required to hold more equity as a substitute for direct monitoring. The positive average relation is also consistent with Bebchuk and Fried's (2003) hypothesis that powerful CEOs use their power to extract excess equity compensation which they are not able to sell. Finally, the coefficient on *Risk Tolerance* is significantly positive, suggesting that more risk tolerant CEOs hold more delta, other things equal.

Columns 4 to 6 report results for the natural logarithm of constrained delta. The results are largely consistent with those in the corresponding specification in Table 2 above and those for total delta in columns 1 to 3 of this table with some important exceptions. Specifically, we find virtually no relation between cumulative stock returns and constrained delta on average. However, similar to the results for total delta, we find that there is considerable heterogeneity in the relation between cumulative stock returns and constrained delta across CEOs. Also notable is the *insignificance* of the means and standard deviations of the coefficients on *Excess Return* and *%Outside directors appointed by CEO*. The lack of statistical significance of these parameters indicates that these two variables are not related to constrained delta either for the average CEO or for any particular CEOs, respectively.

Finally, Columns 7 to 9 report results for *Delta-to-Wealth*. These results are largely consistent with those from the corresponding specification in Table 2 above and those for total delta in columns 1 to 3 of this table. The mean coefficients on several variables are smaller, reflecting the fact, as illustrated in Table 2, these variables affect both delta and wealth. For example, the mean coefficient on *%Outside directors appointed by CEO* is only .088, reflecting the fact that powerful CEOs are significantly wealthier (untabulated).

4.3. Within-between model

Our final research design attempts to more fully account for the different sources of variation that are typically found in time-series, cross-sectional panel data. In particular, certain variables can either explain cross-sectional variation in the dependent variable (e.g., delta) across CEOs (i.e., between effects), time-series variation within CEOs (i.e., within effects), or some combination of the two. To more accurately model these two distinct sources of variation, our final specification includes both CEO-specific time-series averages of the independent variables

to capture cross-sectional effects *between* CEOs and time-series deviations from each CEO's specific average value to capture time-series effects *within* CEOs. We therefore estimate the following specification (the equation uses MVE to illustrate the specification, omitting the remaining independent variables for brevity):

$$Log(Delta_{i,t}) = \beta_{0,i} + \beta_1 Avg.\ Log(MVE_i) + \ldots + \beta_2 Dev.\ Log(MVE_{i,t}) + \ldots \quad (7)$$

where *Avg.* denotes the time-series average of the respective independent variable for the i^{th} CEO and *Dev.* denotes the i^{th} CEO's deviation from his time-series average value in period *t*. Thus, the *Avg* variables take one time-invariant value for each CEO and the *Dev* variables are time-varying deviations from each CEO's *Avg*. We also allow the estimated coefficients on certain CEO deviations to vary across CEOs (i.e., as random coefficients).

Table 6 presents the results for the within-between model using *Total Delta* as the dependent variable. This specification provides some interesting additional insight into the determinants of equity holdings. For example, the positive relation between idiosyncratic volatility and total delta that we find in earlier tables is primarily a cross-sectional phenomenon that explains differences in equity incentive across CEOs, but does not explain variation in particular CEOs' equity incentives over time. The same is true for the well-known positive relation between free cash flow and total delta (i.e., its relation with delta is mainly cross-sectional as opposed to a time series). Conversely, although a positive relation between cumulative stock returns and equity holdings is present in both the cross-section and in time-series, the latter is, on average, nearly three times larger in magnitude. In addition, the large standard deviation of the distribution of time-series "within effects" indicates substantial variation across CEOs in how their equity holdings respond to stock returns over time. For example, CEOs with coefficients one standard deviation below the population average exhibit

only a modest positive relation between stock returns and their equity holdings over time. In the other direction, CEOs with coefficient one standard deviation above the population average have coefficients that are close to one, which corresponds to equity holdings that change proportional to changes in stock price.

With respect to our proxies for reasons why CEOs hold additional equity, many of the findings are similar to those in Table 5, so we focus on the results that produce different inferences for parsimony. With respect to the previously documented (Table 5) positive relation between tenure and *Total Delta*, Table 6 shows that a significant positive relation exists both in the cross-section (i.e., across CEOs), as well as in time-series (i.e., the "Within Effects") for the average CEO. Similarly, Table 6 also shows that the positive relation between cumulative historical stock returns and *Total Delta* is significant both in the cross-section across CEOs, as well as in time-series for the average CEO (with similar percentages of CEOs exhibiting this positive relation).

The results for *Excess Return*$_{t+1}$ and *Investment-to-Cash-Flow Sensitivity* again provide no support for the explanations that the average CEO holds additional equity because he is attempting to earn positive excess returns or because he is overconfident about the valuation of his firm's stock. As in Table 5, the coefficient on *%Outside directors appointed by CEO* is significantly positive, consistent with the prediction that more powerful CEOs are difficult to monitor and so hold more equity. Further, this result holds both in the cross-section and in time-series for a given CEO. Finally, the coefficient on *Risk Aversion* is again significantly negative in the cross-section, suggesting that more risk tolerant CEOs hold more delta, other things equal (we cannot test for an effect of risk aversion in time-series because we have only one estimate of risk aversion for each CEO).

5. Conclusion

We document that US CEOs hold a large amount of equity that is not explicitly constrained by ownership guidelines or vesting requirements. We show that the average CEO receives a pay premium for holding a substantial portion of this equity, suggesting that much of this seemingly unconstrained equity appears to be implicitly required by the board for incentive contacting purposes. Some CEOs, however, hold more equity than one would expect given the magnitude of the risk premium in their pay. We explore reasons why these CEOs might accept a relatively small risk premium for holding equity, such as subjective or objective beliefs about share price undervaluation, or comparatively low risk aversion. Using empirical specifications that allow us to examine both cross-sectional and CEO-specific relations, we find little evidence supporting any one explanation, but rather that there is considerable heterogeneity in the explanations across CEOs.

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Table 1

Descriptive Statistics

	Mean	Standard Deviation	10th Percentile	50th Percentile	90th Percentile
CEO Incentives & Compensation					
Total Delta ($000))	383	547	26	171	1,042
Ownership guideline	0.31	0.46	0	0	1
Constrained delta through ownership guideline ($000s)	11	22	0	0	44
Unvested equity and out-of-money options delta ($000s)	111	205	3	42	278
Constrained Delta ($000s)	123	212	4	52	306
Unconstrained Delta ($000s)	316	670	4	100	744
Proportion Constrained	0.38	0.34	0.03	0.34	0.88
Total Wealth ($000s)	49,161	57,519	8,494	28,348	116,923
Delta-to-Wealth	0.62	0.27	0.26	0.63	0.97
Total Compensation$_{t+1}$	4,711	5,638	749	2,754	10,835
Firm and CEO Characteristics					
Market Value of Equity	6,372	16,147	247	1,437	14,277
Idiosyncratic Volatility	0.35	0.18	0.17	0.31	0.59
Book-to-Market	0.66	0.26	0.31	0.66	0.98
Tenure	6.16	5.70	0.92	4.50	13.92
Free Cash Flow	0.10	0.10	0.01	0.09	0.21
Cumulative Return$_{t}$	2.69	7.57	-0.31	0.58	6.02
Investment-to-Cash-Flow sensitivity	0.00	0.06	-0.06	0.01	0.05
Excess Return$_{t+1}$	0.04	0.52	-0.43	-0.02	0.50
Risk tolerance	-2.43	1.83	-4.91	-1.51	-1.00
%Outside directors appointed by CEO$_{t+1}$	0.57	0.25	0.20	0.60	0.88

Table 1 (continued)

Pearson correlations of independent variables

		1	2	3	4	5	6	7	8	9	10
1	*Log(Market Value of Equity)*	1.00									
2	*Idiosyncratic Volatility*	-0.38	1.00								
3	*Book-to-Market*	-0.35	-0.03	1.00							
4	*Log(Tenure)*	-0.02	0.01	-0.06	1.00						
5	*Free Cash Flow*	0.12	-0.01	-0.45	0.06	1.00					
6	*Cumulative Return$_t$*	0.19	-0.02	-0.40	0.54	0.26	1.00				
7	*Investment-to-Cash-Flow sensitivity*	0.00	0.02	-0.04	0.11	0.15	0.10	1.00			
8	*Excess Return$_{t+1}$*	0.05	-0.04	0.00	0.00	0.02	-0.03	0.02	1.00		
9	*Risk tolerance*	-0.06	0.08	-0.04	0.04	0.01	0.05	-0.03	0.01	1.00	
10	*%Outside directors appointed by CEO$_{t+1}$*	0.06	-0.06	0.01	0.51	0.02	0.25	0.04	0.00	0.02	1.00

This table presents descriptive statistics where the primary variables are grouped according to *CEO Incentives & Compensation* and *Firm and CEO Characteristics*. The sample is 13,635 firm years from 1994 to 2010 for all variables except *%Outside directors appointed by CEO$_{t+1}$* for which the sample is 9,206 firm years from 1998 to 2010. *Ownership guideline* is one if CEO has ownership guideline. *Total Delta* is the change in the risk-neutral value of the CEO's equity portfolio of stock and options for a 1% change in the price of the underlying stock. *Constrained delta through ownership guideline* is the delta from vested equity that is subject to an ownership guideline. If the ownership guideline exceeds actual equity, we set constrained equity to actual equity holdings. *Unvested equity and out-of-money options delta* is the delta from unvested restricted stock, unvested options, and vested out-of-the-money options. *Constrained Delta* is the sum of *Constrained delta through ownership guideline* and *Unvested equity and out-of-money options delta*. *Unconstrained Delta* is *Total Delta* minus *Constrained Delta*. *Proportion Constrained* is the ratio of *Constrained Delta* to *Total Delta*. *Delta-to-Wealth* is *Total Delta×100* divided by *(Total Delta×100 +* outside wealth*)*, where outside wealth is based on the estimate by Dittmann and Maug (2007). *Total Compensation$_{t+1}$* is the CEO's total annual compensation during the subsequent fiscal year. *Market Value of Equity* is the market capitalization of the firm at the end of the fiscal year. *Idiosyncratic Volatility* is the standard deviation of the residual return from a market model regression using monthly returns during the 36 months prior to the fiscal year end. *Book-to-Market* is the ratio of book value to market value of total assets at the end of the fiscal year. *Tenure* is the number of years in which the current CEO has been CEO. *Free Cash Flow* is operating cash flow minus common and preferred dividends divided by average total assets. *Cumulative return$_t$* is the cumulative stock return during the CEO's tenure. *Investment-to-Cash-Flow sensitivity* is the firm's cash flow sensitivity over the CEO's career with the firm, estimated as described in Section 4.1. *Excess Return* is the stock return for the year starting three months after the fiscal year end minus the return on the matched Fama-French (1993) size and book-to-market portfolio. *Risk tolerance* is a proxy for the CEO's risk aversion, estimated as described in Section 4.1. *%Outside directors appointed by CEO$_{t+1}$* is the percentage of outside directors appointed during the CEO's tenure. All variables are winsorized by year at the 1st and 99th percentiles.

Table 2

Determinants of Equity Portfolio Incentive Components

	Log(Total Delta$_t$)	*Log(Constrained Delta$_t$)*	*Log(Wealth$_t$)*	*Log(Delta-to-Wealth$_t$)*
	(1)	(2)	(3)	(4)
Log(MVE$_t$)	0.583***	0.792***	0.475***	0.110***
	(52.88)	(24.48)	(85.89)	(16.36)
Idiosyncratic Vol$_t$	0.617***	0.621**	0.894***	-0.273***
	(7.37)	(2.45)	(20.16)	(-5.52)
Book-to-Market$_t$	-0.552***	-0.015	-0.178***	-0.378***
	(-7.92)	(-0.07)	(-4.95)	(-9.36)
Log(Tenure$_t$)	0.281***	-0.039	0.324***	-0.041***
	(20.65)	(-1.02)	(48.56)	(-4.92)
Free Cash Flow$_t$	0.318**	-0.684	0.406***	-0.088
	(2.54)	(-1.63)	(6.05)	(-1.23)
Cumulative Return$_t$	0.200***	-0.057	0.096***	0.104***
	(11.35)	(-0.86)	(10.33)	(10.28)
Industry Indicators	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes
R^2	69.4%	23.7%	83.9%	33.9%
Observations	13,635	13,635	13,635	13,635

This table presents OLS regression estimates of the natural logarithm of *Total Delta*, *Constrained Delta*, *Wealth*, and *Delta-to-Wealth* on the set of traditional control variables. All variables are defined in the caption of Table 1. Industry indicators based on the Fama and French 48 industries and Year indicators are included in all the equations. Coefficient estimates for the industry and year indicators are not reported. *t*-statistics are reported below coefficient estimates in parentheses and are calculated based on robust standard errors clustered by CEO. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

Table 3

Descriptive Statistics for Risk Premium Analysis

	Mean	Standard Deviation	10th Percentile	50th Percentile	90th Percentile
Panel A					
CEO Incentives & Compensation					
Constrained Delta	123	212	4	52	306
Min(Constrained, Total Delta$_t$)	126	237	4	51	304
Predicted Delta: Median	325	505	41	166	731
Min(Median, Total Delta$_t$)	247	356	22	127	592
Total Delta	383	547	26	171	1,042
Total Compensation$_{t+1}$	4,718	5,674	749	2,754	10,835
Panel B					
Risk Premiums (RRA=2)					
Min(Constrained, Total Delta$_t$)	541	1,542	2	109	1,227
Min(Median, Total Delta$_t$)	1,666	3,372	92	660	3,925
Total Delta$_t$	4,035	9,877	107	1,162	9,072
Panel C					
Risk Premiums (RRA=1)					
Min(Constrained, Total Delta$_t$)	261	835	0	34	587
Min(Median, Total Delta$_t$)	883	1,928	40	327	2,038
Total Delta$_t$	2,174	5,634	53	580	4,874

This table presents descriptive statistics for our sample of 13,635 firm years. *Constrained Delta* is the change in the risk-neutral value of the CEO's equity portfolio of unvested restricted stock, vested equity that is subject to an ownership guideline, unvested options, and vested out-of-the-money options for a 1% change in the price of the underlying stock. *Total Delta* is the change in the risk-neutral value of the CEO's equity portfolio of stock and options for a 1% change in the price of the underlying stock. *Min(Constrained, Total Delta$_t$)* is the minimum of *Constrained Delta* and *Total Delta. Predicted Delta: Median* is computed using a pooled cross-sectional median regression using the same specification as the first column of Table 2, panel A. *Min(Median, Total Delta$_t$)* is the minimum of *Predicted Delta: Median* and *Total Delta*.

The risk premium per unit of delta is based on the firm's idiosyncratic risk, the CEO's percentage wealth in firm stock and a coefficient of relative risk aversion of either 2 (Panel B) or 1 (Panel C). CEOs are assumed to receive a risk premium for holding either constrained delta (*Risk Premium: Min(Constrained, Total Delta$_t$)*, the minimum of *Predicted Delta -Median* and *Total Delta* (*Risk Premium: Min(Median, Total Delta$_t$)*, and Total Delta (*Risk Premium: Total Delta$_t$*).

Table 4
Regressions of Total Direct Compensation on Estimated Equity Portfolio Risk-Premiums

	Total Direct Compensation$_{t+1}$						
		Assumed CEO Relative Risk-Aversion = 2.0			Assumed CEO Relative Risk-Aversion = 1.0		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Risk Premium: Min(Constrained, Total Delta$_t$)		1.385***			2.458***		
		(5.57)			(5.81)		
Risk Premium: Min(Median, Total Delta$_t$)			0.550***			0.856***	
			(5.53)			(5.30)	
Risk Premium: Total Delta$_t$				0.161***			0.262***
				(5.64)			(5.18)
Log(Tenure$_t$)	0.313*	0.460***	0.012	-0.052	0.445***	0.037	-0.015
	(1.93)	(3.36)	(0.07)	(-0.33)	(3.07)	(0.23)	(-0.10)
Log(Sales$_t$)	2.175***	1.883***	1.850***	1.878***	1.955***	1.923***	1.923***
	(21.28)	(19.61)	(15.14)	(18.64)	(21.66)	(16.55)	(19.23)
Book-to-Market$_t$	-3.779***	-1.934***	-1.193**	-2.195***	-2.117***	-1.576***	-2.347***
	(-6.95)	(-5.65)	(-2.29)	(-4.89)	(-5.69)	(-3.09)	(-5.02)
Return$_{t+1}$	0.697	1.133*	0.521	0.329	0.993*	0.503	0.351
	(0.74)	(1.85)	(0.77)	(0.44)	(1.66)	(0.73)	(0.47)
Return$_t$	2.486**	0.692	0.962	1.270	0.746	1.108	1.310
	(2.36)	(0.98)	(1.18)	(1.59)	(1.05)	(1.34)	(1.61)
ROA$_{t+1}$	-1.573	0.549	0.480	2.159	0.728	0.442	2.013
	(-0.34)	(0.14)	(0.14)	(0.58)	(0.18)	(0.12)	(0.53)
ROA$_t$	-8.888*	-4.608	-6.446*	-8.446**	-4.600	-6.575	-8.419**
	(-1.73)	(-1.16)	(-1.66)	(-2.05)	(-1.16)	(-1.63)	(-2.02)
Industry Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.5571	0.6275	0.5992	0.6089	0.6178	0.5902	0.6006
Observations	1,584	1,584	1,584	1,584	1,584	1,584	1,584

This table presents OLS regression estimates of CEO total direct compensation for year *t*+1 on control variables and proxies for risk premia. *Total Compensation$_{t+1}$* is the CEO's total annual compensation during the fiscal year *t*+1. See Table 3 above for details on risk premiums. CEOs are assumed to receive a risk premium for holding either constrained delta (*Risk Premium: Min(Constrained, Total Delta$_t$*), column 2), the minimum of *Predicted Delta -Median* and *Total Delta* (*Risk Premium: Min(Median, Total Delta$_t$*), column 3), and Total Delta (*Risk Premium: Total Delta$_t$,* column 4). Predicted Delta is computed using a pooled cross-sectional median regression using the same specification as the first column of Table 2, panel A. *Sales* is total revenues for fiscal year *t*. *Book-to-Market* is the ratio of book value to market value of total assets at the end of the fiscal year. *Tenure* is the number of years in which the current CEO has held the office of Chief Executive Officer. *Return$_{t+1}$* (*Return$_t$*) is the cumulative stock return during the fiscal year *t*+l (*t*). *ROA$_{t+1}$* (*ROA$_t$*) is return on average assets during the fiscal year *t*+l (*t*). Industry indicators based on the Fama and French 48 industries and Year indicators are included in all the equations. Coefficient estimates

for the industry and year indicators are not reported. *t*-statistics are reported below coefficient estimates in parentheses and are calculated based on robust standard errors clustered by CEO and year. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.

Table 5
Random Coefficient Models of Equity Portfolios

	Log(Total Delta$_t$)			*Log(Constrained Delta$_t$)*			*Log(Delta-to-Wealth$_t$)*		
	Mean Coefficient	*Std. Dev. of Coefficients*	*% greater than zero*	*Mean Coefficient*	*Std. Dev. of Coefficients*	*% greater than zero*	*Mean Coefficient*	*Std. Dev. of Coefficients*	*% greater than zero*
Log(MVE$_t$)	0.540***			0.719***			0.097***		
	(44.05)			(25.49)			(13.19)		
Idiosyncratic Vol$_t$	0.269***			0.568***			-0.357***		
	(4.12)			(2.63)			(-8.36)		
Book-to-Market$_t$	-0.422***			-0.040			-0.350***		
	(-8.40)			(-0.29)			(-10.70)		
Log(Tenure$_t$)	0.235***	0.248***	83%	0.099***	0.413***	59%	-0.043***	0.156***	39%
	(17.97)	(14.41)		(3.33)	(6.33)		(-5.22)	(10.99)	
Free Cash Flow$_t$	0.112			0.169			-0.254***		
	(1.34)			(0.56)			(-4.03)		
Cumulative Return$_t$	0.325***	0.288***	87%	-0.009	0.699***	49%	0.183***	0.212***	81%
	(15.79)	(10.50)		(-0.20)	(7.32)		(14.60)	(7.31)	
Investment-to-Cash-Flow Sensitivity	0.244	1.844**	55%	-1.370*	9.889***	44%	0.004	0.000	NM
	(0.70)	(1.92)		(-1.66)	(3.34)		(0.02)	(0.17)	
Excess Return$_{t+1}$	-0.003	0.105**	49%	-0.033	0.000	NM	-0.007	0.082***	47%
	(-0.25)	(1.86)		(-0.98)	(0.19)		(-1.06)	(2.64)	
Risk tolerance	0.035***	0.070***	69%	0.079***	0.205***	65%	0.019***	0.039***	69%
	(3.86)	(3.84)		(4.30)	(4.49)		(3.30)	(2.74)	
%Outside directors appointed by CEO$_{t+1}$	0.299***	0.259***	88%	-0.094	0.000	NM	0.088***	0.236***	65%
	(5.74)	(3.01)		(-0.69)	(0.05)		(2.64)	(4.44)	
Industry Indicators	Yes			Yes			Yes		
Year Indicators	Yes			Yes			Yes		
Observations	9,225			9,225			9,225		

This table presents estimates of random coefficient regressions of the natural logarithm of *Total Delta*, *Constrained Delta*, and *Delta-to-Wealth* on the set of traditional control variables and additional covariates. A random coefficient model allows the intercept and the indicated independent variables to follow a normal distribution in the population. The estimated population mean and standard deviation are reported in the column *Mean Coefficient* and *Std. Dev. of Coefficients*, respectively. *% greater than zero* is the percentage of CEO-specific coefficients that are greater than zero given the mean and standard deviation of the population distribution of coefficients. *t*-statistics are reported below coefficient estimates in parentheses and are calculated based on robust standard errors clustered by CEO. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively. NM = not meaningful: the mean and standard deviation are both insignificant.

Table 6
Between-Within Random Coefficient Models of Equity Portfolio Incentives

	Log(Total Delta$_t$)			
	CEO Avg. (Between Effects)	*CEO Deviation (Within Effects)*		
		Avg. Coefficient	*Std. Dev. Of Coefficients*	*% greater than zero*
Log(MVE$_t$)	0.594***	0.341***		
	(47.84)	(12.09)		
Idiosyncratic Vol$_t$	0.854***	0.198***		
	(7.40)	(3.88)		
Book-to-Market$_t$	-0.336***	-0.383***		
	(-3.89)	(-7.20)		
Log(Tenure$_t$)	0.261***	0.244***	0.363***	75%
	(13.46)	(16.49)	(29.01)	
Free Cash Flow$_t$	0.509**	0.064		
	(2.29)	(0.96)		
Cumulative Return$_t$	0.201***	0.555***	0.377***	93%
	(8.68)	(16.39)	(22.99)	
Investment-to-Cash-Flow Sensitivity	0.276			
	(0.96)			
Excess Return$_{t+1}$	-0.069	-0.002	0.098***	49%
	(-1.30)	(-0.16)	(4.99)	
Risk tolerance	0.030***			
	(3.66)			
%Outside directors appointed by CEO$_{t+1}$	0.332***	0.180***	0.698***	60%
	(4.61)	(3.35)	(10.01)	
Industry Indicators	Yes			
Year Indicators	Yes			
Observations	9,225			

This table presents estimates of Within-Between OLS regressions of the natural logarithm of *Total Delta* on the set of traditional control variables and additional covariates. The independent variables in each specification consist of each CEO's time-series average (*CEO Avg.*), which has a time-invariant CEO-specific value for each CEO, and the deviation of each year's variable values from their time-series average (CEO *Dev.*). The coefficient estimates of the CEO time-series averages (*CEO Avg.*) capture cross-sectional variation *between* CEOs, and the CEO time-series deviations from their CEO-specific time-series averages (*CEO Dev.*) capture time-series variation *within* CEOs. All variables are defined in the captions of Table 1 and Table 2. Industry indicators based on the Fama and French 48 industries and Year indicators are included in all the equations. Coefficient estimates for the industry and year indicators are not reported. *t*-statistics

are reported below coefficient estimates in parentheses and are calculated based on robust standard errors clustered by CEO. Statistical significance (two-sided) at the 10%, 5%, and 1% level is denoted by *, **, and ***, respectively.