MAINTAINING OPTIMAL CEO INCENTIVES THROUGH EQUITY GRANTS AND CEO PORTFOLIO REBALANCING

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Maintaining Optimal CEO Incentives through Equity Grants and CEO Portfolio Rebalancing*

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August 2002

Abstract

This paper examines the joint hypotheses that firms set optimal levels for CEO incentives, and that firms and CEOs jointly correct deviations from these optimal levels through equity grants and CEO portfolio rebalancing. I investigate two equity-based CEO incentives, pay-for-performance sensitivity and risk-taking incentive. Pay-for-performance sensitivity is defined as the change in CEO wealth for a given change in the firm’s stock price, while risk-taking incentive the sensitivity of CEO wealth to equity risk. I find that firms’ and CEOs’ combined annual adjustment to pay-for-performance sensitivity or risk-taking incentive is negatively related to the degree that each incentive deviates from its target level at the beginning of the year, consistent with firms and CEOs jointly correcting the incentive deviations. Overall, the findings suggest that firms and CEOs coordinate their equity-granting and portfolio-rebalancing decisions to manage optimal CEO incentive levels consistent with economic theory.

Key words: Contracting; Managerial Compensation; Managerial Ownership; Equity incentives; Pay-for-performance sensitivity; Risk-taking incentive; Equity grants; CEO portfolio rebalancing

JEL classification: G32; J33; J42; M4

* This paper is based on my dissertation at MIT. I am indebted to the members of my dissertation committee, Wayne Guay, Peter Wysocki, and especially S.P. Kothari (Chair), for their help and guidance on this paper. I gratefully acknowledge the helpful comments from Mary Ellen Carter, Elizabeth Eccher, Richard Frankel, Li He, Li Jin, Peter Joos, Bjorn Jorgensen, Asís Martinez-Jerez, Michael Mikhail, Stewart Myers, Jowell Sabino, George Plesko, Joe Weber, Larry Weiss, Eric Wolff, Yanfeng Xue, and seminar participants at MIT, UC-Riverside, CUNY-Baruch College, New York University, and U. of Wisconsin at Twin Cities.

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I. Introduction

This paper examines how firms and their CEOs jointly maintain optimal CEO incentives. Economic theory suggests that risk can motivate an effort-averse and risk-averse CEO (e.g., Jensen and Meckling, 1976; Holmstrom, 1979). Toward this end, firms typically implement a CEO compensation scheme that is heavily dependent on the value of the firm’s equity. One measure of the strength of this incentive is pay-for-performance sensitivity (PPS), defined as the dollar change in CEO wealth for a given change in the firm’s stock price.

CEOs holding a large and undiversified portfolio value risky projects lower than well-diversified shareholders, leading to underinvestment (Smith and Stulz, 1985). This problem can be mitigated by linking CEO wealth to firm risk (e.g., Haugen and Senbet, 1981; Lambert, 1986; Hemmer, Kim, and Verrecchia, 1999; Williams and Rao, 1999; Rajgopal and Shevlin, 2002; Core and Qian, 2001). The linkage is generally accomplished by requiring CEOs to hold stock options, whose value increases with equity risk. I define this risk-taking incentive (RI) as the dollar change in CEO wealth for a given change in stock-return volatility.

PPS and RI induce CEOs not only to work industriously, but also to appropriately choose risky projects that increase shareholder wealth. Researchers have examined PPS and RI independently, and their evidence is consistent with CEOs holding equity, in the form of stock and options, to align CEO interests with those of the shareholders (Demsetz and Lehn, 1985; Core and Guay, 1999, Guay, 1999; Himmelberg et al., 1999).¹

Over time, however, CEO incentives can deviate from their optima, either due to shifts in the optimal levels or due to changes in incentives provided by CEOs’ equity portfolios. Because

¹ Throughout this paper, equity holdings (grants) include both stock and options.
of costs of adjustment, such as information gathering and processing costs, deviations from the
optimal PPS and RI levels may not be immediately corrected.

Correcting such incentive deviations is essential to ensure the efficient management of the
firm. Core and Guay (1999) find evidence consistent with firms setting optimal PPS targets and
using equity grants to correct PPS deviations. However, there exists no evidence on the
adjustment of RI. I extend prior work by addressing two unanswered questions. First, I directly
study how excessive PPS is reduced. Equity grants cannot decrease PPS. Second, I examine
how optimal RI is maintained concurrent with PPS. This question is particularly relevant when
the two incentives deviate in opposite directions. Equity grants, usually including at-the-money
options, cannot simultaneously correct both deviations because they increase both PPS and RI.

Based on principal-agent theory, I argue that optimal PPS and RI arise endogenously from
a second-best contract between shareholders and their CEO. Although it is in CEOs’ interest to
reduce their risk exposure through diversification, empirical evidence is consistent with firms
successfully enforcing the adoption of an optimal portfolio through various mechanisms, which
include restricted stock grants, option grants with a vesting schedule, target ownership plans that
require minimum stockholdings (Core and Larcker, 2000), and possibly the threat of termination.

When CEO incentives exceed the target levels, the optimal contract allows CEOs to reduce
the excess. In reality, most CEOs have considerable flexibility in adjusting their equity holdings.
For example, GE’s former CEO Jack Welch exercised 500,000 options and sold about 627,700
shares of stock in 1999. Likewise, when the incentives fall below target levels, CEOs should be
required to increase their equity holdings. It is more likely for firms to grant CEOs new stock
and options, because requiring CEOs to purchase equity on the open market is more costly due to
transaction costs and potential capital constraints. A large purchase can also exert upward stock-
price pressure. Accordingly, I allow for both equity grants and CEO portfolio rebalancing as incentive-adjusting mechanisms. I hypothesize that firms set optimal equity incentive targets and that, when PPS and RI deviate from their targets, firms alter equity grants and CEOs rebalance their firm-specific stock and option holdings to correct both deviations.

Under the assumption that, on average, CEOs’ stock and option portfolios provide optimal PPS and RI, I estimate optimal PPS and RI levels cross-sectionally based on firm characteristics. Residuals from these models are proxies for incentive deviations, and I use them to predict equity (stock and option) grants and CEO portfolio rebalancing (option exercise, stock sales, and purchases). I find evidence consistent with my predictions. Specifically, when both incentives are above their optimal levels, I find that CEOs exercise options and sell stock to reduce their excess incentives. If one incentive is insufficient and the other excessive, my findings are consistent with firms making equity grants to increase the insufficient incentive and CEOs reducing their stock or option holdings to decrease the excessive one. When both incentives are below their optimal levels, I find firms grant equity and CEOs do not fully undo the increase. My results are robust to various sensitivity analyses, including alternative performance measures and rank or firm fixed-effects specifications.

This paper makes three contributions. First, my evidence is consistent with firms setting optimal PPS and RI targets and with firms and CEOs jointly correcting PPS deviations and RI deviations. Prior research focuses exclusively on how firms use equity grants to manage optimal PPS levels. Second, simultaneously considering PPS and RI leads to different predictions on equity grants and CEOs’ portfolio rebalancing from those based on the independent analysis of either incentive. When PPS is excessive and RI insufficient, focusing on PPS alone leads to a prediction of no equity grants, assuming that no other granting reasons such as compensation
exist. I predict that the firm grants stock options to increase RI, and that the CEO sells stock to decrease PPS. My findings support my prediction.

Finally, I find that CEOs rebalance their portfolios to adjust their own incentives in a manner consistent with shareholders’ interests. My findings indicate that, when firms grant equity to increase insufficient CEO incentives, CEOs do not fully undo the increase through portfolio rebalancing. On the other hand, when faced with excessive incentives, CEOs exercise options and sell stock to reduce their incentives. Prior research offers little evidence on whether shareholders implicitly control the portfolio-rebalancing behavior of their CEOs. Although Ofek and Yermack (2000) investigate how CEOs rebalance their firm-specific equity portfolios following equity grants, they do not examine how that rebalancing affects CEO incentives. Nor do they discuss the reasons for the equity grants.

Section II of this paper develops four hypotheses about CEO and firm actions in the face of incentive deviations. Section III describes the research design. I report empirical results in Section IV and present sensitivity analyses in Section V. Section VI concludes with a discussion of contributions and some suggestions for future research.

II. Hypothesis Development

I define PPS as the change in the dollar value of a CEO’s stock and option portfolio for a 1% change in the stock price, and RI as the dollar change in portfolio value for a 0.01 change in annualized standard deviation of stock returns. I discuss alternative CEO incentive measures in Section V, Sensitivity Analysis.

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2 I ignore the incentives from potential CEO turnover and from year-to-year adjustments in cash pay, as well as the variation in incentives from other performance measures. It is reasonable to assume that the majority of CEO incentives are from variation in the value of their equity holdings (Hall and Lieberman, 1998; Core, Guay, and Verrecchia, 2000).
Assuming that optimal incentive levels exist for both PPS and RI, I predict that firms and CEOs jointly correct deviations from these target levels to ensure incentive alignment. Deviations from optimal incentive levels can occur for several reasons. First, target levels shift due to changes in CEO or firm characteristics. Second, incentives from a given equity portfolio vary with stock price, stock-return volatility, and the time remaining until option expiration.\(^3\) Finally, CEOs periodically buy and sell stock and exercise options to realize compensation.

Based on the direction of CEOs’ incentive deviations, I divide these deviations into four types and summarize my predictions in the first three columns of Table 1. The first type of deviations, both PPS and RI are below their optimal levels, can occur if, after an exogenous shock, the firm is faced with more growth opportunities. Since more growth opportunities aggravate information asymmetry, the firm needs to provide its CEO with a higher PPS to ensure the adoption of profitable projects (Yermack, 1995). Also, the problem of underinvestment in risky projects is particularly damaging for high-growth firms because their prospects depend crucially on such projects, so RI needs to be higher too. Since firms can structure CEO compensation to provide reservation utility and replenish insufficient incentives at the same time, the response is to grant options to increase both incentives.\(^4\) If the options do not exactly correct

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\(^3\) The value of one share of common stock increases dollar-for-dollar with stock price. PPS from stock options is determined by an option’s delta. If option holders can fully diversify the riskiness in option payoff, the Black-Scholes formula shows that delta increases monotonically with stock price. For risk-averse and undiversified executives, delta is smaller but also increases with stock price (Hall and Murphy, 2002).

Common stock provides little RI for most firms (Guay, 1999). RI from options is often computed as the partial derivative of their Black-Scholes value to stock-return volatility and has a “bell-shaped” relation to stock price. RI is very small when stock price is close to zero. It increases with stock price because, at a higher stock price, an upsurge in volatility makes it more likely that the option will finish in the money. Since a small increase in volatility can cause the option to go in the money, RI is maximized at a stock price lower than the exercise price. For in-the-money options, increases in stock-return volatility are less desirable because the CEO’s payoff is exposed to risk. Therefore, RI falls as options go further in the money and gradually approaches zero. Lambert et al. (1991) show that, if the probability of the option finishing in the money is sufficiently high, an undiversified executive’s stock options can increase aversion to risk; i.e., provide negative RI.

\(^4\) For a large incentive deficiency, CEOs receive more equity and less cash. If the deficiency is small, CEOs receive their reservation wage mostly in cash. However, equity grants may not fully replenish a large incentive deficiency because firms do not have the desired flexibility to reduce CEO cash pay. Firms usually cannot reduce
the deviations, restricted stock awards can serve as a fine-tuning device. For the incentive increase to be effective, the CEO must not fully undo the equity grants by portfolio rebalancing.

I state the hypothesis that applies to Deviation Type 1 as follows:

\[ H1: \text{When PPS and RI are both too low, firms grant new equity (including options) to increase the incentives. CEOs do not fully undo the increased incentives.} \]

Next, consider the type of deviations where PPS is low and RI is excessive. This scenario can occur after a dramatic stock-price decline that leaves the CEO with many moderately-out-of-the-money and/or moderately-in-the-money options. PPS always declines with stock price, but RI can increase because near-the-money options provide high RI.\(^5\) Assuming that the CEO remains with the firm after the dismal stock performance, it is in the shareholders’ interest to replenish insufficient PPS. Granting restricted stock increases PPS, and has little impact on RI. Excessive RI, on the other hand, may not be easily reduced. CEOs would not exercise out-of-the-money and cannot exercise unvested options. Although CEOs can reduce RI by exercising slightly-in-the-money options, they forfeit the time value of the options by doing so. Huddart (1994) shows that risk-averse employees exercise stock options at a threshold price-to-strike ratio, i.e., the ratio of stock price to exercise price, that is a function of their level of risk tolerance. He further shows that very few exercises take place when the stock price is close to the exercise price because most employees’ thresholds are not exceeded. Huddart and Lang (1996) find supporting evidence that more exercises occur when options are deeper in-the-money. A possible measure to correct both deviations simultaneously is for the firm to cancel

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CEOs’ base salaries. Executive employment contracts typically guarantee minimum salary increases for the subsequent three years. Murphy (1999) finds that 85% of the 1,000 large companies he studies grant options to their CEOs in 1998. Since equity compensation was prevalent in the 1990s, it is likely that a large incentive shortfall can be gradually corrected by requiring the CEO to hold the granted equity.
out-of-the-money options and award new at-the-money options, or to reprice underwater options to set them at-the-money. Gilson and Vetsuypens (1993) suggest that firms in financial distress could be pressured by creditors to reprice CEO underwater options by reducing the exercise price. Doing so reduces CEOs’ incentives to take on high-risk projects. The following hypothesis applies to this Deviation Type 2:

**H2:** When PPS is too low and RI too high, firms increase PPS through equity (restricted stock) grants, and CEOs do not undo the increase. CEOs either reduce RI by option exercise or leave excessive RI unchanged.

In the third type of deviations, PPS is too high and RI is too low. This can happen after a sharp price increase that results in the CEO holding too many deep-in-the-money options. To increase RI, the firm can grant new at-the-money options. Although the option grants also increase PPS, a firm is more likely to permit its CEO to realize compensation when incentives are above optimal levels. The CEO can exercise deep-in-the-money options and sell stock to reduce PPS. Ofek and Yermack (2000) provide evidence that CEOs with high stock ownership usually liquidate all their stock acquired through option exercise. Such an exchange of new at-the-money for old deep-in-the-money options has the desired effect of increasing RI and decreasing PPS. To state these predictions as a hypothesis:

**H3:** When RI is insufficient and PPS excessive, firms increase RI through option grants, and CEOs exercise their deep-in-the-money options and sell stock to decrease PPS.

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5 Out-of-the-money options may provide excessive RI. In Chance, Kumar, and Todd (2000)’s sample, stock price is about half of the exercise price when firms reprice their CEO options.
Finally, consider the type of deviation where both incentives are above their optimal levels. This situation can occur when a CEO holds too many options that are moderately-in-the-money. For example, PPS may become insufficient and RI excessive after a stock-price decline, as described in the Deviation Type 2. When the firm faces financial constraints and opt for equity compensation, new equity grants it makes can exceed the PPS deficiency, resulting in both incentives being excessive. If the CEO fails to immediately reduce the excess PPS, both incentives will be above their optimal levels for some time. While PPS can be decreased through stock sales, excessive RI may not be easily reduced for the reasons discussed in Hypothesis 2.6 The hypothesis that applies to this Deviation Type 4 can be stated as follows:

**H4:** When both PPS and RI are too high, firms do not grant new equity. CEOs decrease PPS by stock sales. RI is either not adjusted or decreased by option exercise.

If shareholders and CEOs can continuously adjust incentives, deviations from optimal levels would not be observed. Such a case is, however, unrealistic. Continuous portfolio rebalancing by CEOs is unlikely. Huddart and Lang (1996) document that high-level employees typically exercise their options in a few large transactions. Similarly, I expect adjustments by firms to occur infrequently. To determine optimal incentive levels, firms must compare their CEOs’ incentives with those in similar firms. Continuously gathering and analyzing such data is costly for compensation committees. Proxy statements containing these data are available only once a year. Core and Guay (1999) find that firms make more than one equity grant to their CEOs in less than 10% of the fiscal years examined.

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6 If one incentive is off from its target but the other is right on the target, I classify this scenario as if the on-target incentive were excessive because the predictions are similar. For example, if PPS is insufficient and RI is at
III. Sample Selection and Research Design

3.1 Sample Selection and Incentive Measurement

I began by extracting a sample of CEOs from the ExecuComp database. For firms not identifying their CEOs, I select the executive with the highest cash compensation. The initial sample includes 11,608 CEO-year observations from 1992 to 1999. I then eliminate financial firms and firms with incomplete Compustat data. Financial firms are excluded because they have few investment expenditures, which I later use as proxies for growth opportunities. CEOs holding more than 25% of their company’s common stock are also excluded because their compensation may not be designed for contracting purposes. The sample used to estimate optimal incentives consists of 9,045 CEO-year observations. When examining incentive adjustments, I retain only those CEOs remaining in their positions the second year and those with complete data on incentive adjustments. The selection procedures result in a final total of 7,054 CEO-year observations.

Guay (1999) finds that, except for firms in severe financial distress, CEO option holdings predominantly drive RI.\(^7\) Accordingly, when calculating CEO incentives, I use RI from stock-option holdings as a proxy for total RI (Guay, 1999), and likewise use RI from stock-option grants as a proxy for RI grants.

Calculating firms’ adjustments to PPS and RI through equity (stock and option) grants is straightforward. The ExecuComp database provides the dollar amount of restricted-stock grants. Multiplying this value by 1% produces the PPS from restricted stock grants. I estimate PPS and

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7 Common stock also provides RI, because the payoff to common stock in a levered firm can be viewed as a call option. The option’s underlying asset is the firm value and the exercise price is the face value of debt. Guay (1999)
RI from option grants using the Black-Scholes (1973) model, as modified by Merton (1973) to account for dividend payouts. The number of options granted, grant-day price, exercise price, and maturity are readily available. I use ExecuComp’s historical volatility and dividend yield measures as proxies for expected stock-return volatility and expected dividend yield. The risk-free rate is estimated by the treasury bond yield corresponding to the options’ maturity.

To calculate total incentives provided by a CEO’s portfolio of stock and stock options at fiscal year-end, I first use Core and Guay (2002)’s method to estimate PPS and RI from the option holdings. The option portfolio consists of the current-year’s option grants, unexercisable options excluding the current-year’s grants, and exercisable options. PPS (RI) from options is the sum of PPS (RI) from these three categories. Then, I calculate PPS from stock holdings as simply their dollar value multiplied by 1%. Incentives provided by the CEO’s entire equity holdings are made up of those from stock and those from options.

A CEO’s adjustment to PPS (RI) is the sum of PPS (RI) adjustments through option exercises and stock-ownership changes. Additions to incentives are coded positive; subtractions negative. To calculate reductions to PPS and RI through option exercises, I assume that exercised options during a year are from the previous year-end’s exercisable options, so the only parameter missing in the Black-Scholes formula is the exercise-day stock price. Since the ExecuComp database provides the number (NUMBER) and total realized value (VALUE) of options exercised, I can estimate average exercise-day stock price by 

\[(\text{average exercise price of exercisable options})_{t} \times \frac{(\text{VALUE})_{t}}{\text{NUMBER}_{t+1}}\]  

To estimate PPS adjustments due to changes in CEO stock ownership, I first calculate the change in shares of stock owned as 

\[[(\text{shares of stock}) - PPS (RI)] \times \text{number of options granted} \times \text{exercise price} \times \text{grant-day price} \times \text{maturity} \]

finds that RI provided by common stock is very small because, except for firms in severe financial distress, these ‘options’ are deeply in the money.
held)_{t+1} - (shares of stock held)_{t} - (shares of restricted-stock granted)_{t+1}].^8 Multiplying this number by 1% of the previously estimated average exercise-day stock price yields the CEO’s adjustment to PPS through changes in stock ownership.\(^9\) I summarize details of all the above incentive estimation procedures in Appendix A.

I calculate combined PPS adjustments, \(\Delta PPS\), as the sum of PPS adjustments through equity grants and through CEO portfolio rebalancing, and calculate combined RI adjustments, \(\Delta RI\), similarly. Table 2A presents the descriptive statistics of all variables. With the exception of year-end portfolio PPS and RI, the highest and lowest percentiles for all variables are set equal to the value at the 1st and 99th percentiles each year to mitigate the influence of outliers. Since PPS and RI are skewed to the right, I winsorize only the largest 1% of the incentives. The minimal values of PPS and RI are $140 and zero respectively. The mean change in CEO wealth for a 1% change in stock price is $488,964 while the median change is $129,533. The mean change in CEO wealth for 0.01 change in stock-return volatility is $61,632, with a median of $24,663. Standard deviations of PPS and RI are $1,382,193 and $112,660 respectively.

### 3.2 Empirical Models for Estimating Optimal Incentives

The empirical models to estimate optimal incentives are based on previous studies (Core and Guay, 1999; Guay, 1999; Himmelberg, 1999). I modify their approach by simultaneously estimating optimal PPS and RI in a two-stage least squares model to capture incentive endogeneity.

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^8 ExecuComp only provides the value, not the number, of restricted-stock grants on the grant day. Since restricted stock is usually granted with options, I calculate the number of stock granted as the granted dollar value divided by the grant-day market price. When there are no option grants or when the grant-day market price is missing, I use the average of stock prices at the beginning and the end of the year.

^9 If the CEO keeps the stock acquired upon option exercise, reduction in PPS from option exercise and increase in PPS from stock retention are consistently measured with the same stock price.
These studies identify firm size, investment opportunity set, CEO risk aversion, and industry differences as the prominent common determinants of PPS and RI. They also use CEO tenure and firms’ free-cash flow problem as determinants that directly affect PPS alone (see Core and Guay, 1999; Guay, 1999; Himmelberg et al., 1999 for in-depth discussions). Based on Guay (1999), I include PPS as a determinant of optimal RI. Higher PPS ties CEO wealth more closely to stock price, and makes the CEO less diversified, implying a need for higher RI. However, I do not use RI as a determinant of PPS, because how RI affects PPS is not obvious.

Among the common determinants of both incentives, I measure firm size as the log of market value of assets, calculated as the sum of the book value of liabilities plus market value of equity. Similar to Himmelberg et al. (1999), firms’ growth opportunities are proxied by their asset composition, i.e., property, plant and equipment (PP&E), changes in working capital, capital expenditures and acquisitions (CAPEX) and R&D expenditures (R&D), all scaled by market value of assets. I set missing R&D expenses to zero, and use a dummy variable (RDUM) to indicate whether the firm reports R&D expense. CEO cash compensation serves as a proxy for both CEO wealth and the degree of risk aversion. I include industry dummies, corresponding to firms’ two-digit SIC codes, to control for industry differences.

The free-cash-flow problem directly affects PPS alone. Following Lang et al. (1991), I measure it as [(operating cash flow - common and preferred dividends)/market value of assets)] if the firm has a market-to-book ratio lower than one, and zero if the market-to-book ratio is higher than or equal to one. In PPS estimation, I also use the log of a firm’s five-year stock-return volatility as a proxy for the uncertainty in the firm’s operating environment. I do not

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10 My results are robust when CEO age is included as an additional explanatory variable in Eqs. (1) and (2). Its exclusion in the reported results is because about half of the observations have missing values for CEO age.

11 Firms’ five-year stock-return volatility has a skewness of 2.5. The logarithmic transformation reduces the skewness to 0.79. Stock-return volatility is positively related to both the noisiness in stock price and the firms’
include this variable in RI estimation, because RI encourages CEO risk-taking, so the causality is reversed.

All above variables are measured at the end of each fiscal year, and I summarize their acronyms in Appendix C. The following first-stage model estimates PPS:

\[
\log (1 + PPS)_{it} = \alpha_0 + \alpha_1 \log (\text{Mkt. value of Assets})_{it} + \alpha_2 \log (\text{Stock-return Volatility})_{it} \\
+ \alpha_3 (\text{PP&E})_{it} + \alpha_4 (\Delta \text{Working Capital})_{it} + \alpha_5 (\text{CAPEX})_{it} + \alpha_6 (\text{R&D})_{it} \\
+ \alpha_7 (\text{RDUM})_{it} + \alpha_8 (\text{Free-Cash-Flow Problem})_{it} + \alpha_9 (\text{CEO Tenure})_{it} \\
+ \alpha_{10} (\text{Cash Compensation})_{it} + \text{Industry Dummies} + \varepsilon_{PPS, it} \tag{1}
\]

I estimate Eq. (1) each year using only annual observations. I then use the predicted value of \(\log(1 + PPS)_{it}\) to estimate RI annually in the second-stage model:

\[
\log (1 + RI)_{it} = \beta_0 + \beta_1 \log (1 + PPS)_{it} + \beta_2 \log (\text{Mkt. value of Assets})_{it} + \beta_3 (\text{PP&E})_{it} \\
+ \beta_4 (\Delta \text{Working Capital})_{it} + \beta_5 (\text{CAPEX})_{it} + \beta_6 (\text{R&D})_{it} + \beta_7 (\text{RDUM})_{it} \\
+ \beta_8 (\text{Cash Compensation})_{it} + \text{Industry Dummies} + \varepsilon_{RI, it} \tag{2}
\]

\textbf{3.3 Design of Tests for the Hypotheses}

Since I assume that Eqs. (1) and (2) approximate optimal levels of PPS and RI at the end of year \(t\), positive (negative) \textit{estimated} residuals, \(\varepsilon_{PPS, it}\) or \(\varepsilon_{RI, it}\), indicate that the incentives are above (below) their optima. To test my hypotheses that firms and CEOs jointly correct incentive growth opportunities. If the growth-opportunity proxies capture CEO discretion well, stock-return volatility reflects the noise in stock price, and a negative coefficient ensues. If the proxies for the growth opportunities do not fully capture CEO discretion, the coefficient on stock-return volatility may be positive.
deviations, I conduct two tests. The first investigates the relation between incentive deviations and combined adjustments by firms and CEOs. The second examines firms’ and CEOs’ separate adjustments. I expect my first test to be more powerful because it allows a direct test on whether net adjustments increase an insufficient incentive or decrease an excessive incentive.

My tests differ in scope from prior research. For example, Core and Guay (1999) examines firms’ PPS adjustments through equity grants, analogous to part of my second test. In addition, I proxy for the degree of incentive deviation by relative, as opposed to absolute deviations in prior work. To obtain the relative measures, I scale PPS deviations, $e_{PPS, it}$, by one plus log of total PPS, i.e., $(1+\log(1+PPS_i))$, and scale RI deviations, $e_{RI, it}$, by one plus log of total RI, i.e., $(1+\log(1+RI_i))$. In both denominators, one is added inside the log because some CEOs have zero incentives. Another one is then added to the log so that the denominators are non-zero.\footnote{Ideally, relative deviations are measured as deviations scaled by the optimal incentive levels. However, the measurement errors in the incentive deviations and the predicted incentives are in opposite directions. Scaling incentive deviations by predicted incentives magnifies the measurement error. In addition, some predicted incentive values are negative.} I argue that, compared with absolute deviations, relative incentive deviations better capture the degree of deviation, and therefore the benefits of incentive alignment. These two types of deviation measures should yield the same results when correction of deviations is immediate and complete. However, when adjusting costs exist, relative deviations may be a superior measure.

Since I measure the degree of deviation by relative deviations, I also express incentive adjustments in relative terms. To do so, I first transform incentive adjustments logarithmically, because Eqs. (1) and (2) estimate the log of optimal incentives. Then, I scale the logarithmically transformed PPS adjustments by one plus log of beginning-of-the-year PPS, i.e., $(1+\log(1+PPS_i))$, and scale RI adjustments analogously. For example, I define logarithmically
transformed combined incentive adjustments as $\ln \Delta PPS$ and $\ln \Delta RI$. Since combined adjustments ($\Delta PPS$ and $\Delta RI$) can be negative, I measure $\ln \Delta PPS$ as the logarithm of 1 plus the absolute value of $\Delta PPS$, and $\ln \Delta PPS$ takes on the sign of $\Delta PPS$. In an analogous manner, I measure $\ln \Delta RI$. The following two equations examine combined PPS and RI adjustments:

$$
(LN\Delta PPS_{it+1}) = \lambda_0 + \lambda_1 (e_{PPS, it}) + \lambda_2 (D_1 \ast e_{PPS, it}) + \lambda_3 (D_2 \ast e_{PPS, it}) + \lambda_4 (D_3 \ast e_{PPS, it})
+ F \text{ (other determinants of equity grants & CEO portfolio rebalancing,)}
+ e_{RI, it}, LN\Delta RI_{it+1}, Industry and Year controls)_{it} + \xi_{1it+1}
$$

(3)

$$
(LN\Delta RI_{it+1}) = \gamma_0 + \gamma_1 (e_{RI, it}) + \gamma_2 (D_1 \ast e_{RI, it}) + \gamma_3 (D_2 \ast e_{RI, it}) + \gamma_4 (D_3 \ast e_{RI, it})
+ G \text{ (other determinants of equity grants & CEO portfolio rebalancing,)}
+ e_{PPS, it}, LN\Delta PPS_{it+1}, Industry and Year controls)_{it} + \xi_{2it+1}
$$

(4)

where,

$LN\Delta PPS_{it+1} = \log(1+|\Delta PPS_{it+1}|)$ if $\Delta PPS_{it+1} \geq 0$, and $-\log(1+|\Delta PPS_{it+1}|)$ otherwise.

$LN\Delta RI_{it+1} = \log(1+|\Delta RI_{it+1}|)$ if $\Delta RI_{it+1} \geq 0$, and $-\log(1+|\Delta RI_{it+1}|)$ otherwise.

$D1 = 1$, when $e_{PPS, it} < 0$ and $e_{RI, it} \geq 0$; $D1=0$, otherwise;

$D2 = 1$, when $e_{PPS, it} \geq 0$ and $e_{RI, it} < 0$; $D2=0$, otherwise;

$D3 = 1$, when $e_{PPS, it} \geq 0$ and $e_{RI, it} \geq 0$; $D3=0$, otherwise;

In both equations, incentive adjustments and incentive deviations are in their relative forms. I use three dummy variables, $D_1$, $D_2$, and $D_3$, to differentiate among the four deviation types discussed in Section II, Hypothesis Development. For example, $D_1$ equals one when PPS is insufficient and RI excessive, and zero otherwise. In Eq. (3), the sum of coefficients, $\lambda_1 + \lambda_2$,
reflects the relation between combined PPS adjustments and PPS deviations in this scenario. In Eq. (3), I predict negative values of $\lambda_1$, $\lambda_1+\lambda_2$, $\lambda_1+\lambda_3$, and $\lambda_1+\lambda_4$. In Eq. (4), I predict $\gamma_1$ and $\gamma_1+\gamma_3$ to be negative, while $\gamma_1+\gamma_2$ and $\gamma_1+\gamma_4$ to be either negative or zero.\(^{13}\)

When testing the relation between combined PPS adjustments and PPS deviations in Eq. (3), I also control for the size of RI deviations and RI adjustments as well as other possible determinants of PPS adjustments. Likewise, in Eq. (4), the relation between combined RI adjustments and RI deviations is tested after controlling for PPS deviations, PPS adjustments, and other determinants. Other determinants of equity grants include firms’ financing constraints, the level of CEO pay, and stock-price performance. In addition, recent stock price performance, the ratio of stock price to option exercise price, and stock-return volatility, among other factors, are among the determinants of CEO portfolio rebalancing. I discuss these variables in section IV, empirical results. In Eqs. (3) and (4), I do not include variables that potentially control for CEO risk-aversion, such as CEO cash compensation or CEO age. According to Core and Guay (2000), if CEOs can rebalance their portfolio of total wealth when portfolio risk deviates from the contracted level, no risk adjustments are needed to value their portfolio changes.

After examining combined adjustments in Eqs. (3) and (4), I study how the combined effects are achieved by separately investigating the firm’s or the CEO’s adjustments.

\[
\begin{align*}
[\log(1+\text{New PPS grant})_{t+1}] & \quad \text{or} \quad [\pm \log(1+|\text{PPS adjustment by CEO}|)_{t+1}] \\
= p_0 + p_1 (e_{PPS, it}) + p_2 (D_1 e_{PPS, it}) + p_3 (D_2 e_{PPS, it}) + p_4 (D_3 e_{PPS, it}) \\
& + G(\text{Other Determinants, } e_{RI, it}, \text{ LN}\Delta R_{it+1}, \text{ Industry & Year controls})_{it} + \nu_{i, it+1}
\end{align*}
\]

\(^{13}\) Incentive deviations are measured at the beginning of the year. If adjustments occur later in the year, deviations are measured with errors. This EIV problem would bias the coefficients toward zero.
\[ \log(1 + \text{New RI grant})_{t+1} \quad \text{or} \quad -\log(1 + |\text{RI adjustment by CEO}|)_{t+1} \]

\[ = r_0 + r_1 (e_{RL, it}) + r_2 (D_1 * e_{RL, it}) + r_3 (D_2 * e_{RL, it}) + r_4 (D_3 * e_{RL, it}) \]

\[ + H(\text{Other Determinants}, e_{PPS, it}, \ln \Delta PPS_{it+1}, \text{Industry & Year controls})_{it} + \nu_{2, it+1} \]

(6)

Eq. (5) estimates firms’ or CEOs’ adjustment to PPS; Eq. (6) estimates firms’ or CEOs’ adjustments to RI. Since CEOs’ adjustment to PPS or RI can be negative, I use as dependent variables log of the absolute value of the adjustments plus one, and the variables take on the sign of the raw adjustments. Same as in Eqs. (3) and (4), both incentive adjustments and incentive deviations are in their relative forms, and the dummy variables, D_1, D_2, and D_3, differentiate among the four deviation types.

In my sample, 23% (27%) of firms make no equity (option) grants. Most CEOs (64%) do not exercise options, but an overwhelming majority (92.5%) adjusts their PPS through portfolio rebalancing each year. As a result, I estimate CEOs’ adjustments to PPS in an OLS model, and CEOs’ adjustments to RI, and the firm’s adjustments to PPS or RI in TOBIT models. My main predictions on coefficients of incentive deviations are summarized in table 1.

IV. Results

4.1 Evidence on the Estimated Optimal Levels of PPS and RI

I estimate Eq. (1) and Eq. (2) using individual annual regressions. For parsimony, the results from pooled cross-sectional and time-series models, with year indicator variables, are reported in table 3, with Column 1 summarizing the predicted signs for each of the coefficients based on prior studies. My findings show that the signs on coefficients are largely consistent with the predictions. PPS increases with CEO tenure and the proxy for free-cash flow problem,
and both incentives are positively related to firm size, cash compensation, and some proxies for
growth opportunities.\textsuperscript{14} For example, PPS is positively associated with changes in working
capital and investment expenditure (CAPEX), RI increases with investment expenditure and
R&D expenses. However, similar to the puzzling findings in Bizjak et al. (1993) and to the
industry-effect results in Himmelberg et al. (1999), I find PPS negatively related to R&D.

Table 4 summarizes CEO and firm characteristics for the four deviation types discussed in
Section II: (I) both incentives are insufficient (1,746 observations), (II) PPS is insufficient while
RI is excessive (2,738 observations), (III) PPS is excessive but RI is insufficient (1,241
observations), and (IV) both incentives are higher than their optimal levels (3,320 observations).
For the two deviation-types where RI is excessive, the mean price-to-strike ratio is 1.49 or 1.72.
When RI is insufficient, mean price-to-strike ratios are above two. This finding is consistent
with deep-in-the-money options providing insufficient RI. Firms are also more likely to reprice
CEO options that offer excessive RI. The percentage of firms that reprice CEO options are
higher in the categories that RI is too high (2.37\% or 2.05\%), compared with cases when RI is
too low (1.54\% or 1.12\%). Further, about 10\% of the CEOs in my sample hold no options.
These CEOs are almost exclusively categorized in type (I) and (III) where RI is insufficient. The
above evidence shows that my estimation models largely capture the conjectured characteristics
of the CEO portfolio holdings for each deviation types.

Table 4 also provides summary statistics of incentive adjustments by deviation types.
Consistent with the predictions in my hypotheses, the mean of annual combined PPS adjustments
is positive (negative) for CEOs with insufficient (excessive) PPS at the beginning of the year.

\textsuperscript{14} It is possible that RI is higher in growth firms because their CEOs accumulate the granted options. Growth
firms are more likely to use equity compensation due to their aggravated financing problems. I reestimate Eq.(2)
including proxies for cash, earnings, and dividend constraints. Unreported results show that log(1+RI) is still
positively related to proxies for growth opportunities.
and the mean of combined RI adjustments is also positive for CEOs with insufficient RI at the beginning of the year. However, the mean of combined RI adjustments is positive for CEOs with excessive RI, suggesting that excessive RI may not be easily reduced. In section 4.2, I provide regression-analysis results on incentive adjustments.

4.2 Evidence on the Four Hypotheses

I examine both combined and separate incentive adjustments by firms and CEOs. Results on combined adjustments, i.e., Eqs. (3) and (4), are reported in table 5, and those on separate adjustments, i.e., Eqs. (5) and (6), are in table 6. To be specific, in table 6, I present findings on firms’ adjustments to PPS (Columns 1 and 2), CEOs’ adjustments to PPS (Column 3), firms’ adjustments to RI (Columns 4 and 5), and CEOs’ adjustments to RI (Columns 6 and 7). Since Eq. (5) estimates either firms’ or CEOs’ adjustments to PPS, I use coefficient \( p_{\text{Firm}} \) to refer to firms’ PPS adjustments, and coefficient \( p_{\text{CEO}} \) corresponds to CEO’s adjustments. Similarly, in Eq. (6), \( r_{\text{Firm}} \) refers to firms’ adjustments to RI while \( r_{\text{CEO}} \) refers to CEO’s adjustments. For ease of interpretation, I report in both tables the sum of the coefficients on incentive deviations. For example, \((\lambda_1 + \lambda_2)\), instead of \(\lambda_2\), is reported.

Preliminary evidence from unreported correlation analysis supports my hypotheses; relative incentive deviations and relative adjustments are significantly negatively correlated. The Pearson correlation coefficient between PPS (RI) deviations and combined annual PPS (RI) adjustments is -0.19 (-0.36), significant with a p-value less than 0.0001 (0.0001). Furthermore, the negative relation holds after controlling for other determinants of equity grants and CEO portfolio rebalancing in table 5. In Columns 1 and 3 of the table, the coefficients on PPS and RI deviations are -1.35 and -0.21 respectively, both significant at a p-value less than 0.001. The –
0.21 coefficient on RI deviation indicate that a CEO whose RI is 10% below average receives a positive RI adjustment that is 2.1% higher than a CEO with an optimal level of RI.

The following four subsections present specific findings for each of the four deviation types discussed in Section II, Hypothesis Development. For each deviation type, I start with evidence on firms’ and CEOs’ combined adjustments; then I analyze how the combined effects are achieved by separately examining equity grants and CEO portfolio rebalancing.

### 4.2a Evidence on H1 (both incentives are below their optimal levels)

When both incentives are below their optimal levels, evidence in table 5 is consistent with combined adjustments increasing the incentives. Specifically, combined PPS adjustments are significantly negatively related to beginning-of-the-year PPS deviations, and combined RI adjustments bear the same relationship to RI deviations. Coefficients on PPS deviations and RI deviations are -0.65 (λ₁) and -0.25 (γ₁) respectively, both significant at p-values less than 0.005.

Table 6 presents separate adjustments by firms and CEOs. PPS grants are positively but insignificantly related to PPS deviations (p₁,Firm of 0.02), inconsistent with my prediction that CEOs with bigger PPS shortages receive more PPS grants. However, RI from equity grants is significantly negatively related to RI deviations (r₁,Firm of -0.20). Taken together, the evidence on equity grants is mixed. When examining CEOs’ portfolio rebalancing, I find that CEOs’ adjustments to PPS are negatively related to PPS deviations, just as their adjustments to RI are negatively related to RI deviations. Both p₁,CEO (-0.77) and r₁,CEO (-0.08) are significant at p-values less than 0.005. The evidence indicates that CEOs with larger incentive shortfalls keep more of the grants to increase their incentives. Since 73% of firms in this category make stock

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15 Zero incentive deviations are included in the excessive-incentive category. In my sample, no PPS deviation is zero, and only one RI deviation is zero. This treatment does not affect the results.
or option grants, and 72% make option grants only, my findings strongly indicate that the observed combined incentives adjustment is driven by CEOs’ retention of equity grants to increase their incentives. To summarize, I find firms’ and CEOs’ combined incentive adjustments increasing PPS and RI, consistent with hypothesis 1. The evidence on whether firms grant more equity (stock and options) to CEOs with larger incentive shortfalls is mixed. I find these CEOs increase their incentives by keeping more of the equity grants.

4.2b Evidence on H2 (PPS is insufficient and RI excessive relative to their target levels)

When PPS is insufficient and RI excessive relative to their target levels, my findings are consistent with that combined adjustments increase PPS but do not reduce excessive RI. Referring once again to Table 5, note that firms’ and CEOs’ combined PPS adjustments are significantly negatively related to beginning-of-the-year PPS deviations ($\lambda_1 + \lambda_2$ of -1.10). Combined RI adjustments are positively related to RI deviations ($\gamma_1 + \gamma_2$ of 0.30), but the relation is not significant.

When investigating separate adjustments by firms and CEOs in Table 6, I find that the observed combined PPS increase is due to firms granting equity to increase PPS and CEOs not fully undoing the increase through portfolio rebalancing. Specifically, in the two versions of Eq. (5), the two coefficients on PPS deviations ($p_{1,Firm} + p_{2,Firm}$ of -0.42 and $p_{1,CEO} + p_{2,CEO}$ of -0.71) are both significantly negative. When investigating RI adjustments in Eq. (6), I find RI from equity grants is positively related to RI deviations ($r_{1,Firm} + r_{2,Firm}$ of 0.85). This positive relation indicates that RI is increased as a result of firms granting options to increase PPS, a finding that is at odds with my prediction of restricted-stock grants. Since at-the-money option grants incur no accounting expense, firms often cite this treatment as the reason for their frequent use of
option compensation. My findings also indicate that CEOs reduce RI through option exercise, because the coefficient on RI deviations, $r_{1,CEO}+r_{2,CEO}$ of –0.88, is significantly negative at a p-value less 0.005. Since I found earlier that excessive RI is not reduced through combined adjustments, CEOs’ reduction of RI through option exercise is counteracted by an increase in RI from option grants. To recapitulate, I find supporting evidence for hypothesis 2 that firms grant equity to increase PPS, and CEOs exercise options to reduce RI. However, I find that firms use option grants, instead of restricted stock, to increase PPS.

4.2c Evidence on H3 (RI is below the optimal level but PPS excessive)

When PPS is excessive and RI is below the optimal level, combined annual PPS adjustments are significantly negatively related to beginning-of-the-year PPS deviations, and RI adjustments bear the same relationship to RI deviations. In Table 5, the coefficients on PPS and RI deviations are -2.82 ($\lambda_1+\lambda_3$) and -0.20 ($\gamma_1+\gamma_3$) respectively. My findings are consistent with PPS being reduced and RI increased.

Separate analysis of firms’ and CEOs’ incentive adjustments is consistent with firms using option grants to increase RI. Table 6 shows that RI from option grants is significantly negatively related to RI deviations ($r_{1,Firm}+r_{3,Firm}$ of -0.13). I also find CEOs reducing excess PPS through option exercise and stock sales (negative $p_{1,CEO}+p_{3,CEO}$ of –1.33). In addition, the evidence is consistent with CEOs dropping less RI through option exercise when they have a larger RI deficiency, because their RI adjustments are negatively related to RI deviations ($r_{1,CEO}+r_{3,CEO}$ of –0.09). To provide further evidence on CEO portfolio rebalancing, I re-estimate Eq. (6) with a different dependent variable, the number of options exercised divided by the total number of options held at the beginning of the year. Unreported results show that CEOs exercise a larger
number of deep-in-the-money options as their RI gets further below target. To summarize, my
evidence is consistent with hypothesis 3. I find that firms grant options to increase RI, and CEOs
exercise their deep-in-the-money options and sell stock to reduce PPS.

4.2d Evidence on H4 (both incentives are excessive)

When both incentives are above their optimal levels, the evidence in Table 5 is consistent
with reductions in excessive PPS with no corresponding decrease in excessive RI. Specifically,
combined PPS adjustments are significantly negatively related to PPS deviations ($\lambda_1 + \lambda_4$ of
-2.20). Combined RI adjustments is insignificantly related to RI deviations ($\gamma_1 + \gamma_4$ of 0.08).

When I separate CEOs’ and firms’ adjustments in Table 6, I find CEOs’ PPS adjustments
are significantly negatively related to PPS deviations, and the same relationship holds true for RI.
The coefficients, $p_{1,CEO} + p_{4,CEO}$ (-0.91) and $r_{1,CEO} + r_{4,CEO}$ (-0.86), are both significant at p-value
less than 0.005. The negative relations indicate that CEOs are reducing their excessive PPS and
RI by exercising options and selling stock. However, when examining equity grants, I find that
PPS grants are negatively related to PPS deviations, while RI grants are positively related to RI
deviations. This finding is inconsistent with my prediction that CEOs with excessive incentives
do not receive equity grants. Since I find no evidence that firms’ and CEOs’ combined RI
adjustments reduce excessive RI, it is likely that CEOs’ reduction to RI through option exercises
and firms’ increase to RI through new option grants cancel each other out. Overall evidence
supports hypothesis 4 that CEOs reduce excessive PPS and RI.

In Eqs. (3) to (6), I also control for other determinants of equity grants and/or CEO
portfolio rebalancing. Prior studies find that equity grants are determined by the level of CEO
pay, firm constraints, and stock-price performance. (see Matsunaga, 1995; Yermack, 1995; Core
and Guay, 1999; Murphy, 1999 for detailed discussions). I control for the level of pay by including proxies for firm size and growth opportunities. Firm size is measured as the log of sales. The proxies for firms’ growth opportunities, as defined in Section 3.2, include plant, and equipment (PP&E); changes in working capital; capital expenditures and acquisitions (CAPEX); and R&D expenditures (R&D). Consistent with CEOs in larger firms receiving higher pay, Columns 1 and 4 of Table 6 show positive coefficients on log(Sales). Coefficients on growth opportunity proxies in the PPS-grants estimation are positive, but they are insignificant when estimating RI grants.

I use four variables to proxy for different constraints faced by firms. Cash constraints in year t are measured as the three-year average of [(common and preferred dividends + cash flow used in investing activities – cash flow from operations)/market value of assets]. Interest coverage, or the ratio of interest expense to operating income before depreciation, is an inverse proxy for earnings constraints. Dividend constraints in year t are measured by a dummy variable equal to one if [(retained earnings at year-end + cash dividends and stock repurchases during the year)/the prior year’s cash dividends and stock repurchases] is less than two in the current or any of the previous two years. If the denominator is zero for all three years, the firm is also categorized as dividend constrained. Yermack (1995) and Dechow, Hutton, and Sloan (1996) find that the use of stock options is greater when firms have higher net operating loss carry-forwards. I use a dummy variable to indicate nonzero tax loss carry-forwards. In both tables 5 and 6, the signs on the coefficients of most of these variables are consistent with my predictions.

Firms may pay part of the CEO compensation with equity (Baber et al., 1996; Murphy, 1999). Similar to Core and Guay (1999), I control for the potential association between total CEO compensation and firm performance by including both the current year’s and the next
year’s stock returns. These returns also control for CEOs’ psychological biases in option exercise attributed to stock-price performance (e.g., Heath et al., 1999). As illustrated in Table 6, equity grants increase with stock returns (Columns 1 and 4). CEOs also reduce more PPS and RI through option exercises and stock sales when the stock price increases (Columns 3 and 6). Heath et al. (1999) find that CEOs tend to exercise their options early when their options are deep-in-the-money. I calculate the fraction of Black-Scholes value realizable as \[
\left(\frac{\text{year-end stock price} - \text{average exercise price of options held at year-end}}{\text{year-end Black-Scholes value per option held}}\right).
\] This variable is closer to one as options go deeper into the money. I predict and find a negative coefficient on this variable (both Columns 3 and 6 in Table 6), consistent with CEOs’ exercising more options and selling more stock when options are deeper-in-the-money.

**V. Sensitivity Analysis**

This section provides several sensitivity analyses designed to evaluate the robustness of my results. The results reported in section IV remain qualitatively unchanged.

**Tests over a Two-year Horizon.** Principal-agent theory does not predict how long it takes for the incentive deviations to be corrected. To investigate whether corrections are more complete in a longer window, I test my hypotheses in a subsample of CEOs who remain in their positions for at least two years after the fiscal year-end when the deviations are measured. All 1999 observations are dropped because 2001 data are not available. The sample size shrinks from 7,054 to 4,746 observations. I report results on combined two-year adjustments in Columns 1 and 3 of table 7A. The coefficients on incentive deviations are more negative than those in the one-year estimation (table 5), and \(R^2\) improves. The results are consistent with incentive deviations being further adjusted to the optimal levels in the second year. I report
results from Eqs. (5) and (6), i.e., separate adjustments by the firm and the CEO in table 7B. They are similar to those from the annual estimation except for the following. When both incentives fall short of the optimal levels, my findings are consistent with firms granting more PPS (RI) over the next two-years to CEOs with bigger PPS (RI) shortfalls.

**The Flexibility in Excess-Incentive Reduction.** Restrictions may limit CEOs’ ability to reduce excessive incentives. For example, CEOs cannot exercise their unvested options to reduce RI; nor can they sell their restricted stock to reduce PPS. The following variables are inverse proxies for the severity of these restrictions:

\[
V_{\text{EST}_{\text{PPS}}} = \frac{(1 + \text{PPS from Vested Options and Unrestricted Stock})}{(1 + \text{PPS from Unvested Options and Restricted Stock})},
\]

\[
V_{\text{EST}_{\text{RI}}} = \frac{(1 + \text{RI from Vested Options})}{(1 + \text{RI from unvested options})}.
\]

I re-estimate Eq. (3) and Eq. (4) by including \(V_{\text{EST}_{\text{PPS}}} \) and \(V_{\text{EST}_{\text{RI}}} \) as interaction terms with their respective incentive deviations. The results are reported in Columns 2 and 4 of table 7A. I find that CEOs with excessive RI subsequently reduce more of the excess when they hold more vested options. However, for CEOs with excessive PPS, the coefficient on the interaction term is insignificant, indicating that restrictions are not binding for reducing excessive PPS. This may be explained by CEOs’ flexibility to reduce excessive PPS by selling their unrestricted stock. In my sample, CEOs have large unrestricted stock holdings. The ratio of shares of restricted stock to total shares held has a mean (median) of 9.68% (0%).

**The Subsample of CEOs with option holdings.** As revealed in table 4, CEOs without options are nearly all classified into the insufficient RI types. To investigate whether the observed negative relation between combined RI adjustments and RI deviations is driven by
these observations, I re-estimate all equations in the subsample of CEOs with options. Results
(Column 5 of table 7A) are robust to this procedure.

**Alternative Standard Errors.** If regression residuals are positively correlated across firms
or within firms, the standard errors of the coefficients in the pooled time-series cross-section
regression are understated and the t-statistics are overstated. To address the potential cross-
sectional dependence in the error terms, I use Fama-MacBeth (1973) regression procedures to
estimate Eq. (3) and Eq. (4) annually and assess the significance of the time-series mean
coefficient using the standard errors of the annual coefficients. My results are robust to this
procedure. To address the potential time-series correlation in the regression residuals, I
randomly select one observation for each firm, and test my hypotheses on this subsample. I find
a negative relation between subsequent combined PPS (RI) adjustments and PPS (RI) deviations.

**Alternative Specifications – Rank Regressions and Firm-Effects Regressions.** As
indicated in table 4, the number of positive RI deviations (6,058) exceeds the number of negative
RI deviations (2,987). When regression residuals are not normally distributed, OLS estimates
are inefficient but still consistent. To address this problem, I re-estimate the optimal RI levels
and RI adjustments with the ranked values of all variables except for dummy variables. The
qualitative inference from this estimation is consistent with the results reported in Tables 6 and 7.
Himmelberg et al. (1999) find that CEO ownership is also determined by unobservable firm
characteristics. I re-estimate all equations using a firm fixed-effects specification. For each
grant year \( t+1 \), I obtain beginning-of-the-year’s incentive residuals by estimating a pooled, time-
series regression using observations from all the years up to and including year \( t \). The inference
from these results is similar to those reported earlier.
**Alternative Performance measures.** Jensen and Murphy (1990) and Yermack (1995) measure PPS as the dollar change in CEO-wealth for a $1,000-change in a firm’s equity market value. Analogously, RI can be measured as the change in CEO-wealth for a $1,000-change in the volatility of a firm’s equity market value. Hereafter I denote them by $\text{PPS}_{JM}$ and $\text{RI}_{JM}$. Baker and Hall (1998) argue that the preferable measure depends on how CEO actions are assumed to affect firm value. If a CEO’s marginal product is invariant with firm size, the strength of CEO incentives is determined by the Jensen-Murphy measures. If CEO marginal product scales up perfectly with firm size, the strength of CEO incentives is determined by the CEO’s dollar holdings, i.e., the measures in my reported results. Baker and Hall (1998) find that CEO marginal product increases at a decreasing rate with firm size, and the elasticity is approximately 0.4 when size is measured as the firm’s market value of equity. Based on their findings, I construct another set of incentive measures as $\text{PPS}_{JM}^*(\text{Equity market value})^{0.4}$ and $\text{RI}_{JM}^*(\text{Equity market value})^{0.4}$. Inferences from results based on these alternative incentive measures are similar to my reported results except for the following. First, under both sets of measures, for CEOs with excessive RI, combined RI adjustments are significantly negatively related to RI deviations. The relation is insignificantly positive in my reported results. Second, under the Baker and Hall measures, I find PPS (RI) from new equity grants negatively related to PPS (RI) deviations when both incentives are insufficient.  

**Alternative Incentive Estimation - A Certainty-equivalent Approach** I estimate CEO incentives in section 3.1 by the Black-Scholes (1973) model, which assumes that option holders can fully diversify the riskiness in option payoff. This assumption does not apply to CEOs because they invest their financial wealth and human capital heavily in their employer firms. To

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16 Baker and Hall (1998) find that the elasticity of $\gamma$ with respect to equity market value (sales) is 0.4 (0.3). When I estimated $\gamma$ by $(\text{Sales})^{0.3}$ in the constructed Baker and Hall measures, the results are similar.
test directly whether my results are robust to a risk-aversion assumption, I re-estimate CEOs’ incentives from their stock and option holdings using a certainty-equivalent approach, same as that in Lambert et al. (1991). Under the approach, I make specific assumptions of CEOs’ coefficient of relative risk aversion. Appendix B describes details of this estimation procedure. The inference based on this procedure is similar to my reported main results, i.e., firms and CEOs jointly correct deviations from optimal PPS and RI levels. In addition, I find that, compared with Black-Scholes model (1973), this alternative procedure leads to minor changes in the ranking of PPS, but it changes the ranking of RI significantly. The rank correlation coefficient between RI estimated by Black-Scholes model (1973) and that based on the certainty-equivalent approach is only 0.82, while that between the two types of PPS measures is 0.98.

VI. Conclusions

This paper examines how firms and CEOs jointly maintain optimal levels of two portfolio equity incentives, pay-for-performance sensitivity (PPS) and risk-taking incentive (RI). I include both equity grants and CEO portfolio rebalancing decisions as incentive-adjusting mechanisms, and hypothesize that the firm and the CEO jointly correct both PPS and RI incentive deviations. Overall, the empirical findings support my hypotheses.

I provide evidence on four types of incentive deviations based on a broad sample of 9,045 CEO-year observations from 1992 to 1999. My findings are consistent with the following scenarios. In the first type of deviations, where both PPS and RI are insufficient, firms’ and CEOs’ combined adjustments increase both incentives. Second, when PPS is too low and RI too high, combined adjustments increase PPS, but do not reduce RI. The no-change in RI is due to firms’ option grants, so CEOs’ reduction of RI through option exercise is countered by option
grants. Third, when PPS is too high and RI too low, firms grant options to increase RI and CEOs reduce their PPS by exercising their deep-in-the-money options and selling stock. And fourth when both PPS and RI are too high, CEOs decreases these incentives by option exercises and stock sales. Results from sensitivity analysis are analogous.

This paper provides more comprehensive evidence than prior research on the maintenance of optimal incentive. First, I ask a broader question that captures the simultaneous maintenance of both optimal PPS and RI levels. Second, I examine two incentive-adjusting mechanisms, equity grants and CEO portfolio rebalancing decisions. Prior research only focuses on equity grants. Third, I use relative incentive deviations to measure the degree of departure from optimal levels, as opposed to the absolute deviations used in prior research. I argue that the relative measure better captures the severity of incentive misalignment. As a final contribution, this paper extends our understanding of CEO incentives by analyzing the dynamics and imperfections in the incentive-adjusting process. I find that incentive adjustments are more complete over a two-year horizon than in an annual window. When CEOs hold a larger proportion of vested options, they tend to reduce more of their excess RI. Based on my findings, a fruitful avenue for future research is to explore how the (temporary) misalignment of incentives influences firms’ investment decisions and performance.
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Appendix A. Calculation of PPS and RI

I first discuss the calculation of PPS and RI from CEOs’ equity (stock and options) holdings at the end of each fiscal year. Then I describe the estimation of adjustments to PPS and RI through equity grants and CEO portfolio rebalancing in the next year.

1. Estimating year-end PPS and RI from CEOs’ stock and option holdings

At each fiscal year-end, pay-for-Performance Sensitivity (PPS) is measured as the change in the dollar value of a CEO's firm-specific equity (stock and option) portfolio for a 1% change in the firm's stock price. Risk-taking incentive (RI) is calculated as the change in the dollar value of a CEO’s firm-specific equity portfolio for a 0.01 change in firm's stock-return volatility. Formally, let the CEO’s firm-specific wealth be

\[ W = n_s S + n_c C \]

where,

- \( n_s \) = Number of shares of common stock owned;
- \( n_c \) = Number of stock options owned;
- \( S \) = Stock price;
- \( C \) = Value of a call option on one share of stock.

Based on the Black-Scholes formula (1973) for valuing European call options, as modified by Merton (1973) to account for dividend payouts, PPS and RI can be calculated as:

- \( PPS_s = \text{PPS from common-stock holdings} = \frac{n_s S}{100} \)
- \( PPS_c = \text{PPS from stock-option holdings} = \frac{n_c \Delta S}{100} \)
- \( RI \approx \text{RI from stock-option holdings} = n_c e^{-dt} N'(Z) S \sqrt{T} * 0.01 \)

where,

- \( \Delta = \frac{\partial C}{\partial S} = e^{-dt} N'(Z) \)
- \( Z = \frac{\ln (S/X) + T (r- d + \sigma^2/2)}{\sigma \sqrt{T}} \)
- \( N \) = cumulative probability function for the normal distribution
- \( X \) = exercise price of the option
- \( \sigma \) = Expected stock return volatility over the life of the option
- \( r \) = log of risk-free interest rate
- \( T \) = time to maturity in years
- \( d \) = log of expected dividend yield over the life of the option

Both \( n_s \) and \( S \) are available in the ExecuComp database, so PPS from stock holdings is year-end stock value multiplied by 1%. Based on Core and Guay (1998), I calculate PPS and RI from option holdings at the fiscal year-end as the sum of

a) PPS or RI from current year’s new equity grants measured at the end of fiscal year. All parameters to the Black-Scholes formula are provided by the database.

b) PPS or RI from unexercisable options, excluding current year’s option grants. I subtract the number and the in-money amount of current year’s grant from the total number and the total realizable value of in-the-money unexercisable options. When the number of option grants exceeds the total number of unexercisable options, the number and the realizable value of exercisable options are reduced by the excess number and the excess realizable value.

c) PPS or RI from exercisable options.

I proxy for expected stock-return volatility and expected dividend yield by ExecuComp’s historical volatility and dividend yield. Risk-free rate is estimated by the treasury bond yield corresponding to the option’s remaining time-to-maturity. I assume that the maturity of unexercisable (exercisable) options is one (three) years less than the maturity of options granted in the current year. When no options are
granted to the CEO in the current year, I use the average maturity of options granted to other executives in
the same firm. When none of the executives receive options, I use nine (six) years as the maturity of
unexercisable (exercisable) options.

2. Estimating PPS and RI provided by new equity (stock and option) grants
To calculate PPS and RI from new option grants, the following parameters to the Black-Scholes
formula are readily available from ExecuComp database: (1) number of options granted, (2) grant-day
price, (3) exercise price, and (4) maturity. In addition, I estimate expected stock-return volatility,
expected dividend yield, and the risk-free rate the same as in the above section.

PPS from the restricted-stock grants is the dollar value granted multiplied by 1%, and the dollar value
is provided by the ExecuComp database. I set RI from restricted stock grants to zero, because they
provide little risk-taking incentives.

3. Estimating PPS and RI adjustments made by the CEOs in the second year
Decrease (increase) in PPS or RI is codes negative (positive). I separately calculate incentive
adjustments due to option exercise and due to stock ownership changes. I assume that the options
exercised are from the previous year-end’s exercisable options. To calculate changes to PPS and RI due
to the options exercised, the only missing parameter to the Black-Scholes formula is the market price at
which these options are exercised. The ExecuComp provides the number (NUMBER) and realized value
(VALUE) of the options exercised. If K1 is the average exercise price of those exercisable options, the
average market price at which options are exercised can be estimated as

\[
\text{VALUE} \, / \, \text{NUMBER} \, + \, K1;
\]

when the number of option exercise exceeds exercisable options, I assume the excess come from
unexercisable options. Let K2 be the average exercise price of unexercisable options, and the average
market price at which the options are excised is

\[
(\text{VALUE} \, + \, K1 \times \text{(number of exercisable options)} \, + \, \\
K2 \times (\text{VALUE} \, - \, \text{(number of exercisable options)})) \, / \, \text{NUMBER};
\]

CEOs may retain or sell the stock acquired upon option exercise, or sell or purchase stock independent
of option exercise. The change in the number of stock owned during the year can be calculated as

\[
(\text{Shares owned})_{t+1} - (\text{Shares owned})_{t} - \text{(number of restricted stock granted)}_{t+1}.
\]

ExecuComp only provides the value of restricted stock granted as of the date of the grant (RSTKGRNT),
but not the number of grants. Since restricted stock is usually granted with options, I divide the granted
dollar value by the market price on the option-grant day to estimate the number of restricted stock
granted. When no options are granted or when the grant-day market price is missing, I use the average of
stock prices at the beginning and the end of the year. To calculate PPS adjustments through the change in
CEOs’ stock holdings, I multiply the change in the CEO’s stock holding by the estimated average price at
which options are exercised.

4. Combining the CEO’s and the firm’s adjustments.
Let \( \Delta \text{PPS} \) and \( \Delta \text{RI} \) be the combined changes to PPS and RI by shareholders and the CEO over the
course of the second year

\[
\Delta \text{PPS}_{t+1} = (\text{PPS from equity grants})_{t+1} + (\text{CEO’s Adjustments to PPS})_{t+1},
\]

\[
\Delta \text{RI}_{t+1} = (\text{RI from equity grants})_{t+1} + (\text{CEO’s Adjustments to RI})_{t+1}.
\]
Appendix B. A Certainty-equivalent Approach to Estimate CEO Incentives

I only use the certainty-equivalent approach to re-estimate incentives from CEOs’ portfolio holdings, not their incentive adjustments. Under the certainty-equivalent approach, I make the following assumptions:

1. A CEO’s utility function is $U(X) = 1/(1-a)X^{1-a}$. The CEO’s coefficient of relative risk aversion, $a$, is constant. I consider $a$ ranging between 0.5 and 4.0.

2. $S$ represents stock price in $T$ years. Stock return in $T$ years is lognormally distributed with volatility $\sigma$ and expected value $(\mu - \sigma^2/2)T$. I assume $\mu$ to be 0.10 and $\sigma$ to be 0.30.

3. The CEO’s entire wealth consists of three components, one unrelated to firm performance with a value $W$, $m$ shares of stock with total value of $mS$, and $n$ stock options with payoff function $nZ(S)$.

I define the value of $n$ stock options to the CEO as $C$, so that the CEO is indifferent between this amount and the uncertain payoff $nZ(S)$, given the composition of the remainder of his wealth. Formally, $C$ is the solution to the equation,

$$\int U(W + mS + nZ(S)) f(S) dS = \int (W + mS + C) f(S) dS$$

Where, $U(X) = 1/(1-a)X^{1-a}$;

$Z(S) = \text{Max}(0, S-K)$, $K$ is option exercise price.

Since risk-averse CEOs also value their stock holdings lower than the stock’s market value, I define $H$, the value of both stock and option holdings to CEOs, as,

$$\int U(W + mS + nZ(S)) f(S) dS = \int (W + H) f(S) dS$$

The following equations calculate incentives provided by CEOs’ stock and option holdings.

$$PPS = (\partial H / \partial S) * (S/100)$$

$$RI = (\partial C / \partial \sigma) * (0.01)$$
Appendix C. Definition of Variables

CEO INCENTIVE VARIABLES

PPS  Pay-for-performance sensitivity, defined as the change in the dollar value of a CEO’s firm-specific equity portfolio for a 1 percent change in the firm’s stock price.

RI  Risk-taking incentive, defined as the change in the dollar value of a CEO’s firm-specific equity portfolio for a 0.01 change in the firm’s stock-return volatility.

\[ \Delta PPS = \text{Firm’s adjustment to PPS (through equity grants)} + \text{CEO’s adjustments to PPS}. \]

\[ \Delta RI = \text{Firm’s adjustment to RI (through equity grants)} + \text{CEO’s adjustments to RI}. \]

\[ \ln \Delta PPS = \pm \log(1 + |\Delta PPS|). \] The variable takes on the sign of \( \Delta PPS \), which can be positive, negative, or zero.

\[ \ln \Delta RI = \pm \log(1 + |\Delta RI|). \] The variable takes on the sign of \( \Delta RI \), which can be positive, negative, or zero.

FIRM CHARACTERISTICS

Market Value of Assets  = book value of debt + market value of equity.

Free-cash-flow problem  = \([(\text{Operating cash flow} - \text{common and preferred dividends})/\text{Market value of assets}],
when \( \text{MTB} < 1 \); or 0, when \( \text{MTB} \geq 1 \).

Interest coverage  = Interest expense/Operating income before depreciation.

Net Operating Loss  = 1 if net operating loss carry forward is non-zero in the current or any of the two previous years, and 0 otherwise.

Cash constraint  = 3 years’ average of \([\text{(common and preferred dividends} + \text{cash flow used in investing activities - cash flow from operations})/\text{Market value of assets}].

Dividend Constraint  = 1, if \([\text{(Retained earnings} + \text{cash dividend and stock repurchases})/(\text{prior year’s cash dividend and stock repurchases}) \leq 2 \text{ in the current or any of the two previous years or if the denominator is zero for all three years}. \) Dividend Constraint, equals 0 otherwise.

PROXIES FOR GROWTH OPPORTUNITIES

\[ \Delta (\text{Working Capital}) \] Changes in working capital, scaled by market value of assets.

CAPEX  The sum of capital expenditure and acquisitions, scaled by market value of assets.

R&D  R&D expenditures, scaled by market value of assets.

RDUM  Dummy variable equal to 1 when R&D expense is missing, and 0 otherwise.

PP&E  Property, plant, and equipment, scaled by market value of assets.

CEO CHARACTERISTICS

Fraction of Black-Scholes Value Realizable  
\[ [(\text{year-end stock price} - \text{Average exercise price of options held at year-end})/\text{year-end Black-Scholes value per option held}] \]
Table 1  
Summary of Hypotheses and  
Predictions on Signs of Coefficients of Incentive Deviations in Eqs. (3), (4), (5) and (6)  

| Type of Deviations | Predictions | Combined $\Delta$PPS (Eq. 3) | $\Delta$PPS By Firm | $\Delta$PPS By CEO | Combined $\Delta$RI (Eq. 4) | $\Delta$RI By Firm | $\Delta$RI By CEO |
|--------------------|-------------|--------------------------|-----------------|------------------|--------------------------|----------------|----------------|
| I                  | Both PPS and RI are insufficient | $\lambda_1$ | $p_1$ | $\gamma_1$ | $r_1$ | $\lambda_1 + \lambda_2$ | $p_1 + p_2$ | $\gamma_1 + \gamma_2$ | $r_1 + r_2$ |
| PPS                | RI          | - | - | $-/0$ | - | - | $-/0$ | $0$ | $-/0$ |
| II                 | PPS is insufficient and RI too high | $\lambda_1 + \lambda_3$ | $p_1 + p_3$ | $\gamma_1 + \gamma_3$ | $r_1 + r_3$ | $\lambda_1 + \lambda_4$ | $p_1 + p_4$ | $\gamma_1 + \gamma_4$ | $r_1 + r_4$ |
| PPS                | RI          | - | $+/-$ | - | - | - | $-/0$ | $0$ | $-/0$ |
| III                | PPS is excessive and RI insufficient | $\lambda_1 + \lambda_4$ | $p_1 + p_4$ | $\gamma_1 + \gamma_4$ | $r_1 + r_4$ | $\lambda_1 + \lambda_2$ | $p_1 + p_2$ | $\gamma_1 + \gamma_2$ | $r_1 + r_2$ |
| PPS                | RI          | - | $0$ | - | $-/0$ | $0$ | $-/0$ | $0$ | $-/0$ |
## Table 2A
Descriptive Statistics

| Variables                                      | N     | Skewness | Mean  | Median | Std. Dev. | Min.   | Q1     | Q3     | Max     |
|------------------------------------------------|-------|----------|-------|--------|-----------|--------|--------|--------|---------|
| **CEO INCENTIVE VARIABLES**                   |       |          |       |        |           |        |        |        |         |
| PPS t ($1,000)                                 | 9,045 | 7.39     | 488.96| 129.53 | 1,382.19  | 0.14   | 47.04  | 367.31 | 18,374.20|
| RI t ($1,000)                                  | 9,045 | 4.58     | 61.63 | 24.66  | 112.66    | 0.00   | 7.60   | 63.09  | 1,136.54|
| ∆PPS t+1 ($1,000)                              | 7,054 | -0.08    | 5.47  | 4.59   | -1,171.14 | -2.50  | 20.77  | 1,449.63|
| ∆RI t+1 ($1,000)                               | 7,054 | 5.52     | 22.48 | 5.55   | 56.21     | -37.74 | 0.00   | 19.45  | 581.12  |
| PPS from Equity Grants t+1 ($1,000)            | 7,054 | 7.91     | 32.15 | 9.19   | 81.21     | 0.00   | 0.88   | 27.77  | 1,360.90|
| RI from Equity Grants t+1 ($1,000)             | 7,054 | 5.22     | 25.31 | 6.71   | 58.98     | 0.00   | 0.00   | 21.80  | 583.89  |
| CEO’s Adjustmt. to PPS t+1 ($1,000)            | 7,054 | -5.89    | -30.35| -0.42  | 133.69    | -1,521.87 | -18.82 | 0.72   | 370.14  |
| CEO’s Adjustmt. to RI t+1 ($1,000)             | 7,054 | -7.21    | -2.67 | 0.00   | -129.65   | -6.22  | 0.00   | 0.00   | 0.00    |
| **FIRM CHARACTERISTICS**                      |       |          |       |        |           |        |        |        |         |
| SALES t ($1,000)                               | 9,045 | 4.06     | 2,909 | 832.06 | 5,520     | 4.04   | 315.38 | 2,493.50| 52,345  |
| Mkt. Value of Asset t ($1,000)                 | 9,045 | 6.40     | 6,143 | 1,408.92| 15,097    | 64.31  | 545.23 | 4,585.61| 190,688 |
| ∆(Working Capital) t                           | 9,045 | -0.49    | 0.01  | 0.05   | -0.25     | -0.01  | 0.03   | 0.03   | 0.19    |
| CAPEX t                                        | 9,045 | 2.02     | 0.06  | 0.05   | 0.06      | 0.001  | 0.03   | 0.08   | 0.35    |
| R&D t                                          | 9,045 | 3.13     | 0.02  | 0.00   | 0.03      | 0.00   | 0.02   | 0.02   | 0.22    |
| PP&E t                                         | 9,045 | 0.99     | 0.25  | 0.18   | 0.21      | 0.002  | 0.08   | 0.37   | 0.92    |
| Free-Cash-Flow Problem t (%)                   | 9,045 | 4.52     | 0.22  | 0.00   | 2.69      | -10.99 | 0.00   | 0.00   | 31.48   |
| Net Operating Loss t                           | 7,054 | 1.10     | 0.26  | 0.00   | 0.44      | 0.00   | 1.00   | 1.00   | 1.00    |
| Cash Constraint t                              | 7,054 | 0.90     | 0.01  | 0.01   | 0.04      | -0.11  | -0.01  | 0.03   | 0.19    |
| Dividend Constraint t                          | 7,054 | 0.57     | 0.36  | 0.00   | 0.48      | 0.00   | 1.00   | 1.00   | 1.00    |
| Interest Coverage t                            | 7,054 | 1.94     | 0.14  | 0.10   | 0.16      | -0.99  | 0.03   | 0.20   | 1.68    |
| Log(stock-return volatility) t                 | 9,045 | 0.78     | 0.31  | 0.30   | 0.12      | 0.11   | 0.22   | 0.38   | 0.92    |
| Stock Return t+1 (%)                           | 7,054 | 2.49     | 21.68 | 12.95  | 54.02     | -77.38 | -9.19  | 39.42  | 554.46  |
| **CEO CHARACTERISTICS**                       |       |          |       |        |           |        |        |        |         |
| CEO Tenure t (Year)                            | 9,045 | 1.25     | 8.03  | 6.32   | 6.05      | 0.82   | 3.44   | 10.82  | 25.03   |
| Cash Compensation t ($1,000)                   | 9,045 | 2.48     | 949.51| 709.77 | 768.98    | 2.22   | 443.68 | 1,150.00| 6,790.00|
| Fraction of Black-Scholes Value Realizable t   | 7,054 | -0.05    | 0.46  | 0.49   | 0.33      | 0.00   | 0.11   | 0.75   | 1.00    |

Variables are defined in Appendix C.
### Table 2B
Correlation Matrix (Eqs. 1 and 2)
Pearson Correlation Coefficients
(Prob > |r| under H0: Rho=0)

|                      | log (Mkt. Value of Assets)$_t$ | log(Stock-return Volatility)$_t$ | ∆(Working Capital)$_t$ | (CAPEX)$_t$ | (R&D)$_t$ | (PP&E)$_t$ | (FCF Problem)$_t$ | (CEO Tenure)$_t$ | (Cash Comp.)$_t$ |
|----------------------|--------------------------------|----------------------------------|------------------------|-------------|-----------|-----------|------------------|------------------|-----------------|
| log(Stock-return Volatility)$_t$ | -0.48                          |                                  |                        |             |           |           |                  |                  |                 |
| (∆(Working Capital)$_t$ | -0.02                          | 0.06                             |                        |             |           |           |                  |                  |                 |
| (CAPEX)$_t$           | -0.08                          | -0.05                            | -0.11                  | <.0001      |           |           |                  |                  |                 |
| (R&D)$_t$             | -0.22                          | 0.34                             | -0.12                  | -0.10       | <.0001    | <.0001    | (Free-Cash-Flow Problem)$_t$ |                  |                 |
| (PP&E)$_t$            | 0.10                           | -0.35                            | -0.14                  | 0.38        | -0.26     |           |                  |                  |                 |
| (CEO Tenure)$_t$      | -0.01                          | 0.001                            | 0.03                   | 0.05        | -0.01     | 0.02      |                  |                  |                 |
| (Cash Compensation)$_t$ | 0.62                          | -0.27                            | -0.004                 | -0.04       | -0.10     | -0.09     | 0.01             | 0.09             |                 |
| log(1+PPS)$_t$        | 0.42                           | 0.06                             | 0.11                   | -0.11       | -0.04     | -0.40     | 0.02             | 0.33             | 0.42            |

Variables are defined in Appendix C.
### Table 2C
Correlation Matrix (Eqs. 3 and 4)
Pearson Correlation Coefficients
(Prob > |r| under H0: Rho=0)

|                         | log(Sales)$_t$ | (Net Operating Loss)$_t$ | (Cash Constraint)$_t$ | (Dividend Constraint)$_t$ | (Interest Coverage)$_t$ | (Stock Return)$_{t+1}$ | (Stock Return)$_t$ | (BSVR)$_t$ | (R&D)$_t$ | (CAPEX)$_t$ |
|-------------------------|---------------|--------------------------|-----------------------|---------------------------|------------------------|----------------------|------------------|------------|-----------|------------|
| (Net Operating Loss)$_t$| -0.12 ( <.0001) |                         |                       |                           |                        |                      |                  |             |            |            |
| (Cash Constraint)$_t$   | -0.24 (<.0001) | 0.07 (<.0001)            |                       |                           |                        |                      |                  |             |            |            |
| (Dividend Constraint)$_t$| -0.33 (<.0001) | 0.19 (<.0001)            | 0.16 (<.0001)         |                          |                        |                      |                  |             |            |            |
| (Interest Coverage)$_t$| 0.19 (<.0001)  | 0.03 (0.004)             | 0.15 ( <.0001)        | 0.03 (0.03)               |                        |                      |                  |             |            |            |
| (Stock Return)$_{t+1}$ | -0.10 (<.0001) | 0.04 (0.02)              | -0.001 (<.0001)       | 0.09 ( <.0001)            | -0.05 ( <.0001)        |                      |                  |             |            |            |
| (Stock Return)$_t$      | -0.09 (<.0001) | 0.04 (0.02)              | -0.13 (<.0001)        | 0.08 ( <.0001)            | -0.13 ( <.0001)        | 0.05 ( <.0001)       |                  |             |            |            |
| Fraction of Black-Scholes Value Realizable (BSVR)$_t$ | 0.09 (<.0001) | -0.001 (<.0001) | -0.12 (<.0001) | -0.04 (<.0001) | -0.16 (<.0001) | 0.016 (0.18) | 0.41 (<.0001) |
| (R&D)$_t$               | -0.27 (<.0001) | 0.17 (<.0001)            | 0.08 (<.0001)         | 0.16 (<.0001)             | -0.22 (<.0001)        | 0.16 (<.0001)      | -0.07 (<.0001) | -0.02 (0.12) |
| (CAPEX)$_t$             | 0.01 (0.35)   | -0.003 (<.0001)          | 0.38 (<.0001)         | -0.03 (<.0001)            | 0.14 ( <.0001)        | -0.04 (-.0003)     | -0.19 (<.0001) | -0.12 (<.0001) | -0.10 (<.0001) |
| Δ(Working Capital)$_t$  | -0.05 (<.0001) | 0.006 (0.58)             | -0.02 (0.08)          | 0.04 (0.002)              | -0.06 (<.0001)        | -0.02 (<.0001)     | 0.20 (0.18)     | 0.12 (<.0001) | -0.11 (<.0001) | -0.12 (<.0001) |

Variables are defined in Appendix C.
Table 3

Estimating Optimal Levels of PPS and RI

Optimal PPS and RI are estimated with 9,045 CEO-year observations from 1992 to 1999. Equations (1) and (2) are estimated annually in a two-stage least squares model, with the estimation of PPS being the first stage. For parsimony, I report results a pooled cross-sectional and time-series model with seven year dummies. Fifty-four dummy variables corresponding to the two-digit SIC codes are included. Intercept terms and coefficients on dummy variables are not reported. T-statistics are reported in the parentheses. Predicted signs on the coefficients are in Columns 1 and 3. Residuals from the two equations, $\epsilon_{PPS}$ and $\epsilon_{RI}$, are the estimated incentive deviations at the end of each fiscal year.

$$\log (1 + PPS)_{it} = \alpha_0 + \alpha_1 \log(Mkt. \ value \ of \ Assets)_{it} + \alpha_2 \log(Stock\-return \ Volatility)_{it} + \alpha_3 (PP&E)_{it} + \alpha_4 (\Delta Working \ Capital)_{it} + \alpha_5 (CAPEX)_{it} + \alpha_6 (R&D)_{it} + \alpha_7 (RDUM)_{it} + \alpha_8 (Free\-Cash\-Flow \ Problem)_{it} + \alpha_9 (CEO \ Tenure)_{it} + \alpha_{10} (Cash \ Compensation)_{it} + Industry \ Dummies + \epsilon_{PPS,it}$$  

(1)

$$\log (1 + RI)_{it} = \beta_0 + \beta_1 \log(1+PPS)_{it} + \beta_2 \log(Mkt. \ value \ of \ Assets)_{it} + \beta_3 (PP&E)_{it} + \beta_4 (\Delta Working \ Capital)_{it} + \beta_5 (CAPEX)_{it} + \beta_6 (R&D)_{it} + \beta_7 (RDUM)_{it} + \beta_8 (Cash \ Compensation)_{it} + Industry \ Dummies + \epsilon_{RI,it}$$  

(2)

| Predicted Sign | log(1+PPS) | Predicted Sign | log(1+RI) |
|----------------|------------|----------------|-----------|
| (1)            | (2)        | (3)            | (4)       |
| log(Mkt. value of Assets)$_{it}$ | + | 0.55 | + | 0.62 |
| PP&E$_{it}$ | - | -2.98 | - | -2.74 |
| (ΔWorking Capital)$_{it}$ | + | 1.19 | + | 0.66 |
| CAPEX$_{it}$ | + | 1.79 | + | 5.50 |
| R&D$_{it}$ | + | -4.05 | + | 8.40 |
| RDUM | - | 0.04 | - | -0.03 |
| Cash Compensation$_{it}$ | + | 1.76E-4 | +/- | 0.001 |
| CEO Tenure$_{it}$ | + | 0.08 | | |
| (Free-Cash-Flow Problem)$_{it}$ | + | 1.20 | | |
| log(Stock-return Volatility)$_{it}$ | +/- | 2.41 | | |
| log(1+PPS)$_{it}$ | + | | | -0.45 |
| Adj. R$^2$ | | 0.57 | | 0.22 |
Table 4
Characteristics of Each Incentive-Deviation Category

This table summarizes the characteristics of CEO holdings for four deviation categories: (I) both incentives are insufficient, (II) PPS is too low and RI too high, (III) PPS is too high and RI too low, and (IV) both incentives are too high. The classification is based on results from estimating Eqs. (1) and (2).

|                | I e_{PPS,t} < 0 & e_{RL,t} < 0 | II e_{PPS,t} < 0 & e_{RL,t} >= 0 | III e_{PPS,t} >= 0 & e_{RL,t} < 0 | IV e_{PPS,t} >= 0 & e_{RL,t} >= 0 |
|----------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|
| Firm & CEO’s Portfolio Characteristics in Year t (9,045 Observations) | 1,746                            | 2,738                            | 1,241                            | 3,320                            |
| Number of Observations                          | 1,746                            | 2,738                            | 1,241                            | 3,320                            |
| Number of CEOs without options                | 502                              | 1                                | 442                              | 2                                |
| Number (percent) of firms that reprice their CEO options | 27 (1.54%)                      | 65 (2.37%)                       | 14 (1.12%)                       | 68 (2.05%)                       |
| Mean of options’ price-to-strike ratios at year-end | 2.12                             | 1.49                             | 2.89                             | 1.72                             |
| Mean stock return t (%)                        | 15.23                            | 14.16                            | 28.71                            | 24.84                            |
| Percentage of firms with negative stock returns in the year (%) | 38.67                           | 41.82                            | 30.73                            | 33.51                            |
| Pearson correlation coefficient between e_{PPS,t} and e_{RL,t} (p-value) | 0.38 (< 0.0001)                   | 0.05 (0.01)                      | -0.30 (< 0.0001)                | 0.21 (< 0.0001)                  |
| Incentive Adjustments in Year t+1 (7,054 Observations) |                                  |                                  |                                  |                                  |
|Mean (Std. Dev.) of ∆PPS t+1 ($)                      | 19,605                           | 10,009                           | -31,758                          | -2,802                           |
|Mean (Std. Dev.) of firm’s PPS Adjustments            | (99,807)                        | (63,991)                        | (205,863)                       | (158,320)                       |
|Mean (Std. Dev.) of CEO’s PPS Adjustments            | 31,267                           | 23,885                           | 32,651                           | 38,362                           |
|Mean (Std. Dev.) of ∆RI t+1 ($)                       | 24,817                           | 16,688                           | 22,891                           | 25,663                           |
|Mean (Std. Dev.) of Firm’s RI Adjustments             | (61,859)                        | (34,663)                        | (66,025)                        | (62,177)                        |
|Mean (Std. Dev.) of CEO’s RI Adjustments             | 26,245                           | 19,474                           | 24,224                           | 29,233                           |
|Mean (Std. Dev.) of ∆RI t+1 ($)                       | 22,891                           | 16,688                           | 24,224                           | 29,233                           |
|Mean (Std. Dev.) of Firm’s RI Adjustments             | (66,025)                        | (36,545)                        | (67,980)                        | (65,257)                        |
|Mean (Std. Dev.) of CEO’s RI Adjustments             | -1,428                           | -2,785                           | -1,333                           | -3,570                           |
|Variable Definitions |                                  |                                  |                                  |                                  |
| e_{PPS,t} | = PPS deviation at the end of year t |
| e_{RL,t}  | = RI deviation at the end of year t |
|Options’ price-to-strike ratio | = (Stock price / option portfolio’s average strike price), where, average strike price = [Stock price – (total realizable value of in-the-money options / total number of options held)]. |
|∆PPS t+1  | = Combined PPS adjustments by firms and CEOs. |
|∆RI t+1   | = Combined RI adjustments by firms and CEOs. |
Table 5
Determinants of Firms’ and CEOs’ Combined Incentive Adjustments

The sample consists of 7,054 CEO-year observations from 1992 to 1999. T-statistics are presented in the parentheses, and calculated using White’s heteroskedasticity-consistent standard errors. Intercept terms and coefficients on fifty-four industry dummies and seven year-dummies are not reported.

$$(\text{LN} \Delta \text{PPS}_{it+1}) = \lambda_0 + \lambda_1 (e_{\text{PPS}, it}) + \lambda_2 (D_1 * e_{\text{PPS}, it}) + \lambda_3 (D_2 * e_{\text{PPS}, it}) + \lambda_4 (D_3 * e_{\text{PPS}, it}) + \lambda_5 \log(\text{Sales})_it + \lambda_6 (\text{R&D})_it + \lambda_7 (\text{CAPEX})_it + \lambda_8 (\Delta \text{Working Capital})_it + \lambda_9 (\text{RDUM})_it + \lambda_{10} (\text{Net Operating Loss})_it + \lambda_{11} (\text{Cash Constraint})_it + \lambda_{12} (\text{Dividend Constraint})_it + \lambda_{13} (\text{Interest Coverage})_it + \lambda_{14} (\text{Stock Return})_it + \lambda_{15} (\text{Stock Return})_it + \lambda_{16} \log(\text{stock-return volatility})_it + \lambda_{17} (\text{Fraction of Black-Scholes Value Realizable})_it + \lambda_{18} (e_{\text{RI}, it}) + \lambda_{19} (\text{LN}\Delta\text{RI})_{it+1} + \text{Industry and Year controls} + \zeta_{1it+1} \quad (3)$$

$$(\text{LN}\Delta\text{RI}_{it+1}) = \gamma_0 + \gamma_1 (e_{\text{RI}, it}) + \gamma_2 (D_1 * e_{\text{RI}, it}) + \gamma_3 (D_2 * e_{\text{RI}, it}) + \gamma_4 (D_3 * e_{\text{RI}, it}) + \gamma_5 \log(\text{Sales})_it + \gamma_6 (\text{R&D})_it + \gamma_7 (\text{CAPEX})_it + \gamma_8 (\Delta \text{Working Capital})_it + \gamma_9 (\text{RDUM})_it + \gamma_{10} (\text{Net Operating Loss})_it + \gamma_{11} (\text{Cash Constraint})_it + \gamma_{12} (\text{Dividend Constraint})_it + \gamma_{13} (\text{Interest Coverage})_it + \gamma_{14} (\text{Stock Return})_it + \gamma_{15} (\text{Stock Return})_it + \gamma_{16} \log(\text{stock-return volatility})_it + \gamma_{17} (\text{Fraction of Black-Scholes Value Realizable})_it + \gamma_{18} (e_{\text{PPS}, it}) + \gamma_{19} (\text{LN}\Delta\text{PPS})_{it+1} + \text{Industry and Year controls} + \zeta_{2it+1} \quad (4)$$

| Explanatory Variables | Predicted Sign | PPS Adjustments - Eq. (1) | Predicted Sign | RI Adjustments - Eq. (1) |
|-----------------------|----------------|---------------------------|----------------|--------------------------|
| **Hypothesis Variables – PPS Deviations** | | | | |
| $\lambda_1$ | - | **-1.35** | +/- | 0.28 | 0.59 |
| | | (16.24) | (4.89) | (1.72) | (2.86) |
| $\lambda_1 + \lambda_2$ | - | **-1.10** | | |
| | | (4.32) | | |
| $\lambda_1 + \lambda_3$ | - | **-2.82** | | |
| | | (9.33) | | |
| $\lambda_1 + \lambda_4$ | - | **-2.20** | | |
| | | (9.85) | | |
| **Hypothesis Variables – RI Deviations** | | | | |
| $\gamma_1$ | +/- | 0.08 | 0.06 | - | **-0.25** |
| | | (18.48) | (13.00) | (19.82) | | |
| $\gamma_1 + \gamma_2$ | -/0 | -/0 | -/0 | 0.30 | |
| | | | | (1.17) | |
| $\gamma_1 + \gamma_3$ | - | - | - | **-0.20** | |
| | | | | (-18.91) | |
| $\gamma_1 + \gamma_4$ | -/0 | -/0 | -/0 | **0.08** | |
| | | | | (0.38) | |
| **Control Variables for the Level of CEO Pay** | | | | |
| $\log(\text{Sales})_it$ | + | 0.02 | 0.02 | + | 0.01 | 0.02 |
| | | (2.83) | (2.43) | (0.99) | (1.23) | |
| $\text{R&D}_it$ | + | 1.86 | 1.85 | + | -1.27 | -1.09 |
| | | (5.32) | (5.29) | (-1.87) | (-1.59) | |
| $\text{CAPEX}_it$ | + | 0.24 | 0.27 | + | -0.46 | -0.39 |
| | | (1.49) | (1.68) | (-1.47) | (-1.25) | |

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Table 5 (continued)  
Determinants of Firms’ and CEOs’ Combined Adjustments

| Explanatory Variables | Predicted Sign | PPS Adjustments - Eq. (1) | Predicted Sign | RI Adjustments - Eq. (1) |
|-----------------------|----------------|---------------------------|----------------|--------------------------|
|                       |                | (1)                       |                | (2)                      | (3)                       | (4)                       |
| (ΔWorking Capital) it  | +              | -0.12                     | -0.16          | +                        | -0.54                     | -0.51                     |
|                       |                | (-0.76)                   | (-1.02)        |                          | (-1.83)                   | (-1.75)                   |
| (RDUM) it             | -              | -0.004                    | 0.004          | -                        | 0.03                      | 0.02                      |
|                       |                | (-0.18)                   | (0.19)         |                          | (0.68)                    | (0.55)                    |
| **Control Variables for Constraints Faced by the Firm** | | | | | | |
| (Net Operating Loss) it | +          | 0.03                       | 0.03           | +                        | 0.01                      | 0.01                      |
|                       |                | (1.38)                    | (1.41)         |                          | (0.30)                    | (0.26)                    |
| (Cash Constraint) it  | +              | 0.01                       | 0.02           | +                        | 0.28                      | 0.30                      |
|                       |                | (0.03)                    | (0.07)         |                          | (0.68)                    | (0.73)                    |
| (Dividend Constraint) it | +            | 0.02                       | 0.02           | +                        | 0.10                      | 0.10                      |
|                       |                | (0.92)                    | (0.97)         |                          | (2.76)                    | (2.81)                    |
| (Interest Coverage) it | -              | 0.12                       | 0.12           | -                        | -0.13                     | -0.14                     |
|                       |                | (2.32)                    | (2.31)         |                          | (-1.33)                   | (-1.40)                   |
| **Control Variables for Firm Performance and CEO Option-Exercising Behavior** | | | | | | |
| (Stock Return) it+1   | +/-           | -0.001                     | -0.001         | +/-                      | 0.001                     | 0.001                     |
|                       |                | (-9.60)                   | (-9.40)        |                          | (4.72)                    | (4.76)                    |
| (Stock Return) it     | +/-           | -1.32E-4                   | -1.24E-4       | +/-                      | -2.15E-4                  | -2.02E-4                  |
|                       |                | (-0.80)                   | (-0.75)        |                          | (-0.67)                   | (-0.63)                   |
| Log(stock-return volatility) it | - | -0.57                       | -0.57          | -                        | 0.32                      | 0.31                      |
|                       |                | (-5.54)                   | (-5.52)        |                          | (1.61)                    | (1.55)                    |
| (Fraction of Black-Scholes Value Realizable) it | - | -0.28                       | -0.28          | -                        | 0.25                      | 0.26                      |
|                       |                | (-9.87)                   | (-9.53)        |                          | (4.46)                    | (4.64)                    |
| **Controlling for Adjustments to the Other Incentive** | | | | | | |
| (LNΔRI) it+1          | +             | 0.13                       | 0.13           |                          |                          |                          |
|                       |                | (22.20)                   | (21.89)        |                          |                          |                          |
| (LNΔPPS) it+1        | +             | 0.50                       | 0.50           |                          |                          |                          |
|                       |                | (22.22)                   | (22.19)        |                          |                          |                          |
| Number of Obs.        |                | 7,054                      | 7,054          |                          | 7,054                     | 7,054                     |
| Adj. R²              |                | 0.18                       | 0.19           |                          | 0.15                      | 0.16                      |

Variable Definitions:

D1 = 1, when ePPS, it < 0 and eRI, it >= 0;  D1=0, otherwise;
D2 = 1, when ePPS, it >=0 and eRI, it < 0;  D2=0, otherwise;
D3 = 1, when ePPS, it >=0 and eRI, it >= 0;  D3=0, otherwise.
RDUM = 1 if R&D expense is missing, and 0 otherwise.
LNΔPPS it+1 = ± log (1+|combined PPS adjustment by firm and by CEO|) it+1. The variable takes on the sign of the combined PPS adjustment, which can be positive, negative, or zero.
LNΔRI it+1 = ± log (1+|combined RI adjustment by firm and by CEO|) it+1. The variable takes on the sign of the combined RI adjustment, which can be positive, negative, or zero.
Both (ePPS, it) and (LNΔPPS) it+1 are scaled by (1+log(1+PPSit)).
Both (eRI, it) and (LNΔRI) it+1 are scaled by (1+log(1+RIit)).
Other variables are defined in Appendix C.
## Table 6

Determinants of Separate Incentive Adjustments by Firms or by CEOs

The sample consists of 7,054 CEO-year observations. Eq. (5A) and Eq. (5B) separately estimate firms’ or CEOs’ adjustments to PPS; Eq. (6A) and Eq. (6B) separately estimate firms’ or CEOs’ adjustments to RI. I run Eq. (5B) in an OLS model, and t-statistics are calculated using White’s heteroskedasticity-consistent standard errors. I run other equations using TOBIT analysis, and t-statistics are based on maximum likelihood standard errors. Intercept terms and coefficients on fifty-four industry dummies and seven year-dummies are not shown. I report t-statistics in parentheses. Predicted signs on the coefficients are presented in the columns to their left.

\[
\log(1 + \text{PPS from equity grants})_{it+1} = p_{0,Firm} + p_{1,Firm}(e_{PPS,it}) + p_{2,Firm}(D_1*e_{PPS,it}) + p_{3,Firm}(D_2*e_{PPS,it}) + p_{4,Firm}(D_3*e_{PPS,it}) + \text{Control Var.} + \nu_{1,it+1} \quad (5A)
\]

\[
\pm \log(1 + |\text{PPS adjustments by CEO}|)_{it+1} = p_{0,CEO} + p_{1,CEO}(e_{PPS,it}) + p_{2,CEO}(D_1*e_{PPS,it}) + p_{3,CEO}(D_2*e_{PPS,it}) + p_{4,CEO}(D_3*e_{PPS,it}) + \text{Control Var.} + \nu_{2,it+1} \quad (5B)
\]

\[
\log(1 + \text{RI from equity grants})_{it+1} = r_{0,Firm} + r_{1,Firm}(e_{RI,it}) + r_{2,Firm}(D_1*e_{RI,it}) + r_{3,Firm}(D_2*e_{RI,it}) + r_{4,Firm}(D_3*e_{RI,it}) + \text{Control Var.} + \nu_{3,it+1} \quad (6A)
\]

\[
-\log(1 + |\text{RI adjustment by CEO}|)_{it+1} = r_{0,CEO} + r_{1,CEO}(e_{RI,it}) + r_{2,CEO}(D_1*e_{RI,it}) + r_{3,CEO}(D_2*e_{RI,it}) + r_{4,CEO}(D_3*e_{RI,it}) + \text{Control Var.} + \nu_{4,it+1} \quad (6B)
\]

| Explanatory Variables | **PPS ADJUSTMENTS** | | | **RI ADJUSTMENTS** | | |
|-----------------------|---------------------|-----------------|-------------------|---------------------|-----------------|
|                       | by Firm (Eq. 5A)    | by CEO (Eq. 5B) | by Firm (Eq. 6A) | by CEO (Eq. 6B)     |
|                       | Estimate (1)        | Marginal (2)    | OLS (3)          | Estimate (4)        | Marginal (5)    |
|                       |                     |                  |                   | Estimate (6)        | Marginal (7)    |
| **Hypothesis Variables – PPS Deviations** | | | | | |
| \(p_1(e_{PPS,it})\)  | \(-0.02\) (0.28)   | \(-0.02\) (0.28) | \(-0.77\) (5.79) | \(0.78\) (2.90)    | \(0.48\) (2.94) |
| \(p_1 + p_2\)        | \(-0.42\) (-3.28)  | \(-0.38\) (-3.28) | \(-0.71\) (2.81) | \(-0.38\) (-2.81)  | \(-0.71\) (2.81) |
| \(p_1 + p_3\)        | \(+/-\) (-10.24)   | \(-1.63\) (-4.46) | \(-1.33\) (-4.46) | \(-1.63\) (-4.46)  | \(-1.33\) (-4.46) |
| \(p_1 + p_4\)        | 0 (6.74)           | \(-0.70\) (-6.74) | \(-0.91\) (-4.13) | \(-0.70\) (-6.74)  | \(-0.91\) (-4.13) |
| **Hypothesis Variables – RI Deviations** | | | | | |
| \(r_1(e_{RI,it})\)   | \(+/-\) (33.45)    | 0.09 (3.34)     | 0.09 (3.34)      | \(-0.20\) (-12.81) | \(-0.12\) (-12.81) |
| \(r_1 + r_2\)        | 0 (2.58)           | 0.52 (2.58)     | 0.52 (2.58)      | \(-0.08\) (-5.11)  | \(-0.08\) (-5.11) |
| \(r_1 + r_3\)        | \(-\) (-9.84)     | \(-0.08\) (-6.66) | \(-0.08\) (-6.66) | \(-0.08\) (-6.66)  | \(-0.08\) (-6.66) |
| \(r_1 + r_4\)        | 0 (2.08)           | 0.33 (2.08)     | 0.33 (2.08)      | \(-0.86\) (-5.03)  | \(-0.86\) (-5.03) |
| **Control Variables for Firm Performance and CEO Option-Exercising Behavior** | | | | | |
| Stock Return \(_{it+1}\) | + 0.0004 (4.00)   | 0.0004 (4.00)   | 0.0004 (4.00)   | + 0.0002 (6.00)    | 0.0002 (6.00)   |
| Stock Return \(_{it}\)  | + 0.0002 (2.00)   | 0.0002 (2.00)   | 0.0002 (2.00)   | + 0.001 (6.00)     | 0.001 (6.00)    |
Table 6 (continued)

| Explanatory Variables | PPS Adjustments by Firm (Eq. 5A) | PPS Adjustments by CEO (Eq. 5B) | RI Adjustments by Firm (Eq. 6A) | RI Adjustments by CEO (Eq. 6B) |
|------------------------|----------------------------------|----------------------------------|---------------------------------|---------------------------------|
| Log(stock-return volatility)$_{it}$ | -0.30 | (-3.23) | -0.70 | (4.86) |
| Fraction of Black-Scholes Value Realizable$_{it}$ | -0.27 | (-9.57) | -0.71 | (-15.59) |

**Control Variables for the Level of CEO Pay**

| log(Sales)$_{it}$ | 0.03 | 0.03 | -0.02 | 0.04 | 0.03 | -0.03 | -0.02 |
|-------------------|------|------|-------|------|------|-------|-------|
| R&D$_{it}$ | 0.99 | 0.89 | -0.25 | -0.15 |
| CAPEX$_{it}$ | -0.04 | -0.03 | -0.66 | -0.41 |
| ΔWorking capital$_{it}$ | 0.21 | 0.19 | 0.01 | -0.01 |
| (RDUM)$_{it}$ | -0.01 | -0.01 | -0.01 | -0.01 |

**Control Variables for Constraints Faced by the Firm**

| Net operating loss$_{it}$ | -0.02 | -0.02 | -0.02 | -0.01 |
|---------------------------|-------|-------|-------|-------|
| Cash constraint$_{it}$ | 0.17 | 0.15 | 0.73 | 0.45 |
| Dividend constraint$_{it}$ | -0.01 | -0.01 | 0.11 | 0.07 |
| Interest coverage$_{it}$ | -0.13 | -0.12 | -0.50 | -0.30 |

**Controlling for Adjustments to the Other Incentive**

| (LNΔRI)$_{it+1}$ | 0.17 | 0.16 | 0.03 | 0.60 | 0.37 | 0.31 | 0.21 |
|-------------------|------|------|------|------|------|------|------|
| (LNΔPPS)$_{it+1}$ |      |      |      |      |      |      |      |

# of obs. 7,054 7,054 7,054 7,054
Adj. R$^2$ 0.11
Log Likelihood -2,811.82 -10,751.01 -4,980.24
Variable Definitions

\[ D_1 = \begin{cases} 1, & \text{if } e_{\text{PPS},it} < 0 \text{ and } e_{\text{RI},it} \geq 0; \\ 0, & \text{otherwise}; \end{cases} \]
\[ D_2 = \begin{cases} 1, & \text{if } e_{\text{PPS},it} \geq 0 \text{ and } e_{\text{RI},it} < 0; \\ 0, & \text{otherwise}; \end{cases} \]
\[ D_3 = \begin{cases} 1, & \text{if } e_{\text{PPS},it} \geq 0 \text{ and } e_{\text{RI},it} \geq 0; \\ 0, & \text{otherwise}. \end{cases} \]

In Eq. (5B), the dependent variable, \([\pm \log(1+|\text{CEO adjustments to PPS}|)_{it+1}\]), takes on the sign of the CEO’s adjustment to PPS.

I scale \((e_{\text{PPS},it})\), the dependent variables in both Eq. (5A) and Eq. (5B), and \((\ln \Delta \text{PPS})_{it+1}\) by \((1+\log(1+\text{PPS}_{it}))\).

I scale \((e_{\text{RI},it})\), the dependent variables in both Eq. (6A) and Eq. (6B), and \((\ln \Delta \text{RI})_{it+1}\) by \((1+\log(1+\text{RI}_{it}))\).

Other variables are defined in Appendix C.
Table 7A

Sensitivity Analysis on Firms’ and CEOs’ Combined Adjustments

I report results on three sensitivity analyses: (1) two-year’s combined incentive adjustments (Columns 1 and 3), (2) restrictions on excessive-incentive reduction (Columns 2 and 4), and (3) on the subsample only including CEOs with option holdings (Column 5). In the third test, I re-estimate Eqs. (1)-(4), and only report results from Eq. (4). t-statistics are reported in the parentheses, and are calculated using White’s heteroskedasticity-consistent standard errors. Coefficients on the hypothesis variables and on some selected control variables are shown.

\[
\begin{align*}
(LN\Delta PPS_{it+1}) &= \lambda_0 + \lambda_1 (ePPS, it) + \lambda (Other\ Determinants\ of\ Equity\ Grants\ and\ CEO\ Portfolio\ Rebalancing) + \lambda_2 (LN\Delta RRI_{it+1}) + \lambda (Industry\ & Year\ controls) + \xi_2it+1 \\
(LN\Delta RRI_{it+1}) &= \gamma_0 + \gamma_1 (eRI, it) + \gamma (Other\ Determinants\ of\ Equity\ Grants\ and\ CEO\ Portfolio\ Rebalancing) + \gamma_2 (ePPS, it) + \gamma_3 (LN\Delta PPS_{it+1}) + \gamma (Industry\ & Year\ controls) + \zeta_2it+1
\end{align*}
\]

| Dependent Variables | Predicted Sign | (LN\Delta PPS)_{t+1} | Predicted Sign | (LN\Delta RRI)_{t+1} |
|---------------------|----------------|----------------------|----------------|----------------------|
| (1)                 |                | (2)                  | (3)            | (4)                  | (5)                  |
| **Hypothesis Variables** |                |                      |                |                      |                      |
| (ePPS, it)          | -              | -1.09                | +/-            | -0.44                | 0.17                 | 0.49                 |
|                     | (-6.74)        | (-5.81)              | (-1.73)        | (1.62)               | (5.48)               |
| (DP * ePPS, it)     | +/-            | -1.96                | -1.73          | (-5.83)              | (-6.55)              |
| (VESTPPS * DP * ePPS, it) | -          | -2.12E-8             |                |                      |                      |
| (eRI, it)           | +/-            | 0.07                 | 0.07           | -0.35                | -0.06                | -0.08                |
|                     | (12.80)        | (15.83)              | (-26.33)       | (-13.34)             | (-3.54)              |
| (DR * eRI, it)      | +/-            | 0.54                 | 0.19           | 1.93                 | 1.71                 | -1.26                |
| (VESTRI * DR * eRI, it) | -              | -0.08                |                |                      |                      |
| (LN\Delta RRI)_{t+1} | +            | 0.13                 |                |                      |                      |
| (LN\Delta RRI)_{2-yr} | +            | 0.08                 |                |                      |                      |
| (LN\Delta PPS)_{t+1} | +              | 0.39                 |                |                      |                      |
| (LN\Delta PPS)_{2-yr} | +              | 0.40                 |                |                      |                      |
| Number of Obs.      | 4,746          | 7,054                | 4,746          | 7,054                | 6,387                |
| Adj. R^2            | 0.21           | 0.18                 | 0.22           | 0.16                 | 0.22                 |

**Variable Definitions**

- DP = 1, if \(ePPS, it \geq 0\); DP = 0, otherwise.
- DR = 1, if \(eRI, it \geq 0\); DR = 0, otherwise.
- LN\Delta PPS_{t+1} = ± log \{ |combined PPS adjustments| \}_{t+1}. The variable takes on the sign of the adjustments.
- LN\Delta RRI_{t+1} = ± log \{ |combined RI adjustments| \}_{t+1}. The variable takes on the sign of the adjustments.
- LN\Delta PPS_{2-yr} = ± log \{ sum of combined PPS adjustments in (t+1) and (t+2) \}. The variable takes on the sign of the adjustments.
- LN\Delta RRI_{2-yr} = ± log \{ sum of combined RI adjustments in (t+1) and (t+2) \}. The variable takes on the sign of the adjustments.
- VESTPPS = \{ 1 + PPS from vested options and unrestricted stock \} / \{ 1 + PPS, from unvested options and restricted stock \}.
- VESTRI = \{ 1 + RI, from vested options \} / \{ 1 + RI, from CEOs’ unvested options \}.
- I scale PPS deviations and PPS adjustments (both LN\Delta PPS_{t+1} and LN\Delta PPS_{2-yr}) by \{ 1 + log(1 + PPS_{it}) \}.
- I scale RI deviations and RI adjustments (both LN\Delta RRI_{t+1} and LN\Delta RRI_{2-yr}) by \{ 1 + log(1 + RI_{it}) \}.

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Determinants of PPS and RI from two-year’s Equity Grants

The sample consists of 4,746 CEO-year observations from 1992 to 1999. Eq. (5) estimates the sum of PPS from two-year’s equity grants, and Eq. (6) estimates the sum of RI from two-year’s equity grants. I use TOBIT models to analyze both equations. t-statistics are reported in parentheses, and are based on maximum likelihood standard errors. Intercept terms and coefficients on fifty-four industry dummies and seven year-dummies are not shown. I only report coefficients on the hypothesis variables and on some selected control variables.

\[
\begin{align*}
\log (1 + \text{Sum of PPS from (t+1)'s and (t+2)'s equity grants}) &= p_0 + p_1 (e_{PPS, it}) + p_2 (D_1 e_{PPS, it}) + p_3 (D_2 e_{PPS, it}) + p_4 (D_3 e_{PPS, it}) + \text{Control Var.} + \nu_{t+1} \quad (5) \\
\log (1 + \text{Sum of RI from (t+1)'s and (t+2)'s equity grants}) &= r_0 + r_1 (e_{RI, it}) + r_2 (D_1 e_{RI, it}) + r_3 (D_2 e_{RI, it}) + r_4 (D_3 e_{RI, it}) + \text{Control Var.} + \nu_{t+1} \quad (6)
\end{align*}
\]

### Dependent Variables

| Explaining Variables | Predicted | Sign | TOBIT (1) | Marginal (2) | Predicted | Sign | TOBIT (3) | Marginal (4) |
|----------------------|-----------|------|-----------|--------------|-----------|------|-----------|--------------|
| **Hypothesis Variables – PPS Deviations** | | | | | | | | |
| \( p_1 (e_{PPS, it}) \) | - | -0.59 | -0.58 | +/- | 1.44 | 0.98 |
| \( p_1 + p_2 \) | - | -0.88 | -0.87 |
| \( p_1 + p_3 \) | +/- | -2.32 | -2.28 |
| \( p_1 + p_4 \) | 0 | -1.23 | -1.21 |
| **Hypothesis Variables – RI Deviations** | | | | | | | | |
| \( r_1 (e_{RI, it}) \) | +/- | 0.09 | 0.09 | - | -1.11 | -0.75 |
| \( r_1 + r_2 \) | 0 | 0 | -0.42 | -0.28 |
| \( r_1 + r_3 \) | - | 0 | -0.93 | -0.63 |
| \( r_1 + r_4 \) | 0 | 0 | -0.83 | -0.57 |
| **Selected Control Variables** | | | | | | | | |
| \( \text{LN}\Delta PPS_{2-yr} \) | + | 0.11 | 0.11 | (38.54) | | | |
| \( \text{LN}\Delta RI_{2-yr} \) | + | 0.27 | 0.18 | (8.88) | | | |
| # of obs. | 4,746 | 4,746 |
| Log Likelihood | -327.69 | -7,567.93 |

**Variable Definition**
- \( D_1 = 1, \) if \( e_{PPS, it} < 0 \) and \( e_{RI, it} \geq 0; \) \( D_1 = 0, \) otherwise;
- \( D_2 = 1, \) if \( e_{PPS, it} \geq 0 \) and \( e_{RI, it} < 0; \) \( D_2 = 0, \) otherwise;
- \( D_3 = 1, \) if \( e_{PPS, it} > 0 \) and \( e_{RI, it} \geq 0; \) \( D_3 = 0, \) otherwise.
- \( \text{LN}\Delta PPS_{2-yr} = \pm \log (1 + | \text{sum of combined PPS adjustments in (t+1) and (t+2) } |). \) The variable takes on the sign of the adjustments.
- \( \text{LN}\Delta RI_{2-yr} = \pm \log (1 + | \text{sum of combined RI adjustments in (t+1) and (t+2) } |). \) The variable takes on the sign of the adjustments.
- I scale PPS deviations and \( \text{LN}\Delta PPS_{2-yr} \) by \( (1 + \log (1 + \text{PPS}_{it}) \), and scale RI deviations and \( \text{LN}\Delta RI_{2-yr} \) by \( (1 + \log (1 + \text{RI}_{it}) \).
- Other variables are defined in Appendix C.