Changes in CEO Stock Option Grants: A Look at the Numbers

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Abstract

We study changes in the number of CEO stock option grants. Motivated by evidence of rigidity in stock option grants, we first provide a detailed description of the main aggregate trends in CEO stock option grants. We then consider the cross-sectional heterogeneity in option-granting activity and examine observable factors which may lead boards of directors to revise their option grants. We find that CEOs of firms with unusual investment patterns subsequently receive fewer stock options as part of their compensation packages. CEOs who hold exercisable deeply-in-the-money options (overconfident CEOs) also receive fewer stock options in subsequent periods. Our results suggest that boards use evidence of high or low investment to learn about CEO preferences and traits. These insights can inform theoretical discussion on the topic of option granting behavior and, more broadly, on the board's re-contracting process.

Keywords: stock option grants, corporate investment, CEO overconfidence

JEL Classifications: G30, G32, J33, M41, M52

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1. Introduction

Recent evidence on the number of option grants shows a high degree of rigidity, with nearly 20% of new option grants containing the same number of options as the previous year's grant (Shue and Townsend 2017). This degree of rigidity in the number of options awarded, combined with rapidly increasing equity prices and a lack of offsetting changes to other forms of compensation, suggests that boards do not always adjust compensation towards a target valuation. In light of these facts, in this paper we examine changes in the number of CEO stock option grants and whether corporate investment decisions can predict such changes over time.

The number of stock option grants is central to executive compensation. Under current NYSE listing requirements, companies need to obtain shareholders' approval for the total number of options granted. In addition, although boards may be able to (and often try to) estimate the market value of executive option grants, the only variable over which they can actually exercise control is the number of options granted. The rigidity in the number of options grants has also been used as one an explanation for the rise in CEO pay since the 1990s (Murphy 2013, Shue and Townsend 2017), which has attracted significant public and investor criticism.

Despite the importance of the number of option grants in executive pay, we currently know relatively little about boards' option granting behavior. Most of the literature on options focuses on the value of options as the outcome variable. This stream of the literature suggests that option pay dynamically adjusts to optimal levels over time (Core and Guay 1999) and that adjustments are more pronounced following periods of aggressive accounting, i.e., earnings restatements (Cheng and Farber 2008). However, since changes in the value of options may be driven by changes in stock prices rather than changes in option grants, option value alone does not offer clear insights on the actual number of option grants awarded. Our paper fills a gap in this literature by examining how the number of option grants changes over time and the extent that such changes are associated with corporate investment. Regarding changes in the number of options, the most direct evidence suggests that some degree of number rigidity exists. This evidence leads to a natural question: do boards grant the same number of options to CEOs each year or do they revise their granting behavior? To answer this question, we first provide a detailed description of the main aggregate trends in CEO stock option grants, and then move on to study boards' option granting behavior by examining factors that predict changes in stock option grants.

New empirical facts about changes in option grants are valuable for future theoretical and empirical research on executive compensation. A universal assumption in agency theory is that the principal (i.e., boards and shareholders) knows the preferences of the CEO (e.g. risk preferences, biases, or career concerns). The principal designs an optimal compensation contract to align the CEO's interests with those of shareholders, subject to some informational or contractual constraints (for a review of the literature, see Edmans and Gabaix (2016)).[1] However, in practice principals may not know CEOs' preferences, which may explain the use of standardized compensation contracts (Ross 2004). Such standardized contracts may explain a certain degree of number rigidity in option grants. Conversely, some theories predict that rational principals learn about CEO preferences from the decisions CEOs make (such as investment decisions) and then dynamically adjust compensation parameters accordingly (see e.g. Gibbons and Murphy (1992)). In this case, learning about CEO preferences implies that compensation structures are changing,

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[1] Most of the existing research on CEO compensation contracts is based on or inspired by variations of the standard principal-agent model with moral hazard, in which a CEO makes decisions that are not fully observable (effort or project choice; see e.g. Ross (1973) and Holmstrom (1979)). As a key element of equity-based compensation, stock options are intended to align manager and shareholder interests, and mitigate managerial risk-aversion to induce an optimal level of investment and risk (Lambert, Larcker, and Verrecchia 1991; Smith and Watts 1992; Gaver and Gaver 1993; Baber, Kang, and Kumar 1998; Guay 1999; Bryan, Hwang, and Lilien 2000; Banker, Huang and Natarajan 2011).

andCEOs' investment decisions predict future changes in compensation parameters.[2] Thus, one the one hand, contractual simplicity and standardization favor rigid compensation contracts, while, on the other hand, learning about CEO preferences and traits leads to compensation parameters that change over time. Consistent with this tension, we find that, despite some evidence of short-term rigidity, the number of options granted changes frequently, and such changes are predictable.

In a sample of large US firms from 1992 to 2013, we measure annual changes in stock option grants as a percentage of total shares outstanding; for simplicity, we refer to this variable as the number of stock option grants. We find that, on average, the number of option grants to CEOs changes over time, and that such changes can be predicted by both past corporate investment decisions and CEO characteristics. Using an empirical model to define high and low investment in capital expenditures and R&D as the part of such investments that is not predicted by firm characteristics, we find that "abnormal" levels of investment predict future changes in stock option grants. More precisely, we find that CEOs of firms that undertake either high or low levels of investment, particularly of capital expenditures, receive fewer stock options in the subsequent period. Our estimated effects are economically large. For example, for the typical firm, being in the top or bottom quintile of the distribution of "abnormal capital expenditures" predicts a subsequent reduction of roughly 10% in the number of options granted to the CEO, compared to all other firms. We document a similar change in the number of options granted when firms undertake high levels of R&D investment. Taken together, our results suggests that, regardless of the reasons for either high or low corporate investment, boards tend to adopt a cautious approach

[2] Although, theoretically, a complete contract may specify all compensation parameters once and for all, the contingent nature of payoffs implies that such a complex contract is more likely to be implemented through a sequence of simple contracts, as we observe in reality.

to option granting by reducing the flow of option grants to CEOs in firms with unusual investment patterns.

One possible interpretation for the stock option grant revisions that we document is that boards view unusual investment patterns as evidence of CEO short-termism, and thus reduce the flow of CEO equity incentives to rebalance the structure of the compensation package. Under traditional agency theories, high-powered equity incentives may induce CEOs to prefer short-termist actions, such as cutting discretionary spending to meet earnings targets (see e.g., Stein (1989)). Bebchuk and Stole (1993) show that short-term managerial incentives may lead to either underinvestment or overinvestment. Edmans, Feng and Lewellen (2017) provide evidence consistent with short-term managerial incentives created by equity incentives leading to either excessive levels of investment or investment cuts (e.g., of research and development).[3] Thus, under this traditional agency theory view, changes in stock option grants may be a response to managerial short-termism.

An alternative interpretation for the stock option grant revisions is that boards view unusual investment patterns as evidence of CEO overconfidence, and thus reduce the flow of equity incentives to the CEO to offset the high-powered incentives embedded in this behavioral trait. A

[3] This literature builds on agency theories guiding the association between stock options and risky outcomes, which are either explicitly or implicitly linked to corporate investment (Aggrawal and Mandelker 1987; Balachandran, Kogut, and Harnal 2010; Cohen, Hall, and Viceira 2000; Guay 1999; Rajgopal and Shevlin 2002; Sanders and Hambrick 2007). While this literature documents a positive association between the convexity of compensation contracts and corporate investment, there is also evidence that when option holdings are too high, they may induce managers to invest too much (Coles et al. 2006), undertaking overly risky projects for a given level of return (Core and Guay 1999). Prior research suggests that too many stock options may also trigger earnings management incentives and lead short-termist CEOs to invest too little, in an attempt to meet earnings targets. In this case, low levels of discretionary investment, in particular R&D, which is fully expensed in the current period, become a means to inflating profitability to meet short-term earnings targets (Dechow and Sloan 1991; Bartov 1993; Baber et al. 1998; Bushee 1998; Bens, Nagar and Wong 2002; Bens Nagar, Skinner, and Wong 2003; Roychowdhury 2006). This research assumes that earnings management survives optimal executive contracts (Dutta and Fan 2014, Goldman and Slezak 2006) and that high stock option holdings are associated with earnings management (Burns and Kedia 2006; Bergstresser and Philippon 2006; Cheng and Warfield 2005; Efendi, Srivastava, and Swanson 2007; Cohen, Dey, and Lys 2008; Grant, Markarian, and Parbonetti 2009). In turn, earnings management has been shown to interfere with investment decisions (Biddle, Hilary, and Verdi 2009).

CEO who is overconfident about her abilities, albeit with unbiased preferences over projects, may place too much weight on her own idiosyncratic information, and end up either over- or under investing relative to the industry norm (see e.g., Malmendier and Tate 2005, 2008, Gervais, Heaton, and Odean (2011)).[4] The literature acknowledges the possibility that boards may offset the negative effects of CEO overconfidence by properly designing compensation contracts. Malmendier and Tate (2005) make this point explicitly: "*If the board chooses a CEO because of his overconfidence, it should be aware of the "dark sides" of this personality feature (such as distorted investment behavior) and take steps to explicitly address them*" (p. 2664). Gervais et al. (2011) suggest that overinvestment by overconfident CEOs should be moderated by (or factored into) compensation arrangements. Otto (2014) provides evidence consistent with this claim, showing that overconfident CEOs receive less equity pay and more cash-based compensation. However, if overconfidence cannot be ascertained at the point of hiring, or develops over time, perhaps a board learns about a CEO's overconfidence progressively by observing her past decisions. This learning is likely to lead to dynamic adjustments to equity incentives, as episodes of unusual investment activity may be perceived as evidence of CEO overconfidence.

These two interpretations of the direction of option grant revisions are neither exhaustive nor mutually exclusive. Our results seem to suggest that boards that are concerned about the potential detrimental effects of high CEO equity incentives appear to err on the side of caution when adjusting CEO compensation. Distinguishing between the two main explanations is challenging, in particular because we cannot directly observe CEO overconfidence and myopia.

[4] Malmendier and Tate (2005, 2008) propose that overconfident CEOs are more likely to overinvest and engage in value-destroying acquisitions, as they tend to overestimate investment returns and their ability to pick profitable projects. In line with this prediction, the authors show that overconfident CEOs are more likely to undertake riskier investments than less-overconfident CEOs. Goel and Thakor (2008) provide similar evidence for CEOs that are highly overconfident. Underinvestment may also occur because overconfident managers put excessive weight on their own private information (Gervais et al. 2011).

To investigate CEO overconfidence further, we consider the effect of CEO overconfidence measures on future option grants. We follow Malmendier and Tate (2005) and measure CEO overconfidence by the holding of vested deeply-in-the-money options. We find that this overconfidence measure is also a predictor of fewer option grants. These findings lend explicit support to the overconfidence story. At the same time, they suggest that boards may combine both direct and indirect evidence about CEO preferences when revising stock option grants.[5] By contrast, we are unable to find additional supporting evidence for short-termism.

In additional analyses, we investigate changes in the equity/cash mix of CEO compensation and changes in restricted share grants. Our results show that CEOs who overinvest subsequently receive more cash-based compensation (salary and bonuses). By contrast, we find no evidence of changes in restricted shares. Overall, the evidence suggests that reducing stock options is part of an attempt to rebalance the CEO compensation package, rather than an attempt to decrease overall CEO compensation.

Our results shed light on boards' option-granting behavior by highlighting dynamic changes in the number of option grants. A possible explanation for our results is that boards use evidence of high or low investment to learn about CEO preferences. Exogenous investment shocks – by definition – do not contain information that is useful for learning about CEOs' preferences. We therefore cannot use exogenous investment shocks in our analysis, even if such shocks were available. As we do not use a random source of variation for corporate investment, we also make no causality claims. Our goal is simply to document changes in compensation patterns after periods of unusual investment behavior: we identify variables that predict changes in stock option grants. We provide no causal evidence on the determinants of stock option grants; this is beyond the scope

[5] Cornelli, Kominek, and Ljungqvist (2013) reach a similar conclusion when examining turnover decisions as way of monitoring CEO competence.

of this paper, and not particularly helpful for choosing between different theoretical views. Our evidence extends recent evidence on the number of option grants (Shue and Townsend 2017) by showing that while there is a degree of rigidity in option grants, there is also considerable variation in annual changes in the number of options; such variation is partly predicted by measures of corporate investment. As such, our evidence can inform theoretical discussions on the topic of option granting behavior.

Another contribution of this paper is to improve our understanding of re-contracting in executive compensation. While efficiency in the design of compensation schemes is a central theme in recent governance debates and in the rising role of accounting in building public trust, there is little empirical evidence of feedback effects from firm outcomes to compensation design. A notable exception is the work of Cheng and Farber (2008), who find that firms revise stock option grants downwards following earnings restatements. However, earnings restatements occur infrequently, thus it is difficult to generalize this finding to the majority of firms, which do not demonstrate significant failures in reporting. Unusual investment patterns, on the other hand, can be more easily and frequently detected. They therefore offer an alternative setting for investigating the dynamics of CEO compensation contracts. An interesting add-on of our study is that, alongside the evidence of the importance of "hard" variables such as corporate investment, our findings suggest that boards may also consider "soft" CEO characteristics, e.g., overconfidence.

The rest of the paper is organized as follows. In Section 2 we discuss our measures of changes in stock option grants, high and low investment, and our empirical models. Section 3 describes our sample and data. Section 4 presents our findings, and Section 5 concludes.

2. Research Design

2.1 Measuring levels and changes in option grants

Most of the empirical literature on CEO compensation uses valuation-based measures of equity-incentives. For example, in the case of executive stock options, many studies use option valuation models to calculate their variables of interest, which are often the proportion of the value of option holdings over total compensation, or some option "Greeks," such as delta or vega. Valuation-based measures of equity incentives are particularly useful for directly measuring the strength of the incentives provided to CEOs through compensation contracts. The downside in using valuation-based measures as a measure of the board's choices is that this value is always endogenously determined; among other things, this value reflects the market expectations of changes in CEO behavior induced by the compensation scheme.

When interested in directly measuring boards' choices of compensation parameters, *valuation-free* measures, such as the number of option and share grants (normalized by the total number of shares), are arguably preferable to valuation-based measures. The argument is simple but subtle. In granting stock options, the board has two variables within its control: the number of stock options granted and the exercise price. The common practice of granting stock options at the money means that, in practice, the only tool remaining in the control of boards is the number of stock options granted. The number of grants is always a clean and direct measure of the choices made by the board.

We define option grants, $\#Option\_Grants_{it}$, as the number of annual option grants divided by total shares outstanding, as follows:

$$\#Option\_Grants_{it} = \left(\frac{Number\ option\ grants\ in\ the\ year}{Number\ of\ shares\ outstanding}\right)_{it} \times 100. \quad (1)$$

Changes in option grants, $\Delta\#Option\_Grants_{it}$, is the first difference of equation (1).[6]

Other papers that use the number of stock option grants as a key variable include Cheng and Farber (2008), Kedia and Rajgopal (2009), and Call, Kedia, and Rajgopal (2016), among other studies.

2.2 Measures of investment

Prior literature examining the association between the design of CEO compensation schemes and CEO investment decisions emphasizes R&D investments (Bryan, Hwang and Lilien 2000; Coles et al. 2006; Cheng and Farber 2008; Kim and Lu 2011).[7] Investment in R&D is more discretionary in nature than investment in physical assets, and has immediate accounting effects, as it is expensed, not capitalized, and therefore directly affects a company's reported profitability. Capital expenditures, while initially capitalized, also affect reported profitability indirectly, through subsequent depreciation charges. However, unlike investment in R&D, which conveys superior investment information mainly in R&D-intensive industries (Amir, Guan, and Livne 2007), capital expenditure information is available for all industries. Furthermore, investments in physical assets have less uncertain returns, which may facilitate the board in detecting abnormally high or low levels of investment, given business fundamentals. Accordingly, we examine unusual investment patterns, e.g. high and low investment, in both capital expenditures and R&D.

To capture high and low investment levels in capital expenditures, we identify investments that are substantially higher or lower than the amount that would be justified by business fundamentals, according to an empirical model. We calculate identifiers of high and low capital

[6] Dividing by the number of shares outstanding is common practice both in studies that have also used number of options grants (Cheng and Farber (2008) for executive options; Kedia and Rajgopal (2009) for options to rank-and-file employees) and in studies examining the sensitivity of option holdings (Core and Guay 1999; Guay 1999).

[7] Stock return volatility has also been used as a proxy for the riskiness of investments (see Cheng and Farber 2008). Stock return volatility may capture risk relating to the firm's operating, financing and reporting decisions. However, it is difficult to normalize and is inevitably affected by stock market anomalies. Stock returns may also be beyond the control of managers as they also reflect changes in the economy or industry-wide circumstances.

expenditure (*HCAPEX* and *LCAPEX*) for firms in the top and bottom quintile of abnormal capital expenditures. We follow McNichols and Stubben (2008) to estimate the normal investment level as follows:

$$CAPEX_{it} = \alpha_0 + \alpha_1 CAPEX_{it-1} + \alpha_2 Q_{it-1} + \alpha_3 Q_{it-1} \times QRT2_{it-1} + \alpha_4 Q_{it-1} \times QRT3_{it-1} + \alpha_5 Q_{it-1} \times QRT4_{it-1} + \alpha_6 CF_{it} + \alpha_7 Growth_{it} + e_{it}, \quad (2)$$

where *CAPEX* is total investment in capital expenditures scaled by net property, plant and equipment, *Q* is Tobin's Q, *QRT2* (*QRT3*, *QRT4*) equals 1 if *Q* is in the second (third, fourth) quartile of its industry-year distribution, *CF* is cash flow from operations scaled by net property, plant and equipment, and *Growth* is growth in total assets. The model builds on the premise that investment opportunities and cash flows (because of financial constraints) determine optimal investment. The model also allows for nonlinear effects of *Q*. Lagged capital expenditures control for time-varying firm-specific components of investment decisions not captured by other business fundamentals. The Appendix provides detailed definitions of all variables. Subscripts *i* and *t* indicate firm and year, respectively.

We estimate equation (2) for each of Fama and French (1997)'s 48 industry groups with at least 20 firms in each industry-year combination. Annual cross-sectional estimations of equation (2) yield firm- and year-specific residuals representing abnormal capital expenditure (*ACAPEX*). As we are interested in both high and low levels of investment, we form quintiles by year based on *ACAPEX*. *HCAPEX* equals 1 for all firm-years in the top quintile of residuals of equation (2) (*ACAPEX*), and 0 otherwise. *LCAPEX* equals 1 for all firm-years in the bottom quintile of the residuals (*ACAPEX*), and 0 otherwise.

The model in (2) imposes some structure on the data, and thus one may wonder whether such a structure is important for the results that follow. As a simple alternative to (2), we also define high and low levels of investment by forming quintiles of total investment levels by industry. We show that the results are similar if we use either approach.

To derive a measure of high and low investment in R&D, as with capital expenditures, we calculate identifiers of high and low R&D (*HRD* and *LRD*) for firms in the top and bottom quintile of abnormal R&D (*ARD*), respectively. We define abnormal R&D (*ARD*) as the residuals of an empirical model as in Berger (1993) and Gunny (2010):

$$RD_{it} = \alpha_0 + \alpha_1 RD_{it-1} + \alpha_2 FUNDS_{it} + \alpha_3 CAPEXS_{it} + \alpha_4 Q_{it} + \alpha_5 ROA_{it} + e_{it}, \quad (3)$$

where *RD* is R&D investment, *FUNDS* is pre-R&D cash flow, *CAPEXS* is capital expenditures, *Q* is Tobin's Q as above, and *ROA* is income before extraordinary items divided by average total assets. R&D divided by sales is a common measure of R&D intensity among capital market participants. Lagged R&D intensity, RD_{it-1}, allows for innovation opportunities to be autocorrelated.[8] The level of internal funds, *FUNDS,* may affect R&D expenditure as R&D projects may need to be rationed if external finance cannot be raised. Capital expenditures (*CAPEXS*) controls for the potential competition for resources between capital expenditures and R&D projects. *Q* proxies for investment opportunities. Following the prior literature on abnormal levels of R&D (Athanasakou, Strong, and Walker 2011), we also control for operating performance (*ROA*). Following Berger (1993), we deflate all variables by sales.

R&D levels in certain concentrated industries have been found to be a major element of competition, thus a firm's R&D spending is expected to be influenced by its rivals. We therefore also estimate equation (3) for each of Fama and French (1997)'s 48 industry groups with at least 20 firms in each industry-year combination, to ensure efficient parameter estimation. Annual cross-sectional estimations of equation (3) yield abnormal R&D investment levels (*ARD*). *HRD*

[8] Firms that have identified more potentially profitable innovation opportunities may be expected to spend more on R&D each year.

equals 1 for all firm-year observations in the top quintile of residuals from equation (3) (*ARD*) and 0 otherwise. *LRD* equals 1 for all firm-year observations in the bottom quintile of *ARD* and 0 otherwise.

Finally, as we do for capital expenditures, we also construct a model-free measure of high and low R&D investment by ranking R&D levels within each industry. We show that the results are not much sensitive to how we measure R&D investment.

2.3 Empirical model of changes in stock option grants

We examine boards' revisions of CEO stock option grants using the following specification:

$$\Delta\#Option\_Grants_{it} = \boldsymbol{z'}_{it-1}\boldsymbol{\alpha} + \Delta\boldsymbol{x'}_{it-1}\boldsymbol{\beta} + \boldsymbol{p'}_t\ \boldsymbol{\gamma} + e_{it,} \qquad (4)$$

where $\Delta\#Option\_Grants_{it}$ is the change in stock option grants for firm *i* in year *t*, as defined in equation (1) above, $\boldsymbol{z}_{it-1}$ is a vector of lagged firm characteristics in levels, $\Delta\boldsymbol{x}_{it-1}$is a vector of lagged firm characteristics in first differences, $\boldsymbol{p_t}$ is a vector of year dummies, $\boldsymbol{\alpha}, \boldsymbol{\beta}$, and $\boldsymbol{\gamma}$ are vectors of parameters to be estimated, and e_{it} is the error term.

All right-hand-side variables in equation (4) (except year dummies) are lagged by one year. Our variables of interest are in $\boldsymbol{z}_{it-1}$. The variables in this set are dummy variables, and thus for interpretational simplicity are expressed in levels rather than first differences. This choice is motivated by our focus on the extent to which unusually high or low investment *levels* are associated with *changes* in the number of options granted to CEOs. The composition of set $\boldsymbol{z}_{it-1}$ varies across different specifications. This set may include high and low capital expenditure indicators (*HCAPEX* and *LCAPEX*), high and low R&D indicators (*HRD* and *LRD*), and an overconfidence indicator (discussed in section 4.2).

All variables in $\Delta\boldsymbol{x}_{it-1}$ are lagged by one year and differenced. In this set of covariates, we first include changes in capital expenditures (*ΔCAPEX*) and changes in R&D (*ΔRD*). We also include a number of factors that are known to be correlated with CEO equity holdings, as identified by Core and Guay (1999), Hanlon, Rajgopal, and Shevlin (2003), and Cheng and Farber (2008).[9] We consider CEO-level characteristics such as cash compensation, stock ownership, and turnover. We also include changes in CEOs' existing option and stock portfolios to control for the proportion of the change in stock option grants related to changes in the number of expiring, exercised, and vesting stock options, and changes in ownership (*ΔExercisable_Options*, *ΔUnexercisable_ Options*, and *ΔShares_Own*). Controlling for changes in the existing option and share portfolio effectively controls for changes in option grants that are related to maintaining a constant level of equity incentives. We include an indicator of new CEOs (*ΔNewCEO*) to account for structural changes in the equity/cash mix of newly appointed CEOs.

We also include a number of firm characteristics that may affect boards' stock option grant revisions. We include firm size (*ΔSize)* and investment opportunities, measured as *ΔB/M*. Firms with operating losses and constrained amounts of cash are more likely to compensate managers with stock options in order to preserve firm liquidity, and the risk of distress is associated with increased incentives for performance (Chang, Hayes, and Hillegeist 2015, Feltham and Wu 2001). To control for revisions in option grants associated with changes in these situational incentives, we include *ΔNetOperatingLoss* and *ΔCashShortfall*. We add changes in leverage (*ΔLev*), as debt financing may act as a substitute monitoring mechanism to stock options. We also add changes in the structure of CEO compensation induced by stock price performance (Edmans, Gabaix, Sadzik,

[9] Core and Guay (1999) model CEO portfolio holdings of equity incentives drawing from literature examining the determinants of managerial ownership (Demsetz and Lehn 1985; Jensen 1986; Himmelberg, Hubbard, and Palia 1999). The factors include firm and director characteristics affecting monitoring difficulty and agency costs.

and Sannikov 2012) by including returns lagged by one and two periods ($\Delta Return_{t-1}$ and $\Delta Return_{t-2}$, respectively). Finally, we account for stock option grant revisions related to changes in stock return volatility ($\Delta \sigma Return$), and add year dummies to control for time-specific variation in stock option grants not captured by the other independent variables. More specifically, including year fixed effects controls for inter-temporal changes related to events such as the requirement to expense stock options under FAS 123R, which induced many firms to reduce the number of stock options granted, or stop issuing options altogether (Hayes, Lemmon, and Qiu 2012).

By considering changes instead of levels of option grants (and also changes in all non-binary control variables), we control for the impact of time-invariant firm characteristics on CEO compensation structures. As our model is in first differences, we estimate a number of variations of equation (4) using pooled OLS regressions with standard errors clustered by firm.[10] Because we need to consider the information available to boards at the time of the decision to grant options in a given year, we use lagged values for all variables. Using lagged values also mitigates the concern that $\#Option\_Grants_{it}$ may decrease because firms that overinvest issue more shares, and thus dilute the proportion of CEO options over total shares outstanding. This reverse causality story requires the issuing of shares before investments are made; lagged investment variables should not predict future changes in shares outstanding.

More generally, scaling by the number of shares outstanding makes our measure of stock option grants sensitive to changes in share capital. Increases in share capital are possible for firms undertaking high investment in either R&D or physical assets. To address this concern, we re-

[10] Our model is essentially a fixed effects model implemented through first differences. Our results are robust to estimating a fixed effects model implemented through firm dummies. Our results are also unaffected by clustering standard errors by both firm and year.

estimate equation (4) controlling for changes in the number of shares outstanding from year $t-1$ to year *t*, and our core findings remain.

3. Sample and summary statistics

3.1 Sample

Our initial sample is composed of an unbalanced panel of CEOs of non-financial firms covered by *Execucomp* from 1992–2013, which have accounting data from *Compustat* and market data from *CRSP*. *Execucomp* covers firms that are members or have been members of the S&P 1500 index. Our use of a first-difference specification with lagged variables causes us to lose two years of observations. Our final sample consists of 21,590 firm-years, and 2,295 unique firms, from 1994–2013.

3.2 Aggregate trends in option grants

We first investigate aggregate trends in stock option grants. Figure 1 plots the frequency of firms that offer no stock options (i.e. zero option grants) over our sample period. This frequency rises steadily from 2001, reaching 48% in 2013 compared to a sample period low of 22% in 2001. As firms that use stock-based compensation may, in some years, choose not to grant any options, we also plot the frequency of firms that offer no stock options in both the current and preceding fiscal period, i.e. firms with two consecutive years of zero option grants. This frequency shows a similar trend, peaking at 41% in 2003.

We next investigate the significance of option grants for actively granting firms, i.e. firms that have non-zero option grants in the current and preceding accounting period. Figure 2 plots $\#Option\_Grants_{it}$. Consistent with prior findings on the decrease in use of stock option grants following mandatory accounting recognition of stock option expenses under FAS 123R (Brown and Lee 2011; Hayes et al. 2012), we observe that stock option grants are declining among actively granting firms, from a period high of 0.34% of shares outstanding in 2001 to 0.17% in 2013.[11] This evidence adds to prior findings of a decline in the use of option-based compensation (Carter, Lynch, and Tuna 2007; Brown and Lee 2011; Hayes, Lemmon, and Qiu 2012). Despite this trend, a substantial fraction of firms still actively grants stock options in 2013.

We next explore evidence of rigidity among granting firms. Figure 3 plots the frequency of firms that grant the same number of options as in the previous year and those granting round multiples of the previous year's number (similar to Shue and Townsend's (2017) measure of rigidity). Over our sample period, only a minor fraction of option-granting firms — an average of 11% — grants the same number of options from one year to the next (or round multiples of the same number), with evidence of a declining trend from 2004, reaching a period low of only 5% by 2013. Among the remaining granting firms, increases in option grants (on average 47% of firms) exceed declines (42%) over the sample period. While the fraction of firms increasing their stock option grants increases up to 2001 (Figure 4), and then again in 2008−2009, in the remaining periods, option grant declines dominate, reaching 53% in 2013.

Taken together, the aggregate trends in stock option grants in Figures 3 and 4 provide some evidence of rigidity in stock option grants, albeit limited to a minor fraction of sample firms and declining over time. It also provides evidence of inter-temporal changes for actively-granting firms, with declines in option grants becoming more dominant in recent years.

3.3 Descriptive statistics

Table 1 presents the basic descriptive statistics of our sample. The mean value of option grants as a percentage of shares outstanding is 0.19%. The mean value of changes in option grants,

[11] While there is a sharp decline in option grants in 2006 upon adoption of FAS123R (Brown and Lee 2011; Hayes et al. 2012), the declining trend starts earlier, from 2002. Such earlier declines in stock option usage may reflect anticipation of FAS123R (Carter, Lynch, and Tuna 2007; Choudhary, Rajgopal, and Venhkatachalam 2009), or stock option revisions unrelated to accounting cost considerations.

our dependent variable $\Delta\#Option\_Grants_{it}$, is −0.009, while the median is zero, in line with a gradual decline in the dominance of option grants over our sample period. Over our sample period, approximately 34% of firms award no options, while firms not granting options in the current and preceding period is 22.9%. Across all firms, the percentage of firms granting the same number of option grants (or round multiples) from one year to the next is 9%.

The average percentage increase in salary is 6%, while the average increase in bonus is 26% over our sample period. Mean *ΔRD* and *ΔCAPEX* are −0.001 and −0.012, suggesting that investment levels are decreasing over time in our sample.[12] The mean value of *ACAPEX* is also negative, suggesting that the average firm in the final sample firm reports below-benchmark investment in *CAPEX*. The mean and median change in the CEO's number of exercisable options ($\Delta Exercisable\_Options_{t-1}$) is positive, and the change in the number of unexercisable options ($\Delta Unexercisable\_Options_{t-1}$) is negative and close to zero, suggesting that over the entire sample, exercisable options are increasing, and unexercisable options are decreasing. The positive mean and median change in firm size, $\Delta Size_{t-1}$, show that the sample firms are growing over time. Table 1 also presents the distribution of our other control variables, including changes in leverage, stock returns and lagged stock returns, volatility, and book to market ratio.

Table 2 presents the correlations between some of the key variables used in our analysis. HRD_{t-1} and $HCAPEX_{t-1}$, are only weakly positively associated, and LRD_{t-1} and $LCAPEX_{t-1}$ are not significantly correlated. This suggests that, to a large extent, the investment indicators capture non-overlapping instances of high and low investment, and warrant separate investigation. We observe a negative association between $\Delta\#Option\_Grants_t$ and $\Delta CashCompensation_{t-1}$, consistent

[12] The average sample firm invests 12% of revenues on R&D (mean *RD*: 0.116), and 28% of net property, plant and equipment on capital expenditure (mean *CAPEX*: 0.277).

with the rebalancing properties of the equity/cash mix. We also find a negative correlation between $\Delta Size_{t-1}$ and $\Delta Cash\ Compensation_{t-1}$, consistent with Cheng and Farber (2008).

4. Results

4.1 Changes in CEO option-based compensation and investment levels

Table 3 reports the results of regressing changes in option grants on indicators of high and low investment in capital expenditures ($HCAPEX_{t-1}$ and $LCAPEX_{t-1}$) and R&D (HRD_{t-1} and LRD_{t-1}) and a vector of control variables (equation (4)). Column 1 reports the results for capital expenditure indicators, using a parsimonious specification including only basic control variables, i.e. changes in firm size, book-to-market ratio, and lagged changes in capital expenditures and R&D. Column 2 reports the output of a regression with the full set of control variables. The estimated coefficient on $LCAPEX_{t-1}$ is negative and significant in both specifications. The coefficient on $HCAPEX_{t-1}$ is also negative and significant in the full model. These results suggest that CEOs of firms in either the bottom or the top quintile of abnormal investment in capital expenditure receive fewer stock option grants in the subsequent period than other CEOs. These findings are economically significant: in our sample, the average number of annual option grants as a percentage of shares outstanding is 0.19%, and firms in the bottom or top quintile of abnormal capital expenditure reduce subsequent option grants by about 0.02 percentage points (0.018 and 0.016 in Column 2). Thus, CEOs who seem to invest too little or too much in capital expenditures experience a reduction of approximately 9% in the number of the new options granted to them.[13]

The next two columns repeat the analysis of equation (4) for R&D indicators. Columns 3 and 4 show the results for the parsimonious model and the full model, respectively. In both

[13] Since we normalize the number of annual option grants by the total number of shares outstanding, the sample average of 0.19% means that a typical CEO in a typical year receives new options that equal 0.0019 times the number of shares outstanding.

columns, the coefficients on both LRD_{t-1} and HRD_{t-1} are negative, but only those for HRD_{t-1} are statistically significant. The evidence suggests that CEOs of firms in the top quintile of abnormal investment in R&D receive fewer stock option grants in the subsequent period than other CEOs. Firms in the top quintile of abnormal R&D reduce further option grants by about 0.02 percentage points (0.018 in Column 3 and 0.025 in Column 4). Thus, CEOs who invest too much in R&D experience a reduction of about 10% in the number of the new options granted to them.

We obtain similar results when we include all four indicators of high and low investment in Columns 5 and 6 to capture the incremental response to evidence of high or low investment in R&D. In this specification the estimated coefficients on $LCAPEX_{t-1}$, $HCAPEX_{t-1}$ and HRD_{t-1} remain negative and statistically significant and of similar magnitude as in Columns 2–4. The results in these two last columns suggest the amounts of CAPEX and R&D investment have independent predictive ability for changes in option grants.[14]

With respect to control variables, the negative estimated coefficient on ΔRD_{t-1} in Columns 2, 4, and 6 suggests that boards adjust CEOs' stock option grants down after periods of increasing R&D intensity (this effect is only statistically significant in the full model). Thus, the number of option grants decreases both when firms invest more than their peers (the effect of HRD_{t-1}) and when firms invest more than they did in the past (the effect of ΔRD_{t-1}).[15] Unlike changes in R&D,

[14] While in principle the reported value of option grants is noisier than the number of grants in capturing the board's revision of option based compensation, we also repeat the analysis using option value (the change in the dollar value of stock options granted to the CEO from year *t–1* to *t*). In this specification (results not tabulated) we retain the inferences about the board response to high levels of capital expenditure ($HCAPEX_{t-1}$ coefficient of -0.675 and HRD_IND_{t-1} coefficient -1.453), but the coefficient on $LCAPEX_{t-1}$ loses significance.

[15] We also estimate both the parsimonious and the full model using the differenced variable ΔHRD_{t-1} instead of HRD_{t-1}, so that the model becomes a standard fixed effects model. The variable ΔHRD_{t-1} reflects movements into and out of the top quintile of abnormal R&D spenders. The coefficients on ΔHRD_{t-1} are significantly negative, with a similar magnitude to those of HRD_{t-1} in Table 3. We choose to use HRD_{t-1} in our specifications to facilitate the interpretation of results, as this variable has a more natural economic interpretation in our setup. All qualitative results are similar, however, if we use ΔHRD_{t-1} instead.

changes in capital expenditures ($\Delta CAPEX_{t-1}$) do not seem to reliably predict changes in option grants.[16]

For our other variables, we note that the coefficient on $\Delta Size_{t-1}$ is negative, consistent with the findings of Cheng and Farber (2008, p. 1234). Changes in option grants are negatively related to $\Delta Return_{t-1}$ and positively associated with $\Delta B/M_{t-1}$, suggesting that stock market performance feeds back into stock option grants. Also, CEOs with increasing amounts of exercisable and unexercisable options receive fewer option grants, as evidenced by the negative and statistically significant coefficients on $\Delta Exercisable\_Options_{t-1}$ and $\Delta Unexercisable\_Options_{t-1}$. This finding controls for a stock option maintenance effect, or a potential "target" level of stock options that boards expect CEOs to hold. While descriptive statistics show that, at the median, $\Delta Exercisable\_Options_{t-1}$ and $\Delta Unexercisable\_Options_{t-1}$ are positive, an alternative interpretation is that CEOs with decreasing amounts of exercisable and unexercisable stock options receive more new stock options. This effect suggests an adjustment of option grants to options that have vested, expired, or been exercised. CEO succession also predicts changes in option grants, as there is a negative and statistically significant coefficient on $\Delta NewCEO_{t-1}$.[17] The coefficients on changes in cash compensation, cash constraints, net operating losses, and stock return volatility are not statistically precise.

Collectively, the results in Table 3 are consistent with boards responding to evidence of high investment in either capital expenditures or R&D by reducing CEOs' stock option grants. With respect to low investment, our results suggest that the boards also reduce stock option grants;

[16] In further analysis (not tabulated), we introduce an interaction term between ΔRD_{t-1} and HRD_{t-1}; the interaction coefficient is small and not statistically significant.

[17] As our first-differences specification requires compensation data for the previous year, this result refers only to new internally-hired CEOs. Recently promoted CEOs may be more innovative than continuing or externally-hired CEOs and thus may require less high-powered incentives. Bereskin and Hsu (2014) find that CEO turnover is associated with greater quantity and quality of future innovation (i.e. more patents, citations) and that the innovation is higher for new internal compared to new external CEOs.

here the evidence is only statistically significant for capital expenditures. It is important to note that the evidence is of predictive ability, and not of causal inference.

Our evidence is consistent with boards learning about CEO preferences and revising contracts over time. The direction of the revision, the reduction of stock option grants seems consistent with a board that responds either to CEO short-termism or CEO overconfidence (as discussed in detail in the introduction). In the next section, we examine CEO overconfidence more thoroughly.

4.2 The role of CEO overconfidence

In this subsection we investigate the role of overconfidence. Overconfident CEOs may overestimate investment returns and undertake projects that would have been rejected by rational or less-overconfident CEOs (Malmendier and Tate 2005; 2008). Goel and Thakor (2008) propose that highly overconfident CEOs may invest in projects that are value-destroying. Gervais et al. (2011) propose that overinvestment by overconfident CEOs results from inefficient contracting; this implies that some revision of contract may take place when a CEO is identified as (or is believed to be) overconfident. Boards may view evidence of high or low investment as a way of updating their beliefs about CEO overconfidence and correct distortions in the incentive structure by reducing future stock option grants. In this section, we consider whether further to high or low investments levels, boards consider other, more subtle, evidence of CEO overconfidence.

Malmendier and Tate (2005; 2008) classify CEOs as overconfident if they hold exercisable options that are deep in-the-money, and find that these CEOs systematically overestimate returns on investment projects (Malmendier, Tate, and Yan 2011; Deshmukh, Goel, and Howe 2013).[18]

[18] A related literature on CEO overconfidence using alternative measures of overconfidence also finds that overconfident CEOs are likely to make bold actions, such as actions that lead to volatile organizational performance (Chatterjee and Hambrick 2007), earnings management or fraud (Schrand and Zechman 2012). Firms with

To assess how boards respond to evidence of CEO overconfidence, we construct a similar identifier of CEOs with continued holding of exercisable in-the-money stock options and assess its association with changes in subsequent stock options. One important property of this approximation of CEO overconfidence is that it is time-varying, and therefore allows for dynamic assessments of CEO overconfidence.

Malmendier and Tate (2005) identify CEO optimism using continued holding of in-the-money stock options, with options that are at least 67% in the money, provided that the CEO has demonstrated this holding behavior at least twice in the sample period. This 67% threshold is also applied by Hirshleifer, Low, and Teoh (2012). We follow the more robust threshold of 100% "moneyness" of Campbell, Gallmeyer, Johnson, Rutherford and Stanley (2011), to capture CEOs that exhibit high levels of overconfidence. [19] We calculate moneyness using the difference between the fiscal year-end stock price (*PRCCF*) and the estimated exercise price of exercisable options.[20] We then calculate the moneyness of the exercisable options as *PRCCF* divided by *Est_Exercise_Price* minus 1. We classify CEO-years in which *Moneyness*>100% as overconfident CEO-years (*OC*), starting with the first time that the holding behavior is observed, provided that the CEO has had *Moneyness*>100% at least twice over the period. As we are interested in board responses to observed option holding behavior, we use *OC* lagged by one period, to reflect holding

overconfident CEOs are also more likely to miss voluntary earnings forecasts (Hribar and Yang 2016), use short-term debt, and repurchase shares (Ben-David, Graham, and Harvey 2007).

[19] Malmendier and Tate (2005) rely on a proprietary data set of stock and stock option holdings (from Yermack (1995) and Hall and Liebman (1998)), which provides details about exercise prices, number of underlying shares, and time to maturity for a set of data from 1980-1994. Since we do not have the same data on a per-grant basis, we calculate moneyness using an estimate of the exercise price similar to Campbell et al. (2011) and Hirshleifer et al. (2012).

[20] We use the approximation of Core and Guay (2002), also used by Campbell et al. (2011) and Hirshleifer et al. (2012). We estimate the per-option realizable value by taking the total realizable value of exercisable options and dividing by the number of exercisable options. We then estimate the average exercise price (*Est_Exercise_Price*) by subtracting the per-option realizable value from the fiscal year-end share price (*PRCCF*), where: $Est\_Exercise\_Price = \frac{OPT\_UNEX\_EXR\_EST\_VAL}{OPT\_UNEX\_EXER\_NUM}$. Variable names in capital letters are those used by *Execucomp* on the WRDS platform.

characteristics at the beginning of the period. We re-estimate equation (4) adding a lagged indicator of overconfident CEOs (OC_{t-1}). Our requirement to examine the exercising or holding behavior of executives limits our sample to firms with CEOs who have exercisable stock options (like Campbell et al. 2011), which results in a reduction in the sample size to 17,940 observations.

Table 4 reports the regression results. Column 1 presents a model that includes OC_{t-1} and additional controls, without investment level variables. Column 1 shows that overconfidence indicator predicts a reduction in the number of options granted to the CEO. In the years following the observation that the CEO holds options that are more than 100% in the money, the number of options granted as a proportion of shares outstanding falls by 0.02 percentage points. For a typical CEO-year in our sample, such a change represents a reduction of roughly 11% in the number of options granted. Column 2 presents the results of a regression that includes OC_{t-1} alongside the high and low investment indicator variables. The estimated coefficient on OC_{t-1} remains negative and statistically significant, and its magnitude falls only slightly. The results for high and low investment variables (for both *CAPEX* and *RD*) are similar to those reported in Table 3, Column 6. We also add interaction terms between overconfidence and the investment variables. The coefficients of the interaction terms (not tabulated) are small and not significantly different from zero.

Overall, the results in Table 4 suggest that there is no perfect overlap between CEO overconfidence and high investment levels, and that boards may respond to both in their contracting decisions. These results are consistent with the idea that boards combine both indirect and direct evidence about CEO behavior and investment decisions, when revising stock option grants. At the same time, this evidence lends further support to the CEO overconfidence story, i.e. to boards adjusting equity flows in response to evidence associated with CEO overconfidence.

4.3 Industry-based high and low investment measures

So far, we capture high and low investment levels in corporate investment by the extent investment levels deviate by amounts that would be justified by business fundamentals, as measured by models (2) and (3). There are potentially two issues with this approach. The first issue is related to interpretation. If the evidence is to be explained by boards reacting to past investment decisions, we need to assume that compensation committees can identify deviations of investment levels from "normal operational levels" as implied by the empirical model that we use. In other words, the model needs to be approximately right. This may be a crude assumption for many reasons, such as, for example, requiring a high level of board sophistication, which depends on the level of financial expertise (Ahmed and Duellman 2007; Guner, Malmendier, and Tate 2008; Krishnan and Visvanatha 2008). Second, our approach yields estimates of high and low investment levels based on regression residuals (estimated independent variables), which may lead to understated standard errors (Newey 1984).

To mitigate these two concerns, we repeat the analysis using simple measures of high and low investment, based on the deviation of capital expenditures and R&D from the industry median in each year. We construct dummy variables for cases where the deviation from the industry median is in the top or bottom quartile ($HCAPEX\_IND_{t-1}$, $LCAPEX\_IND_{t-1}$, $HRND\_IND_{t-1}$, $LRND\_IND_{t-1}$). Table 5 reports the regression results. In Column 1, the coefficients to $LCAPEX\_IND_{t-1}$, $HCAPEX\_IND_{t-1}$ and HRD_IND_{t-1} are negative and statistically significant. As in Table 3, this evidence suggests that boards respond to evidence of both high and low investment in capital expenditure and high investment in R&D, by reducing CEOs' stock option grants, even when high and low levels are relative to industry medians. In Column 2, we include OC_{t-1}. The results for the investment indicators remain, while the coefficient on OC_{t-1} is also negative and statistically significant, and of similar magnitude to Table 4.

An alternative way of dealing estimated independent variables (EIV) is to adjust standard errors for pre-estimation biases. A simple and robust method for achieving this is to use the EIV as *instruments* for the industry-based measures of high and low investment in instrumental variable regressions. In IV procedures, estimated instruments do not require standard errors to be adjusted. Our IV regression results (not tabulated) yield negative and significant coefficients for $LCAPEX\_IND_{t-1}$, $HCAPEX\_IND_{t-1}$, and HRD_IND_{t-1} and of higher magnitude to those reported in Table 5 (the coefficients of −0.037, −0.033 and −0.043).[21]

4.4 Investment levels and other elements of compensation

Our results show that high or low investment levels, especially in capital expenditures, predict reductions in option grants in subsequent periods. A natural question is whether this change in option-based compensation reflects a change in the equity/cash mix or a change in overall compensation levels (or both). For example, boards may discipline CEOs who invest either too much or too little by reducing their total compensation. In such a case, we should see a negative or zero effect of high or low levels of investment on cash compensation. Alternatively, if boards simply rebalance CEO compensation towards cash after periods of high or low investment, we should see an offsetting positive effect on cash compensation. To address these possibilities, we estimate the following model:

$$\Delta Cash\_based\_pay_{it} = \boldsymbol{z'}_{it-1}\boldsymbol{\alpha} + \Delta\boldsymbol{x'}_{it-1}\boldsymbol{\beta} + \boldsymbol{p'}_{t}\ \boldsymbol{\gamma} + e_{it,} \tag{5}$$

[21] Note that we do not use IV methods to claim causal effects; we use this method to obtain consistent standard errors with estimated independent variables. This procedure is similar to that of Newey 1984.

where $\Delta Cash\_based\_pay_{it}$ is either $\Delta Salary_{it}$ (the percentage change in salary from year $t-1$ to year t) or $\Delta Bonus_{it}$ (the percentage change in bonus from year $t-1$ to year t).[22] Our vector of control variables is the same as before, with some minor modifications. We replace cash compensation with change in equity compensation scaled by sales ($\Delta EquityCompensation_{t-1}$). Also, because bonus is confirmed at year-end and may be contingent on current period performance, we include $\Delta Return$ for years t and $t-1$ instead of for years $t-1$ and $t-2$.

Table 6 presents the results. Columns 1 and 2 present results using $\Delta Salary_{it}$. We observe a positive and significant relationship between change in salary and $HCAPEX_{t-1}$. Our results are economically significant; with a mean salary increase of 6.6% (see Table 1), the coefficient of 0.010 (1.0 percentage points) for $HCAPEX_{t-1}$ reflects a 15% increase in salary for CEOs of firms with high investment in capital expenditure compared to CEOs undertaking normal levels of investment. The coefficients on high or low R&D investment levels is not statistically significant. Column 2 presents results using $\Delta Bonus_{it}$. In this specification, both high and low levels of R&D investment predict subsequent increases in CEO salary and bonus. The coefficients on capital expenditure investment levels are not statistically significant at conventional levels. The evidence is thus a bit mixed in statistical terms, but overall it suggests that high and low investment levels in capital expenditures or R&D also predict changes in cash-based compensation of an offsetting nature, i.e. decreases in stock option grants coincide with increases in cash-based pay.

To assess changes in the entire equity portfolio we also examine changes in restricted shares. Laux (2015) proposes that the board may correct incentive structures that affect investment levels by replacing some of the stock options with restricted shares, as restricted shares make it costly for the CEO to undertake excessive risks. Our results so far suggest that boards substitute

[22] Our inferences are similar when using the change in salary scaled by total compensation or change in log salary.

fewer options with more cash-based pay following periods of high or low investment. It is possible that some firms choose to change the structure of the equity portfolio, i.e. the options/stock mix, instead of or further to changing the equity/cash mix. In this case, if boards adjust the CEO equity portfolio towards restricted shares, we would see a positive effect of high or low levels of investment on restricted shares. To test this empirically, we repeat equation (4) replacing $\Delta\#Option\_Grants_{it}$ with change in restricted share grants. Similar to how we measure $\Delta\#Option\_Grants_{it}$ we calculate $\Delta\#Res\_Shares\_Grants_{it}$ as the change in the percentage of restricted shares grants divided by total shares outstanding in year *t*.[23] Our untabulated results provide no evidence of a significant association between changes in restricted shares grants and LRD_{t-1}, $LCAPEX_{t-1}$, or HRD_{t-1}, $HCAPEX_{t-1}$. These results point to boards changing mainly the equity/cash mix following periods of high or low investment levels in physical assets or R&D.

4.5 Measures of CEO short-termism — real earnings management

Low levels of investment may also reflect short-termist behavior of CEOs, who manage earnings with a view to maximizing contracts that are highly geared towards stock options (Dechow and Sloan 1991; Bartov 1993; Baber et al. 1998; Bushee 1998; Bens et al. 2002; Bens et al. 2003). Low levels of investment, especially of the discretionary nature of R&D, have been the main focus of studies examining earnings management through real transactions (Dechow and Sloan 1991; Bartov 1993; Baber et al. 1998; Bushee 1998; Bens et al. 2002; Bens et al. 2003, Roychowdhury 2006). Healy and Wahlen (1999), Fudenberg and Tirole (1995), Dechow and Skinner (2000) and Roychowdhury (2006) further consider real operational activities, e.g. accelerating sales, cutting advertising or maintenance expenses, and overproducing to reduce cost of sales, as real earnings management methods available to managers. With both investing and

[23] We proxy restricted shares grants using the change in restricted share holdings in year *t*. Further adding number of shares acquired on vesting in the year does not change our results.

operational activities, real earnings management suggests departures from normal practices motivated by managers' intention to meet financial reporting objectives. If boards are able to identify such departures from normal operations as evidence of short-termism in CEOs, they may decide to reduce stock options in subsequent period to remedy the compensation structure. We therefore repeat the analysis adding identifiers of real earnings management.

Roychowdhury (2006) examines operational activities manipulation using abnormal levels of operating cash flows (*ACFO*), production costs (*APROD*) and abnormal levels of selling general and administrative expense (*ASG&A*). Abnormally low operating cash flows are associated with attempts to accelerate revenues using price discounts or more lenient credit terms. Abnormally high production costs are associated with attempts to overproduce, so that fixed production costs remain lodged in inventory and profits increase. Abnormally low SG&A expenses are associated with attempts to inflate profitability by cutting discretionary spending. We follow this approach and estimate identifiers for (1) low operating cash flows (*LCFO*), for firms in the bottom quintile of *ACFO*, (2) high production costs (*HPROD*), for firms in the top quintile of *APROD*, and (3) low S&A (*LSG&A*), for firms in the bottom quintile of *ASG&A*. We then re-estimate equations (4) and (5), adding these three identifiers as additional measures of real earnings management further to LRD_{t-1}. In the results (not tabulated), the coefficients on $LCAPEX_{t-1}$, $HCAPEX_{t-1}$, and HRD_{t-1} are significant and negative when examining $\Delta\#Option\_Grants_{it}$. Coefficients to our investment variables are also consistent with our earlier findings in other specifications. The coefficients on remaining indicators, *LCFO*, *HPROD* and *LSG&A*, are insignificant in the option grants specification. Similarly, they fail to exhibit a robust or consistent pattern in cash-based specifications. We therefore conclude that measures of abnormal operating activities potentially reflecting real earnings management activity have no statistically significant effect on changes in stock option grants. This result may reflect the more subtle nature of operational activity manipulation, which may be more difficult for the board to detect, compared to investment activity manipulation. For example, deciding price discounts or reducing discretionary selling or administrative expenses may be optimal actions in certain circumstances, e.g. maintaining competitive position during price wars. It may therefore be difficult to detect the point at which such activities are no longer justified by business fundamentals. Alternatively, this result may be consistent with boards already shielding CEOs from R&D and other strategic expenditures, as suggested by Duru et al. (2002).

5. Conclusion

Contractual simplicity and standardization favor rigid compensation contracts, while, learning about CEO preferences and traits leads to compensation parameters that change over time. Consistent with this tension, we find that, despite some evidence of short-term rigidity, the number of options granted changes frequently, and such changes are predictable. CEOs who demonstrate unusual investment patterns, such as investing either too much or too little in physical assets or R&D, or CEOs that hold options that are deep in the money (which may be seen as a measure of overconfidence) appear to receive fewer options in subsequent years. This effect is not explained by the general decline in stock options following FAS 123R.

The evidence in this paper has a number of implications. One implication of our findings is that boards actively incorporate both "hard" and "soft" information about the CEO's preferences when they review their stock option-granting policies. That is, boards learn about the adequacy of current compensation arrangements by observing CEO decisions. But other explanations are also possible. For example, our measure of high investment may be capturing some firm life-cycle effects, in which firms start investing more exactly at the time when a shift towards less equity-based compensation is needed. Even in that case, however, the conclusion that firms are actively changing option grants to fit their current situation remains valid. And the fact that levels of investment can predict such changes in compensation remains an interesting finding.

Our results, if taken at face value, suggest that boards believe that overconfident and myopic CEOs *should* be paid more like bureaucrats (to paraphrase Hall and Liebman 1998). Malmendier and Tate (2005) argue that boards should take actions to counteract the possible inefficiencies introduced by biased CEOs. Consistent with Otto (2014), our paper presents evidence that boards *change* the compensation structure of CEOs who appear to be overconfident (as evidenced by their holding of in-the-money options) or who behave in an overconfident manner (as evidenced by high levels of investment). Moreover, the direction of stock option changes in response to evidence of unusual investment patterns, suggesting that, regardless of the underlying reasons, boards seem to prefer to err to the side of caution when adjusting CEO option pay.

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Appendix

Definition of variables in alphabetical order

Variable	Description
#Option_Grants	Number of options granted during the year to the CEO, scaled by shares outstanding.
#OptionsZero	Equals 1 if the firm grants no options to the CEO during the year *t*, 0 otherwise.
#OptionsZerotoZero	Equals 1 if the firm grants no options to the CEO during both year $t-1$ and year *t*, 0 otherwise.
#Res_Shares_Grants	Annual change of restricted shares holdings of the CEO, scaled by shares outstanding.
ACAPEX	Abnormal capital expenditures, calculated as the residual from annual regression models estimating normal capital expenditure based on the McNichols and Stubben (2008) model, for 48 Fama-French industry groups.
ARD	Abormal R&D, calculated as the residual from estimating a model of R&D based on Berger (1993) and Gunny (2010).
B/M	Ratio of book value of to market value of equity.
CAPEX	Capital expenditure (excluding R&D) divided by net property, plant and equipment.
CAPEXS	Capital expenditure (excluding R&D) divided by sales.
CashCompensation	Salary and Bonus, scaled by Sales.
CashShortfall	Cash flow shortfall calculated as common and preferred dividends plus cash flow used in investment activities minus cash flows from operations all divided by total assets
EquityCompensation	Sum of restricted stock and stock option grants (measured at fair value), scaled by sales
Exercisable_Options	Number of exercisable options owned by the CEO, scaled by shares outstanding.
FUNDS	Proxy for the firm's pre-R&D cash flow, defined as pre-tax income, plus interest expense, plus the R&D expense, plus depreciation divided by sales.
Growth	Growth in total assets
HCAPEX	Dummy variable equal to 1 if the observation belongs to the top quintile of abnormal capital expenditure (*ACAPEX*), 0 otherwise. We derive abnormal capital expenditure based on the McNichols and Stubben (2008) model.
HCAPEX_IND	Dummy variable equal to 1 if the difference between the firm's *CAPEXS* (capital expenditure divided by sales) and the industry median *CAPEXS* is in the top quintile in year $t-1$, 0 otherwise.
HRD	Dummy variable equal to 1 if the observation belongs to the top quintile of abnormal R&D (*ARD*), 0 otherwise. We obtain *ARD* based on the models of Berger (1993) and Gunny (2010).
HRD_IND	Dummy variable equal to 1 if the difference between the firm's *RD* (R&D divided by sales) and the industry median *RD* is in the top quintile in year $t-1$, 0 otherwise.

LCAPEX	Dummy variable equal to 1 if the observation belongs to the bottom quintile of abnormal capital expenditure (*ACAPEX*), 0 otherwise. We derive abnormal capital expenditure based on the McNichols and Stubben (2008) model.
LCAPEX_IND	Dummy variable equal to 1 if the difference between the firm's *CAPEXS* (capital expenditure divided by sales) and the industry median *CAPEXS* is in the bottom quintile in year $t-1$, 0 otherwise.
Lev	Total debt divided by total assets.
LRD	Dummy variable equal to 1 if the observation belongs to the bottom quintile of abnormal R&D (*ARD*), 0 otherwise. We obtain *ARD* based on the models of Berger (1993) and Gunny (2010).
LRD_IND	Dummy variable equal to 1 if the difference between the firm's *RD* (R&D divided by sales) and the industry median *RD* is in the bottom quintile in year $t-1$, 0 otherwise.
Moneyness	Stock price divided by estimated exercise price of exercisable stock options, less 1.
NetOperatingLoss	Dummy variable equal to 1 if the firm reports operating losses, 0 otherwise.
NewCEO	Dummy variable equal to 1 if there is a change in CEO during the year, 0 otherwise.
OC	Dummy variable equal to 1 if the CEO holds exercisable options with a moneyness of at least 100%, and has done so at least twice in the sample period, 0 otherwise.
QRT(2,3,4)	Dummy variable equal to 1 if *TobinQ* is in the second (third, fourth) quartile of its industry-year distribution.
RD	R&D expense divided by sales.
Return	Accumulated monthly stock return for the current year.
ROA	Profit before extraordinary items divided by average total assets.
Shares_Own	Shares owned by the CEO, excluding options, scaled by shares outstanding
Size	Natural log of sales revenue.
TobinQ	Total market capitalization plus book value of preferred stock, plus long-term debt, plus short-term debt all divided by total assets.
Unexercisable_Options	Number of unexercisable options owned by the CEO, scaled by shares outstanding
Δ#*Option_Grants*	Change in #*Option_Grants* from year $t-1$ to year t.
Δ#*Option_GrantsNeg*	Equals *Δ#Option_Grants*, when *Δ#Option_Grants<0* for option-granting firms, i.e. firms with non-zero option grants in the either year $t-1$ or year t (*#OptionsZerotoZero=0*), 0 otherwise.
Δ#*Option_GrantsPos*	Equals *Δ#Option_Grants*, when *Δ#Option_Grants>0* for option-granting firms, i.e. firms with non-zero option grants in either year $t-1$ or year t (*#OptionsZerotoZero*=0), 0 otherwise.
Δ#OptionsZero/Roundmultiples	Equals 1 if the firm grants the same number of stock options (*Δ#Option_Grants*) to the CEO in year t as in year $t-1$, or round multiples of the number granted in year $t-1$, 0 otherwise.
ΔBonus	Bonus in year t less salary and bonus in year $t-1$, divided by salary and bonus in year $t-1$.
ΔSalary	Salary in year t less salary in year $t-1$, divided by salary in year $t-1$.
σReturn	Standard deviation of monthly stock returns in the current year.

Figure 1: Zero option grants

Figure 2: #Option_Grants (granting firms)

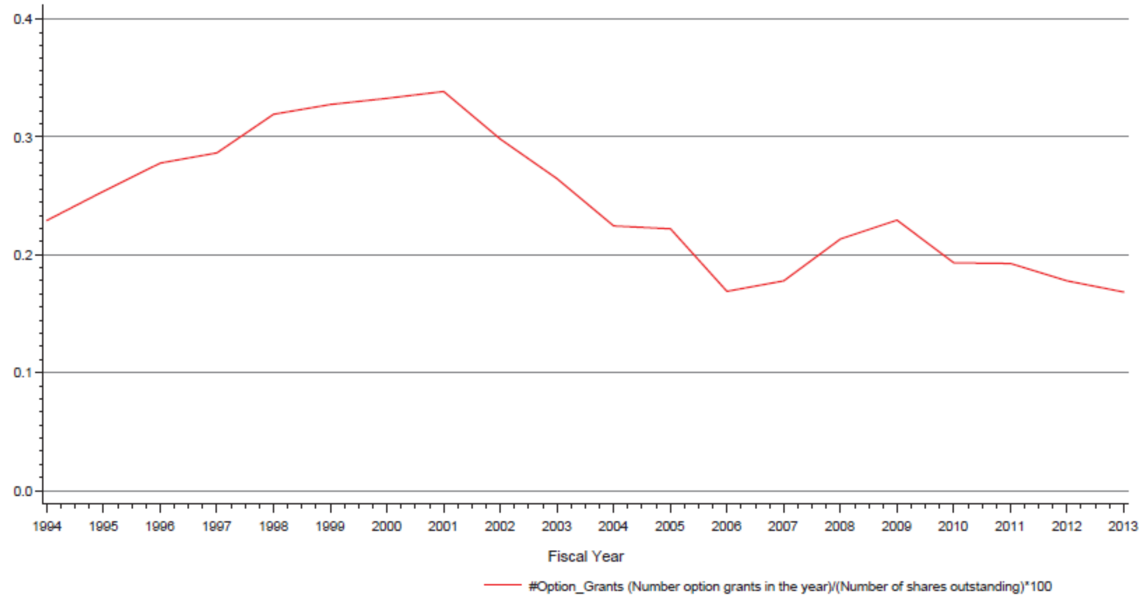

Figure 3: Zero or round multiple changes in option grants (granting firms)

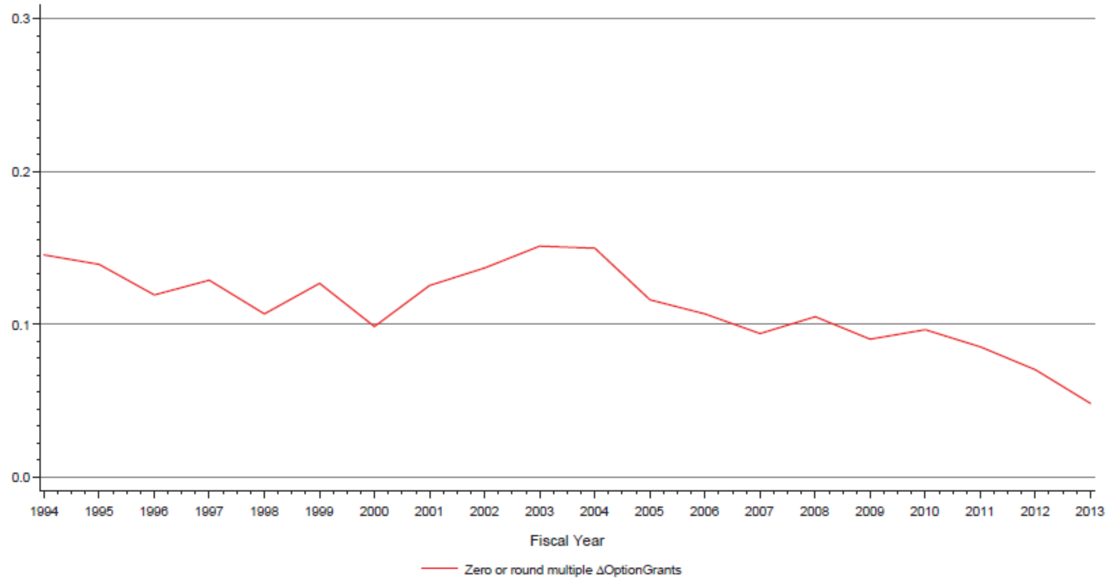

Figure 4: Positive vs. negative changes in option grants (granting firms)

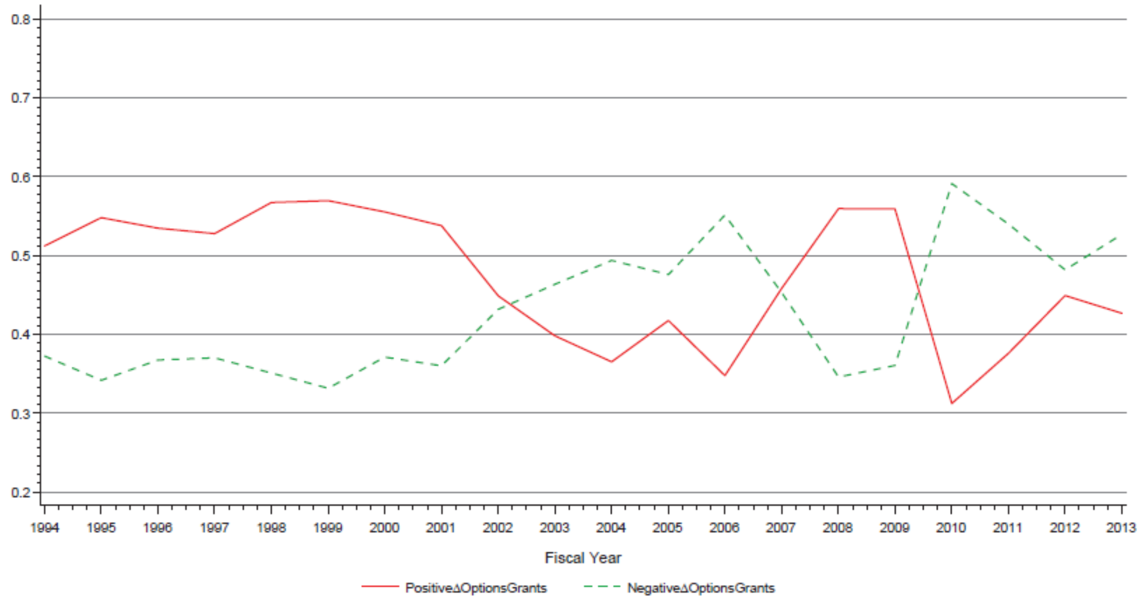

Table 1: Descriptive Statistics

This table reports descriptive statistics for our dependent variables, *Δ#Option_Grants*, *ΔSalary*, and *ΔSalBonus,* key variables of interest measuring abnormal corporate investment (R&D and capital expenditure), overconfidence, earnings management, changes in director characteristics and holdings, and changes in firm characteristics (e.g. size, growth, leverage). Our sample consists of 21,590 observations from 2,295 U.S. firms from 1994–2013. All variables are as defined in the Appendix, and are presented in the form used in the regression model.

Variable	Mean	Q1	Median	Q3	S.D.
#Option_Grants (unscaled, '000)	146.759	0.000	58.050	174.190	249.472
#Option_Grants	0.192	0.000	0.082	0.229	0.356
Δ#Option_Grants	−0.009	−0.040	0.000	0.031	0.350
Δ#Option_Grants_Pos	0.212	0.019	0.077	0.244	0.325
Δ#Option_Grants_Neg	−0.220	−0.244	−0.078	−0.018	0.345
#OptionsZero	0.336	0.000	0.000	1.000	0.472
#OptionsZerotoZero	0.229	0.000	0.000	0.000	0.420
Δ#OptionsZero/Roundmultiples	0.087	0.000	0.000	0.000	0.282
ΔSalary	0.056	0.000	0.040	0.094	0.189
ΔBonus	0.261	−0.388	0.017	0.400	1.389
ARD_{t-1}	−0.001	−0.005	0.000	0.005	0.072
$ACAPEX_{t-1}$	−0.012	−0.114	−0.033	0.051	0.198
ΔRD_{t-1}	−0.001	0.000	0.000	0.000	0.030
$\Delta CAPEX_{t-1}$	−0.012	−0.059	0.000	0.052	0.221
$\Delta CashCompensation_{t-1}$	−0.054	−0.204	−0.011	0.127	0.857
$\Delta EquityCompensation_{t-1}$	−0.218	−0.321	0.000	0.326	5.190
$\Delta Exercisable\_Options_{t-1}$	0.015	−0.035	0.024	0.160	0.422
$\Delta Unexercisable\_Options_{t-1}$	−0.013	−0.094	0.000	0.050	0.343
$\Delta Size_{t-1}$	0.087	0.000	0.078	0.170	0.205
$\Delta B/M_{t-1}$	0.013	−0.078	0.003	0.094	0.263
$\Delta Return_{t-1}$	−0.018	−0.368	−0.031	0.320	0.764
$\Delta Return_{t-2}$	−0.035	−0.391	−0.043	0.317	0.816
$\Delta Shares\_Own_{t-1}$	−0.175	−0.075	0.002	0.055	1.387
$\Delta NewCEO_{t-1}$	−0.058	0.000	0.000	0.000	0.496
$\Delta NetOperatingLoss_{t-1}$	0.001	0.000	0.000	0.000	0.263
$\Delta CashShortfall_{t-1}$	0.005	−0.069	0.001	0.075	0.174
ΔLev_{t-1}	0.002	−0.027	0.000	0.020	0.072
$\Delta \sigma Return_{t-1}$	−0.001	−0.028	−0.002	0.024	0.056

Table 2: Correlation Matrix of Variables

This table reports correlations between key variables, with Spearman (Pearson) correlation coefficients and significance levels in the upper (lower) triangle of the matrix. All variables are as defined in the Appendix, and are presented in the form used in the regression model.

Variables	*Δ#Option_Grants*	$\Delta CAPEX_{t-1}$	ΔRD_{t-1}	$LCAPEX_{t-1}$	$HCAPEX_{t-1}$	*LRDt-1*	HRD_{t-1}	OC_{t-1}	*ΔCash* $Compensation_{t-1}$	$\Delta Size_{t-1}$	$\Delta B/M_{t-1}$	$\Delta Return_{t-1}$
Δ#Option_Grants	1.000	0.002	−0.002	0.006	−0.007	−0.007	−0.025	−0.017	−0.031	−0.013	0.085	−0.083
		0.740	0.797	0.404	0.311	0.321	0.000	0.020	<.001	0.049	<.001	<.0001
$\Delta CAPEX_{t-1}$	−0.003	1.000	−0.039	−0.145	0.374	0.004	−0.024	0.066	−0.053	0.200	−0.029	−0.108
	0.711		<.001	<.001	<.001	0.512	0.001	<.001	<.001	<.001	<.001	<.0001
ΔRD_{t-1}	−0.007	−0.032	1.000	−0.017	0.016	−0.108	0.143	−0.016	0.009	−0.231	0.062	−0.043
	0.330	<.001		0.012	0.016	<.001	<.001	0.032	0.172	<.001	<.001	<.0001
$LCAPEX_{t-1}$	0.008	−0.086	−0.002	1.000	−0.239	−0.002	−0.018	−0.044	0.048	−0.071	−0.012	0.030
	0.219	<.001	0.720		<.001	0.726	0.009	<.001	<.001	<.001	0.082	<.0001
$HCAPEX_{t-1}$	−0.007	0.357	−0.001	−0.239	1.000	0.074	0.040	0.115	−0.111	0.196	0.019	−0.041
	0.337	<.001	0.911	<.001		<.001	<.001	<.001	<.001	<.001	0.005	<.0001
LRD_{t-1}	−0.001	0.000	−0.163	−0.002	0.074	1.000	−0.239	0.046	−0.051	0.065	−0.011	0.018
	0.922	0.976	<.001	0.726	<.001		<.001	<.001	<.001	<.001	0.105	0.007
HRD_{t-1}	−0.022	−0.039	0.146	−0.018	0.040	−0.239	1.000	0.056	0.001	0.016	0.028	−0.005
	0.002	<.001	<.001	0.009	<.001	<.001		<.001	0.909	0.022	<.001	0.496
OC_{t-1}	−0.009	0.041	−0.019	−0.044	0.115	0.046	0.056	1.000	−0.088	0.306	−0.114	0.010
	0.226	<.001	0.010	<.001	<.001	<.001	<.001		<.001	<.001	<.001	0.176
ΔCash $Compensation_{t-1}$	−0.031	−0.044	0.255	0.032	−0.086	−0.061	0.017	−0.064	1.000	−0.276	−0.196	0.242
	<.001	<.001	<.001	<.001	<.001	<.001	0.015	<.001		<.001	<.001	<.0001
$\Delta Size_{t-1}$	−0.008	0.164	−0.314	−0.068	0.192	0.070	−0.018	0.258	−0.337	1.000	−0.005	−0.091
	0.269	<.001	<.001	<.001	<.001	<.001	0.010	<.001	<.001		0.478	<.0001
$\Delta B/M_{t-1}$	0.071	−0.016	0.051	−0.020	0.029	−0.012	0.014	−0.078	−0.108	0.018	1.000	−0.623
	<.001	0.018	<.001	0.003	<.001	0.084	0.035	<.001	<.001	0.007		<.0001
$\Delta Return_{t-1}$	−0.067	−0.086	−0.049	0.035	−0.043	0.021	−0.005	0.001	0.171	−0.097	−0.514	1.000
	<.001	<.001	<.001	<.001	<.001	0.002	0.490	0.909	<.001	<.001	<.001	

Table 3: R&D, capital expenditures and changes in CEO option-based compensation

The table reports regression results of estimating changes in the number of option grants on R&D investment, capital expenditure, and a set of control variables. $\Delta\#Option\_Grants_{it}$ is measured as the change in the number of options granted scaled by shares outstanding from year $t-1$ to year t. $LCAPEX_{t-1}$ and $HCAPEX_{it-1}$ are indicator variables for firms with abnormal capital expenditure in the bottom and top quintiles in year $t-1$. LRD_{t-1} and HRD_{it-1} are indicator variables for firms with abnormal R&D expense in the bottom and top quintiles in year $t-1$. Our sample consists of 21,590 observations from 2,295 U.S. firms from 1994–2013. Detailed definitions of all variables are provided in the Appendix. *t*-statistics are shown in parentheses with significance indicated at ***p<0.01, ** p<0.05, * p<0.10. The equations have been estimated using pooled OLS regressions with errors clustered by firm. Year dummies are omitted for brevity.

Variables	$\Delta\#Option\_Grants_{it}$					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
$LCAPEX_{t-1}$	−0.018***	−0.018***			−0.015**	−0.014**
	(−2.91)	(−3.20)			(−2.35)	(−2.33)
$HCAPEX_{t-1}$	−0.009	−0.016***			−0.008	−0.013**
	(−1.43)	(−2.63)			(−1.21)	(−2.21)
LRD_{t-1}			−0.003	−0.008	−0.000	−0.005
			(−0.50)	(−1.53)	(−0.03)	(−0.94)
HRD_{t-1}			−0.018***	−0.025***	−0.015***	−0.022***
			(−3.36)	(−4.82)	(−2.65)	(−4.03)
$\Delta CAPEX_{,t-1}$	−0.006	−0.008	−0.003	−0.010	−0.006	−0.009
	(−0.35)	(−0.50)	(−0.21)	(−0.66)	(−0.38)	(−0.54)
ΔRD_{t-1}	−0.191	−0.292**	−0.159	−0.256**	−0.160	−0.255**
	(−1.54)	(−2.49)	(−1.26)	(−2.16)	(−1.27)	(−2.15)
$\Delta Size_{t-1}$	−0.036**	−0.080***	−0.037***	−0.082***	−0.036**	−0.079***
	(−2.50)	(−5.31)	(−2.61)	(−5.53)	(−2.45)	(−5.25)
$\Delta B/M_{t-1}$	0.099***	0.057***	0.098***	0.057***	0.099***	0.057***
	(6.45)	(3.84)	(6.42)	(3.85)	(6.45)	(3.86)
$\Delta Return_{t-1}$		−0.015**		−0.014**		−0.015**
		(−2.54)		(−2.39)		(−2.48)
$\Delta Return_{t-2}$		−0.008		−0.007		−0.007
		(−1.60)		(−1.45)		(−1.55)
$\Delta CashCompensation_{t-1}$		0.003		0.002		0.002
		(0.53)		(0.50)		(0.49)
$\Delta Exercisable\_Options_{t-1}$		−0.045***		−0.045***		−0.045***
		(−4.39)		(−4.38)		(−4.38)
$\Delta Unexercisable\_Options_{t-1}$		−0.412***		−0.412***		−0.412***
		(−27.71)		(−27.76)		(−27.77)
$\Delta Shares\_Own_{t-1}$		−0.001		−0.001		−0.001
		(−0.35)		(−0.30)		(−0.35)
$\Delta NewCEO_{t-1}$		−0.022***		−0.022***		−0.022***
		(−3.56)		(−3.59)		(−3.61)
$\Delta NetOperatingLoss_{t-1}$		0.001		0.001		0.001
		(0.09)		(0.07)		(0.09)
$\Delta CashShortfall_{t-1}$		0.020		0.020		0.020
		(1.15)		(1.15)		(1.15)
ΔLev_{t-1}		0.112***		0.110***		0.112***
		(2.98)		(2.94)		(2.97)
$\Delta\sigma Return_{t-1}$		0.066		0.064		0.063
		(1.05)		(1.01)		(1.01)
Year Dummies	YES	YES	YES	YES	YES	YES
Observations	21,590	21,590	21,590	21,590	21,590	21,590
Number of firms	2,295	2,295	2,295	2,295	2,295	2,295
Adjusted R^2	0.0080	0.1681	0.0080	0.1683	0.0082	0.1686

Table 4: R&D, Capital expenditures, overconfidence, and changes in CEO option-based compensation

The table reports regression results of changes in the number of option grants on overconfidence, R&D, capital expenditure, and a set of control variables. $\Delta\#Option\_Grants_{it}$ is measured as the change in the number of options granted scaled by shares outstanding from year $t-1$ to year t. OC_{it-1} is an indicator variable for firms with overconfidence CEOs. LRD_{t-1} and HRD_{it-1} are indicator variables for firms with abnormal R&D expense in the bottom or top quintiles in year $t-1$, and $LCAPEX_{t-1}$ and $HCAPEX_{it-1}$ are indicator variables for firms with abnormal capital expenditure in the top quintile in year $t-1$. Our sample consists of 17,940 observations from 2,155 U.S. firms from 1994–2013 with data available on CEOs' exercisable stock options. The vector of control variables includes those reported in Table 3. Detailed definitions of all variables are provided in the Appendix. t-statistics are shown in parentheses with significance indicated at *p<0.01, ** p<0.05, * p<0.10. The equations have been estimated using pooled OLS regressions with errors clustered by firm. Remaining control variables and year dummies are omitted for brevity.

Variables	$\Delta\#Option\_Grants_{it}$	
	(1)	*(2)*
OC_{t-1}	−0.020***	−0.016***
	(−3.99)	(−3.11)
$LCAPEX_{t-1}$		−0.014**
		(−2.14)
$HCAPEX_{t-1}$		−0.015**
		(−2.35)
LRD_{t-1}		−0.010*
		(−1.79)
HRD_{t-1}		−0.022***
		(−3.74)
$\Delta CAPEX_{t-1}$		0.001
		(0.04)
ΔRD_{t-1}		−0.216*
		(−1.90)
$\Delta Size_{t-1}$	−0.056***	−0.060***
	(−3.39)	(−3.65)
$\Delta B/M_{t-1}$	0.033**	0.035**
	(2.08)	(2.18)
Remaining Controls	YES	YES
Year Dummies	YES	YES
Observations	17,940	17,940
Number of firms	2,155	2,155
Adjusted R^2	0.1667	0.1684

Table 5: R&D, Capital expenditures, overconfidence, and changes in CEO option-based compensation – industry based measures

The table reports regression results of changes in the number of option grants on overconfidence, R&D, capital expenditure, and a set of control variables. $\Delta\#Option\_Grants_{it}$ is measured as the change in the number of options granted scaled by shares outstanding from year $t-1$ to year t. OC_{it-1} is an indicator variable for firms with overconfidence CEOs. LRD_IND_{t-1} and HRD_IND_{it-1} are indicator variables for firm years where the difference between the firm's *RD* (R&D divided by sales) and the industry median *RD* is in the bottom or top quintiles in year $t-1$, and $LCAPEX\_IND_{t-1}$ and $HCAPEX\_IND_{it-1}$ are indicator variables for firms years where the difference between the firm's *CAPEXS* (capital expenditure divided by sales) and the industry median *CAPEXS* in the top quintile in year $t-1$. Our sample consists of 21,590 observations from 2,295 U.S. firms from 1994−2013 and 17,940 observations with data available on CEOs' exercisable stock options. The vector of control variables includes those reported in Table 3. Detailed definitions of all variables are provided in the Appendix. *t*-statistics are shown in parentheses with significance indicated at *p<0.01, ** p<0.05, * p<0.10. The equations have been estimated using pooled OLS regressions with errors clustered by firm. Remaining control variables and year dummies are omitted for brevity.

Variables	$\Delta\#Option\_Grants_{it}$	
	(1)	*(2)*
OC_{t-1}		−0.015***
		(−3.02)
$LCAPEX\_IND_{t-1}$	−0.011*	−0.009*
	(−1.66)	(−1.66)
$HCAPEX\_IND_{t-1}$	−0.026***	−0.029***
	(−3.58)	(−3.72)
LRD_IND_{t-1}	−0.000	−0.006
	(−0.06)	(−1.41)
HRD_IND_{t-1}	−0.016***	−0.017**
	(−2.89)	(−2.53)
$\Delta CAPEX\_IND_{t-1}$	−0.271**	−0.220*
	(−2.31)	(−1.96)
ΔRD_{t-1}	−0.000	0.009
	(−0.02)	(0.58)
$\Delta Size_{t-1}$	−0.076***	−0.056***
	(−4.94)	(−3.37)
$\Delta B/M_{t-1}$	0.057***	0.034**
	(3.82)	(2.16)
Remaining Controls	YES	YES
Year Dummies	YES	YES
Observations	21,590	17,940
Number of firms	2,295	2,155
Adjusted R^2	0.1685	0.1666

Table 6: Capital expenditures, R&D and changes in other elements of CEO compensation

This table reports regression results of changes in cash-based compensation on changes in R&D, capital expenditure, and a set of control variables. $\Delta Salary_{it}$ and $\Delta Bonus_{it}$ are measured as the percentage change in salary and bonus, respectively, from year $t-1$ to year t. $LCAPEX_{t-1}$ and $HCAPEX_{t-1}$ are indicator variables for firms with abnormal capital expenditure in the bottom and top quintiles in year $t-1$. LRD_{t-1} and HRD_{t-1} are indicator variables for firms with abnormal R&D expense in the bottom and top quintiles in year $t-1$. The vector of control variables is similar to that used in Table 3, with the exception of cash based compensation, which has been replaced with equity based compensation. Our sample consists of 21,489 (17,687) observations from 2,291 (2,191) U.S. firms which have non-zero lagged salary (bonus) data from 1994–2013. Detailed definitions of all variables are provided in the Appendix. *t*-statistics are shown in parentheses with significance indicated at ***p<0.01, ** p<0.05, * p<0.10. The equations have been estimated using pooled OLS regressions with errors clustered by firm. Remaining control variables and year dummies are omitted for brevity.

Variables	$\Delta Salary_{it}$ *(1)*	$\Delta Bonus_{it}$ *(2)*
$LCAPEX_{t-1}$	0.003	−0.032
	(0.87)	(−1.19)
$HCAPEX_{t-1}$	0.010***	−0.039
	(2.92)	(−1.43)
LRD_{t-1}	0.002	0.050**
	(0.62)	(1.98)
HRD_{t-1}	0.003	0.068**
	(0.96)	(2.50)
$\Delta CAPEX_{,t-1}$	−0.018**	0.012
	(−2.31)	(0.21)
ΔRD_{t-1}	0.024	−0.497
	(0.43)	(−1.29)
$\Delta EquityCompensation_{t-1}$	0.001***	0.001
	(3.18)	(0.49)
$\Delta Size_{t-1}$	0.090***	−0.295***
	(10.25)	(−4.90)
$\Delta B/M_{t-1}$	−0.046***	−0.313***
	(−6.09)	(−4.23)
Remaining Controls	YES	YES
Year Dummies	YES	YES
Observations	21,489	17,687
Number of firms	2,291	2,191
Adjusted R^2	0.0492	0.0804

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