Executive Overconfidence and Compensation Structure*

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Abstract

We examine the impact of overconfidence on the structure of compensation. Prior theoretical literature suggests that incentive-heavy compensation contracts are offered to overconfident CEOs to take advantage of their overly-positive view of firm prospects (the *exploitation hypothesis*). We extend the prior theoretical work to suggest that option compensation can incentivize overconfident CEOs (the *strong-incentive hypothesis*). Our empirical evidence is more consistent with the exploitation hypothesis. We also find overconfidence is associated with non-CEO executives being compensated with more option incentives, independent of CEO overconfidence. Our results indicate that compensation contracts are tailored to individual behavioral traits such as overconfidence.

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1 Introduction

There is a burgeoning literature on the impact of CEO overconfidence on corporate policies. The literature suggests that overconfident CEOs are prone to overestimate returns to investments and to underestimate risks (Dittrich et al., 2005). As a result, overconfident CEOs are often associated with more innovative outcomes and a willingness to take risks (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). On the down side, they also tend to overinvest, often in excessively risky projects (Kolasinski and Li, forthcoming; Malmendier and Tate, 2005 and 2008). Little is known about whether the structure of compensation contracts for overconfident managers is different from that of rational managers, i.e., whether firms "fine-tune" their compensation contracts to match a manager's personality traits. We fill this gap.

Our objective is to study whether, and how, overconfidence influences incentive compensation. While we expect that compensation contracts might differ for overconfident CEOs, the nature of these differences is not obvious. On the one hand, overconfident CEOs may receive a compensation contract with weak incentives in the form of options or restricted stock. This is because overconfident managers tend to assign a higher probability to a successful outcome compared to rational managers. With their overly positive view of future firm value, a smaller equity stake might be sufficient to induce overconfident managers to deliver the required effort or to make the appropriate decision.[1] It is also possible for strong incentives to be counterproductive, since such incentives could exacerbate risk-taking by an already overconfident manager. We refer to this as the *weak-incentive hypothesis*, which predicts a negative association between overconfidence and incentive intensity of compensation contracts.

[1] Throughout the paper, when we refer to equity we are referring to both options and stock.

On the other hand, Gervais, Heaton and Odean (2011) [hereafter GHO] argue that it can be optimal to offer stronger incentive contracts to overconfident CEOs.[2] Their insight is that if an overconfident CEO places a sufficiently high probability on good outcomes, it is relatively inexpensive for the firm to offer a compensation package with high option and stock intensity. Hence, on the margin, the purpose of a compensation contract with high equity intensity is to take advantage of the CEO's misvaluation rather than to provide incentives. We call this the *exploitation hypothesis*, which predicts a positive association between overconfidence and incentive intensity of compensation contracts.

We develop a simple extension of GHO's model to show that the need to provide incentives can also lead to overconfident managers being offered compensation contracts with greater incentives. We refer to this as the *strong-incentive hypothesis*. The intuition behind this theory is that it is relatively cheaper to provide incentive-compensation to overconfident CEOs than to non-overconfident CEOs. Thus, in some cases, it can be cost-effective to provide incentives to overconfident CEOs but not to non-overconfident CEOs. This implies a positive association between overconfidence and incentive intensity of compensation contracts.

While both the exploitation hypothesis and the strong-incentive hypothesis imply that overconfident CEOs will be compensated with greater option incentives, there are two key differences. The first is that the compensation contract for an overconfident CEO will have *incentive slack* under the exploitation hypothesis. The notion is that a modest reduction in equity intensity should not have a material effect on the actions of the CEO or on firm value (other than through a decrease in CEO exploitation). On the contrary, the strong-incentive hypothesis predicts a reduction in equity intensity will lead to a reduction in firm value since equity provides

[2] GHO differentiate between mild overconfidence and excessive overconfidence. The weak-incentive hypothesis we outlined earlier aligns with GHO's mild overconfidence scenario. Throughout the paper, when we refer to overconfidence, we refer to excessive overconfidence in the GHO framework.

incentives. The second difference relates to the effect of an increase in the CEO's bargaining position with the firm. As discussed in GHO, the exploitation hypothesis predicts an increase in option intensity. As the CEO's bargaining power increases, he/she will demand higher total compensation. Since overconfident CEOs overvalue equity, the increase in CEO compensation takes the form of even more equity-based pay. On the contrary, the strong-incentive hypothesis predicts a decrease in option intensity because an increase in CEO compensation takes the form of more cash pay due to there not being any incentive slack.

We conduct empirical tests to explore the relation between CEO overconfidence and incentive compensation and to differentiate among the three hypotheses (weak-incentive, exploitation and strong-incentive hypotheses). We use the compensation data of CEOs between 1994 and 2011 to create options-based measures of overconfidence.[3] These are premised on the idea that a manager's human capital and compensation are tied to the company, rendering the CEO undiversified. Consequently, a rational CEO exercises options as soon as the options vest. Thus, holding deep-in-the-money options indicates overconfidence. We check that the results are robust to using media-based measures of overconfidence.

Consistent with both the exploitation and the strong-incentive hypotheses, but inconsistent with the weak-incentive hypothesis, CEO overconfidence increases option intensity and stock intensity, measured as the proportion of compensation that comes from options and stock, respectively. We find some evidence that overconfident CEOs feature even greater option (and stock) intensity in innovative and risky firms.

We use the passage of the Sarbanes-Oxley Act of 2002 (SOX) as an exogenous shock to the optimal compensation contract. SOX exposed CEOs to significantly higher risk and board

[3] We follow the recent finance literature in creating our overconfidence measure. See, amongst others, Campbell et al (2011), Malmendier et al (2011) and Hirshleifer et al (2012).

monitoring. Firms would thus lower option intensity to adjust for the CEO's risk exposure. In addition, if incentive compensation and board monitoring are substitute governance mechanisms, we would also find SOX being associated with a reduction in option intensity. . However, this reduction is less severe for overconfident CEOs since these CEOs tend to underestimate risks.

We supplement the CEO-level results with evidence on the compensation of overconfident non-CEO executives. We hypothesize and find that overconfidence impacts non-CEO executive compensation in a similar manner to which it impacts CEO compensation. That is, overconfident executives also receive higher levels of option and stock intensity than do non-overconfident executives. Importantly, the impact of executive overconfidence on compensation does not depend on whether the CEO is also overconfident. This indicates incentive compensation is being driven by the same economic rationale, reflecting individual traits and not merely firm-level characteristics.

The above results are consistent with both the exploitation hypothesis and the strong-incentive hypothesis. Next, we conduct tests to differentiate between these two hypotheses. In particular, we first examine the relation between the CEO's bargaining power and incentive compensation. With increased pay slice and salary increases of all other executives in the same industry and state as two separate proxies of the CEO's enhanced bargaining power, we find that the positive relation between overconfidence and option (and equity) intensity increases with the CEO's bargaining power. These findings are consistent with the exploitation hypothesis, but inconsistent with the strong-incentive hypothesis. We next use the passage of FAS 123R as a natural experiment to further differentiate between the exploitation hypothesis and the strong-incentive hypothesis. FAS 123R requires firms to report option-based compensation at fair value on the income statement, thus rendering options-based compensation more expensive from an

accounting perspective.[4] Both Hayes et al (2012) and Skantz (2012) show option intensity decreases following the passage of FAS 123R. We find this trend similarly affects overconfident and non-overconfident CEOs. While the percentage decrease in option intensity is similar, we find that the dollar amount of stock and cash compensation increases more for overconfident CEOs post FAS 123R. This is consistent with the exploitation hypothesis since cash and stocks are more expensive forms of compensation for overconfident CEOs. In addition, we find the exogenous increase in the accounting cost of option compensation, and the resulting decrease in option use, has an insignificant effect on firm value for overconfident CEOs compared with non-overconfident CEOs. This result suggests that compensation packages for overconfident CEOs have incentive slacks, again consistent with the exploitation hypothesis but inconsistent with the strong-incentive hypothesis.

We take steps to mitigate various econometric concerns. The two natural experiments (SOX and FAS 123R) help to mitigate endogeneity concerns as both are exogenous shocks that affect the compensation contract and thus the impact of CEO overconfidence on compensation. Our results are robust to using propensity score matching and weighting-based approaches, which also mitigate the concern that firms hiring overconfident CEOs are inherent different. In addition our inferences are unaffected when we control for anti-takeover provisions and the general ability of CEOs . Our results are also robust to alternative measures of overconfidence and constraining the sample to CEOs with material option compensation When we use the Fama and MacBeth (1973) type regression and tobit regressions, our inferences are unchanged. Finally, when we examine pay-performance-sensitivity as an alternative measure of incentive compensation, our inferences stays the same.

[4] Prior to the implementation of FAS 123R firms were allowed to expense stock options at intrinsic value, which in most cases was zero as firms usually grant at-the-money stock options.

Our analysis of overconfidence contributes to the literature in several ways.[5] Supporting the theoretical arguments in GHO, we document empirical evidence suggesting that overconfident CEOs are exploited for their overly positive view of the firm's prospects and/or their ability, hence compensated with greater option and equity incentives. Our results suggest that firms "fine-tune" their contracts to match a manager's personality traits such as overconfidence.

We also contribute to the literature by investigating whether the overconfidence of top executives outside of the CEO also impacts compensation. To the best of our knowledge, we are the first to do so. As Malmendier et al (2011) point out, it is imperative for boards to calibrate incentives to account for behavioral traits. We find executive overconfidence impacts compensation for non-CEO executives in a similar manner to which it impacts CEOs. Moreover, the impact is independent of the CEO's level of overconfidence. This is important as it highlights boards write compensation contracts that reflect *individual* behavioral traits such as overconfidence, and not merely firm-level characteristics.

The remainder of our paper is organized as follows. Section 2 develops and contains the hypotheses. Section 3 discusses the data. We present the empirical analyses in Section 4 and examine whether the relation between overconfidence and compensation represents efficient contracting in Section 5. Section 6 reports robustness tests and Section 7 concludes.

[5] In a related paper, Otto (Forthcoming) distinguishes between optimism and overconfidence (as modeled in GHO). He argues firms provide weaker incentives to optimistic CEOs because incentive compensation is less necessary to motivate optimistic managers (similar in spirit to the weak-incentive hypothesis). Focusing on optimism and the level of compensation, he finds optimistic CEOs receive smaller stock option grants and less total compensation than their peers. In contrast, our analysis focuses on overconfidence as modeled in GHO and the structure of compensation (i.e., the proportion, rather than the level, of compensation attributable to incentives).

2 Hypotheses

In Section 2.1 we briefly discuss and provide the intuition for our main ideas. This discussion forms the basis of our empirical predictions in Section 2.2. Our arguments are presented more fully (and formally) in Appendix 1. While we focus exclusively on CEOs, many of the insights from Section 2.1 extend, to some degree at least, to other senior executives.

2.1 Contracting with Overconfident CEOs

GHO provide a theoretical analysis of optimal incentive contracting when the CEO is overconfident about her ability and/or the firm's prospects. They consider two possibilities depending on the extent of the CEO's overconfidence.

The first case, we label the *weak-incentive hypothesis*, is when the CEO is mildly overconfident. Since the CEO expects success with a higher-than-rational likelihood, weaker incentives are sufficient to induce appropriate investment choices or effort by the CEO. As a result, the overconfident CEO receives less incentive pay than an otherwise rational CEO

The second possibility, we label as the *exploitation hypothesis*, is when the CEO is extremely overconfident and becomes, in a sense, 'risk-preferring'. Despite being risk-averse, she is so confident of success that she places a higher value on cash flows that are contingent on success than the risk-neutral, rational firm (i.e., board). As a result it is "cheaper" for a rational firm to provide her with an incentive-laden (i.e. option-intensive) compensation contract.

We provide an alternative to the *exploitation hypothesis* developed in GHO that we term the *strong-incentive hypothesis*. In what follows, we produce a slimmed down variant of the GHO model that can be regarded, in effect, as a counter-example to some of the implications from their model. Our main objective is to show that stronger incentive contracts for overconfident CEOs do not necessarily imply CEO overconfidence is being exploited. Our

argument is that incentives offered to overconfident CEOs and rational CEOs could differ because it may be optimal to induce overconfident CEOs to choose a different set of projects or a different scale for otherwise similar projects. A more detailed version of our argument is in Appendix 1.

Outline of Main Idea:

Here we illustrate our main idea through a simple example. There is a project with two stages. The first stage involves an investment. The second stage involves an expansion option. The reservation wage for the CEO is *R*. However, the CEO requires additional compensation for exerting effort. In the first stage, the project pays σ_1 if it is successful and 0 if it is not. The probability of success is 0.5 if the CEO puts in effort that she values at 1, otherwise the project fails. At this stage, we assume that overconfident and non-overconfident CEOs have the same beliefs about the first-stage project (i.e., it is a relatively non-information-intensive project). The CEO is paid a base-pay of R. In order to induce the CEO to put in (unobserved) effort, the firm offers the CEO an equity stake so that she receives β_1 if the project succeeds and 0 otherwise. To capture risk-aversion, we follow GHO and assume that managers apply a discount rate of $\rho < 1$ to risky payoffs. Thus, the firm will set bonus compensation such that the CEO expects to recoup her effort cost, i.e., $0.5\beta_1\rho = 1$.

In the second stage, the CEO decides whether to undertake the expansion option. The expansion pays σ_2 if it succeeds and zero otherwise. The probability of success is η_2. Thus, the expected payoff to the company is $\eta_2\sigma_2$. The expansion option again requires effort from the CEO she values at 1, for which the firm will need to incentivize her. One way to structure this is through option compensation. Given that this expansion option is available only if the first stage

succeeds, the firm will want to provide an option contract that becomes in-the-money if the first stage succeeds. That is, it will have a strike price of σ_1 (the payoff from the first stage). The options will then payoff some amount β_2.

The required compensation differs between the overconfident CEO and the rational CEO. The overconfident CEO believes the project will succeed with probability η_2^* ($> \eta_2$). Thus, to the overconfident CEO the compensation is worth $\rho\eta_2^*\beta_2$, while to the rational CEO the compensation is worth $\rho\eta_2\beta_2$. In order to induce the CEO to exert the required effort, the compensation needs to satisfy $\rho\eta_2^*\beta_2 = 1$ for the overconfident CEO, or $\rho\eta_2\beta_2 = 1$ for the rational CEO. However, it is easy to see that there can exist ρ, η_2 and η_2^* such that $\rho\eta_2\beta_2 < 1$, while $\rho\eta_2^*\beta_2 > 1$.[6] That is, there exists a $\beta_2 < \sigma_2$ such that it is optimal to induce the overconfident manager (but not the rational manager) to take up the expansion project. The rational CEO would not be offered a contract to take-up the second-stage project since incentivizing the rational CEO would mean paying her more than the firm would make from the project. Therefore, in this case, the overconfident CEO would receive more options than the rational CEO. The options are intended to induce effort on the part of the overconfident manager, rather than to exploit her overconfidence.

Numerical Example:

To make this more concrete, we provide a numerical example. Suppose the expansion project has a payoff of 6 if it succeeds and 0 otherwise. The CEO's (risk-aversion) discount factor is $\rho = 0.7$ and the effort required is valued at 1 by the CEO. The probability of success is $\eta_2 = 0.2$. Thus, the expected NPV (excluding compensation) is 6*0.2=1.2. The overconfident

[6] We also assume $\rho^2\eta_2^* < \eta_2$, the non-exploitation assumption, in order to rule out the possibility of certain extreme contracts e.g., the possibility that the CEO is compensated entirely in pay that is contingent on the success of both projects. This is discussed more fully in Appendix 1.

CEO believes the expansion has a probability of success $\eta_2^* = 0.4$. The overconfident (OC) CEO will take the expansion project only if her payoff is at least as much as the effort required (which is normalized to 1), i.e., $\eta_2^* \rho \beta_2^{oc} = 1$. The non-overconfident (NOC) CEO will take the expansion only if her payoff is $\eta_2 \rho \beta_2^{noc} = 1$. Thus, substituting in the parameters and solving these equations produces $\beta_2^{oc} = 3.57$ and $\beta_2^{noc} = 7.14$. So, the NPV to the firm from paying $\beta_2^{oc} = 3.57$ is 0.2*(6-3.57)=0.49 but from paying $\beta_2^{noc} = 7.14$ is 0.2*(6-7.14)=-0.23. Therefore, it would be optimal to give the overconfident CEO options at time 0 with strike price σ_1 but not to give options to the rational CEO.

We illustrate this further by simulating the NPV of the project for various discount factors ρ. We calculate the required compensation for the overconfident manager and the rational manager and the subsequent project NPV. We assume again that $\eta_2 = 0.2$, $\eta_2^* = 0.4$ and the expansion project has a payoff of 6 if it succeeds and 0 otherwise. We then iterate through values of ρ from 0.10 to 0.99 in order to find β_2^{oc} and β_2^{noc} such that $\eta_2^* \rho \beta_2^{oc} = 1$ and $\eta_2 \rho \beta_2^{noc} = 1$. The resulting project NPVs for various values of ρ are in Figure 1. The important point is that with an overconfident CEO it is possible to design an incentive contract that yields a positive NPV for a greater range of ρ values relative to a rational CEO. This suggests option contracts can be useful in several situations for overconfident CEOs even if options are not optimal to incentivize rational CEOs.

Bargaining Power

For reasons that will become apparent shortly, we extend the above analysis to consider the impact of labor market competition on the incentives provided to overconfident CEOs. The expected pay for the overconfident CEO is $\mathrm{E(pay)} = \mathrm{R} + 0.5\beta_1 + 0.5(\eta_2^*)\beta_2$, where "$\mathrm{R}$" represents the reservation wage, "$0.5\beta_1$" represents the compensation from a successful first

stage of the project and "$0.5(\eta_2^*)\beta_2$" represents the compensation for the overconfident CEO from the second-stage expansion project (recall the probability of success in the first stage is 0.5). Thus, the equity intensity for the overconfident CEO is

$$\Gamma = \frac{0.5\beta_1 + 0.5(\eta_2^*)\beta_2}{R + 0.5\beta_1 + 0.5(\eta_2^*)\beta_2}.$$

We consider the scenario in which there is a reduction in labor market competition (i.e. improvement in the CEO's bargaining position). Here, the CEO can potentially demand higher compensation. This could come from either an increase in the base reservation wage (i.e. R) or from an increase in incentive pay (i.e., β_1, β_2). The firm will increase incentive pay if the CEO values that incentive pay more than the firm does. At the time of the entering into the contract (i.e. before the first stage), the overconfident CEO values one dollar of incentive pay at a rate of $0.5\rho^2\eta_2^*$, whereas the firm values it at the larger value of $0.5\eta_2$. Given our non-exploitation assumption that $\rho^2\eta_2^* < \eta_2$ (see footnote 6), the firm prefers to pay the overconfident CEO in the form of fixed pay, rather than incentive pay which would be more costly for the firm. Hence, an improvement of the CEO's bargaining position results in a decrease in equity intensity. This is contrary to the prediction from the "exploitation" case in GHO in which the CEO's overvaluation of incentive pay is so large that an increase in bargaining power leads to even more incentive pay.

The implication of the above discussion is that incentive contracts provided to overconfident managers can serve an incentive purpose. While both the exploitation and the strong-incentive hypotheses predict overconfident CEOs will receive option-intensive contracts, there are at least two implications where the hypotheses differ.

1. *Incentive Slack:* Under the *exploitation hypothesis* the compensation contract offered to an overconfident CEO has incentive slack in the sense that a small reduction in incentive

pay will not materially affect the actions of the CEO and thus not affect firm value. Under the *strong-incentive hypothesis*, the compensation contract offered to overconfident CEOs does not have incentive slack. Hence, weakening option incentives will have value implications under the strong-incentive hypothesis but not the exploitation hypothesis.

2. *Bargaining Power:* Under the *exploitation hypothesis*, an increase in CEO bargaining power leads to overconfident CEOs receiving even greater incentive pay. The rationale, as pointed out by GHO, is since the overconfident CEO overvalues incentive pay, increases in her bargaining power take the form of relatively more equity. Under the *strong-incentive hypothesis*, on the contrary, an increase in an overconfident CEO's bargaining power results in incentive pay becoming a smaller fraction of total pay (i.e., a drop in incentive intensity).

2.2 Empirical predictions

This section presents the empirical predictions that flow from the *weak-incentive hypothesis* (discussed above), the *exploitation hypothesis* (per GHO) and the *strong-incentive hypothesis* (discussed above). We test these predictions in the following sections of the paper.

Overconfidence and compensation

Under the weak-incentive hypothesis, given an overconfident CEO's relatively positive view of future firm value, a smaller equity stake is sufficient to induce overconfident managers to deliver the required effort or to make the appropriate decision. Under the exploitation hypothesis, firms pay overconfident CEOs more with options and equity because overconfident CEOs are more likely to believe they can increase corporate value and thus, extract greater value

from such contracts. Under the strong-incentive hypothesis, firms are also willing to provide such equity-linked contracts due to the potential to incentivize overconfident CEOs in situations in which it is not optimal to incentivize non-overconfident CEOs. Thus, we have:

Hypothesis 1a (weak-incentive): CEO overconfidence reduces the proportion of their compensation that comes from options and/or stock.

Hypothesis 1b (exploitation and strong-incentive): CEO overconfidence increases the proportion of their compensation that comes from options and/or stock.

For the remainder of this section we will focus on predictions from the exploitation and strong-incentive hypotheses as predictions from the weak-incentive hypothesis are either opposite the strong-incentive hypothesis or ambiguous.

Corporate innovativeness and risk

We expect overconfident CEOs to receive more option/stock-based compensation in firms that are more innovative or riskier. GHO argue highly overconfident CEOs are attracted to riskier and innovative companies, which are more likely to use incentive-based compensation. Overconfident CEOs are more likely to believe they can increase corporate value and thus, are more likely to accept, and potentially pursue, incentive-intensive compensation contracts. Such an assumption by overconfident CEOs is not baseless: prior literature suggests that overconfident CEOs tend to perform better in more innovative companies (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). Thus, we have the following hypothesis:

Hypothesis 2: The option intensity of compensation awarded to overconfident CEOs (i.e. the proportion of compensation that comes from options) is greater in innovative firms and riskier firms.

Impact of CEO bargaining power

Under the exploitation hypothesis, an increase in CEO bargaining power leads to overconfident CEOs receiving even greater incentive pay. Under the strong-incentive hypothesis, an increase in an overconfident CEO's bargaining power results in incentive pay becoming a smaller fraction of total pay (i.e., a drop in incentive intensity). That is:

Hypothesis 3a: Under the exploitation hypothesis, there is a positive relation between CEO bargaining power and the option intensity of compensation.

Hypothesis 3b: Under the strong-incentive hypothesis, there is a negative relation between CEO bargaining power and the option intensity of compensation.

Impact of the Sarbanes-Oxley Act (SOX) of 2002

We expect SOX to be associated with a reduction in option intensity, but this will be less severe for overconfident CEOs. SOX is likely to result in a general reduction in incentive compensation for at least two reasons. First, corporations must be cognizant of the CEO's risk exposure when designing optimal incentive contracts (Aggarwal, 2008). SOX exposed CEOs to significantly more personal liability by, for example, requiring them to personally certify

financial statements (Arping and Sautner, 2013). SOX was also associated with significant increases in risk to directors and increases in D&O insurance premiums (Linck et al., 2009). This can result in granting CEOs compensation contracts that are less risky. Second, monitoring and incentive compensation are arguably substitutes. For example, Cadman et al (2010) indicate that incentive compensation decreases with institutional monitoring. SOX increased monitoring by, for example, mandating a majority independent board and a fully independent audit committee. Thus, to the extent that monitoring and incentive compensation are substitutes, SOX leads to a shift away from option-based compensation.

SOX, however, is likely to have a weaker impact on overconfident CEOs. Under the strong-incentive hypothesis, option-based compensation is an efficient way to compensate overconfident CEOs. Similarly, under the exploitation hypothesis option-based compensation is a relatively cheap way to compensate overconfident CEOs. Hence, in either case we expect SOX will have a less severe impact on overconfident CEOs relative to other CEOs. Thus, we have the following hypotheses:

Hypothesis 4a: SOX reduces the option intensity of CEO compensation.

Hypothesis 4b: SOX reduces the option intensity of CEO compensation less for overconfident CEOs.

Non-CEO Executive overconfidence and compensation

To the extent that the arguments in Section 2.1 carry over to senior executives – i.e. options provide a strong incentive to overconfident managers (strong-incentive hypothesis) or

that option-based compensation is a relatively "cheap" way to compensate overconfident managers (exploitation hypothesis) – we expect overconfident executives, similar to overconfident CEOs, will also have an incentive-intensive compensation package. That is, we expect overconfident executives to have higher levels of option intensity and/or stock intensity. We thus have:

> *Hypothesis 5: Executive overconfidence increases the option intensity and/or the stock intensity of executive compensation.*

Moreover, we expect the intuition behind Hypotheses 2, 3 and 4 to also extend, to some extent at least, to overconfident executives.

Efficiency of the compensation of overconfident CEOs and executives

The next issue is whether the relation between compensation and overconfidence represents efficient contracting. GHO argue that option-based compensation contracts are a better way to compensate overconfident CEOs because they allow the firm to exploit the CEO's behavioral bias. Under this exploitation hypothesis, options do not serve as an incentive-mechanism and thus the compensation package has incentive slack. By contrast, under the strong-incentive hypothesis there is no incentive slack. Consequently, the optimal compensation contract for overconfident CEOs implies that a reduction in option intensity will have a negative effect on the relation between CEO overconfidence and firm value.

From an empirical perspective, FAS 123R provides a way to analyze the relation between the compensation structure for overconfident CEOs and firm value. FAS 123R requires firms to

report option-based compensation at fair value on their income statement, rather than intrinsic value which was often zero. Thus, FAS 123R had the effect of making option-based compensation more expensive from an accounting perspective. Subsequently, Hayes et al (2012) find option use substantially declined. Skantz (2012) finds FAS 123R disproportionately affects CEOs who receive more options. To the extent overconfident CEOs have higher latent levels of option-based compensation, FAS 123R will affect overconfident CEOs more. This suggests FAS 123R and the associated reduction in option use it caused provides a way to analyze the relation between CEO incentive compensation and firm value. Thus:

Hypothesis 6a: Under the exploitation hypothesis, a reduction in option intensity does not impact the relation between CEO overconfidence and firm value.

Hypothesis 6b: Under the strong-incentive hypothesis, a reduction in option intensity has a negative effect on firm value for overconfident CEOs.

If senior executives at firms can also impact firm value then the above arguments can be extended, possibly to a lesser extent, to overconfident non-CEO executives. That is:

Hypothesis 7a: Under the exploitation hypothesis, a reduction in option intensity does not impact the relation between executive overconfidence and firm value.

Hypothesis 7b: Under the strong-incentive hypothesis, a reduction in option intensity has a negative effect on firm value for overconfident executives.

3 Data

3.1 Sample construction

We examine the relation between overconfidence and compensation between 1994 and 2011. We obtain compensation data from Execucomp and merge this data with CRSP/Compustat for financial/accounting variables. Patent and citation data are from NBER (this data is only available up until 2006). The overall CEO sample contains 12,772 CEO-year observations and the overall executive sample contains 48,703 executive-year observations. However, the sample sizes decrease when we require additional data such as patent data. The dependent variables are measured in year *t* and independent variables are measured in year *t*-1.

3.2 Measure of CEO and executive overconfidence

We use an option-based measure of overconfidence. Since a CEO's wealth is undiversified, a rational CEO would exercise her options as soon as the options vest. Therefore, retaining vested in-the-money options signals a degree of overconfidence. We construct a *Holder67* measure for overconfidence using publicly available data following the literature (e.g., Campbell et al., 2011; Malmendier et al., 2011; Hirshleifer et al., 2012; Ahmed and Duellman 2013). To do this, we start by calculating a continuous *Confidence* measure as follows:

$$Confidence = \frac{Average\ Value\ Per\ Vested\ Option}{Average\ Strike\ Price} \quad (1)$$

$$Where,$$

$$Average\ Value\ Per\ Vested\ Option = \frac{Value\ of\ vested\ unexercised\ options}{Number\ of\ vested\ unexercised\ options}$$

$$Average\ Strike\ Price = Stock\ price - Average\ Value\ Per\ Vested\ Option$$

We define the *Average Strike Price* as the *Stock Price* at the end of the fiscal year less the *Average Value Per Vested Option*. We then define the *Holder67* measure as an indicator that equals one if the *Confidence* measure is at least 67% in at least two years, in which case, we classify the CEO as overconfident from the first time that the *Confidence* measure is at least 67%. We follow an identical procedure to classify an executive as overconfidence (*Exec Holder67*).

3.3 Main interaction variables

We interact our overconfidence variables *Holder67* and *Exec Holder67* with the following:

Innovativeness*:* We capture the firm's level of innovation by examining its innovative productivity, which is measured as the cumulative number of citations a firm's patents receive scaled by the number of patents obtained up to year t. We compute this both using the whole history of patents in the NBER patent database (*Cites/Patents*) and over the preceding five year period (*Cites/Patents (5yrs)*).[7]

Risk: we capture firms risk by calculating the volatility of the firm's daily stock returns over the year (*Stock Volatility*).

[7] When computing citations, we exclude self-citations. Following the innovation literature, in particular Hall et al (2001, 2005), we adjust patent counts using "weight factors" computed from the application-grant empirical distribution and adjust citation counts by estimating the shape of the citation-lag distribution. These are necessary in order to address truncation issues inherent in the NBER patent database. See Hall et al (2001, 2005) for a discussion.

Bargaining power: We capture the CEO's bargaining power with two sets of variables. The first set is based on the CEO's "pay slice" (see e.g. Bebchuk et al., 2011). The logic is that CEO's with greater bargaining power are more able to increase their pay relative to that of the non-CEO executives. We first create an indicator that equals one if the CEO's total compensation is in the top 25% of the sample for that year (*Total Compensation Top 25%*).[8] We also create three pay-slice measures, being the CEO's total compensation scaled by the sum, average, or median of the total compensation of the top-three highest remunerated non-CEO executives. We then create indicators for whether the CEO's pay slice measure is in the top quartile of all firms in that.year (*Compensation Slice (M1) Top 25%*, *Compensation Slice (M2) Top 25%*, and *Compensation Slice (M3) Top 25%*, respectively).

The second set of bargaining power variables relate to labor market competition in the CEO's state and industry. Significant industry-wide compensation increases tend to suggest (inter alia) labor shortages and/or an increase in labor-market bargaining power. Thus, the CEO's bargaining power is likely higher in states and industries that have experienced a significant increase in CEO salary (on average). We capture this by analyzing whether the CEO is in a state and four-digit (or two-digit) SIC industry that has experienced compensation growth in the top 25% (or conversely, bottom 25%) in that year (*Δ State & 4D-Industry Compensation Top 25%*, *Δ State & 4D-Industry Compensation Bottom 25%*, *Δ State & 2D-Industry Compensation Top 25%*, *Δ State & 2D-Industry Compensation Bottom 25%*, respectively).

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[8] The results are qualitatively similar if we instead use indicators for whether the CEO's compensation is in the top 25% of the firm's state and/or industry (as opposed to the whole sample).

SOX and FAS 123R: We define *SOX* as an indicator variable that equals one if the observation is after 2002 and equals zero otherwise. *FAS 123R* is an indicator variable that equals one if the observation occurs in 2005 or later and zero otherwise.[9] When analyzing SOX, we restrict the sample period to 1999 to 2004.[10] When analyzing FAS 123R, we restrict the sample to contain only observations from 2003 to 2008.[11] In both cases we restrict the sample periods to reduce the amount of overlap between the two event windows.

3.4 Control variables

We control for a variety of factors that the compensation literature suggests are potentially important. At the CEO level we control for ownership, tenure and age. At the firm level we control for age, free cash flows, R&D, tangible assets, leverage, stock price return, stock price volatility and the degree of industry competition the firm faces. Appendix 2 describes the control variables in detail along with all other variables we use in the paper.

3.5 Summary statistics

The summary statistics are reported in Table 1. The numbers for the full sample are largely consistent with the literature.[12] In Panel A we also present summary statistics for the overconfident (*Holder67*=1) and non-overconfident (*Holder67*=0) CEO samples separately.

[9] We follow Hayes et al (2012) and define fiscal year 2005 as the beginning of the post-FAS 123R period even though FAS 123R became effective for all firms in 2006.

[10] Our results are robust to dropping 2001 and/or 2002 as those are transition years and firms may have made changes in anticipation of SOX.

[11] Our results are robust to dropping 2005 (a transition year), or ending the sample period in 2006 or 2007 to mitigate the impact of the 2008 financial crisis.

[12] The sum of cash and equity intensity is not equal to one because CEOs also receive other types of compensation such as long-term incentive plans (LTIPs). Hayes et al (2012) find that while the use of LTIPs increased on average with the passage of FAS 123R, the median LTIP value both before and after FAS 123R is zero. Moreover, they find little evidence LTIPs replace the convexity options provide.

There are significant differences between the two samples. Overconfident CEOs have greater option intensity, equity intensity and smaller cash intensity than their non-overconfident counterparts. They also have greater stock ownership and are longer-tenured. Overconfident CEOs also tend to be at companies that are younger, have higher market-to-book ratios and greater innovation intensity (e.g. *Cites/Patents*). This is consistent with the idea that overconfident CEOs gravitate towards innovative companies, where they are documented to add value (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). In Panel B, we also find overconfident executives have greater option intensity, equity intensity and smaller cash intensity than their non-overconfident counterparts.

4 Does overconfidence influence compensation?

4.1 Overconfidence and CEO compensation

We first examine whether overconfidence impacts CEO incentive compensation. We analyze this within an OLS regression framework. The dependent variables are option intensity, equity intensity and cash intensity, respectively.

Table 2 reports regression results testing the first set of hypotheses relating CEO overconfidence to incentive compensation (Hypotheses 1a and 1b). Columns 1-6 report models that use year and Fama-French 48-industry fixed effects; Columns 7-12 report models that use year and firm fixed effects. Since CEO overconfidence is a behavioral trait the mainly changes with CEO turnover, i.e., *Holder67* is often time-invariant for firms, potentially changing only if the CEO changes, controlling for firm fixed effects could potentially reduce the power of the tests. All models cluster standard errors by firm. In each case, we report models that use *Holder67* to measure CEO overconfidence, and also report results for models in which we divide

CEO overconfidence into three categories: *Holder30-Holder67*, *Holder67-Holder100*, and *Holder100*.

Since results controlling for year and industry fixed effects are very similar to those controlling for year and firm fixed effects, our discussion below focuses on the former. The main finding is that CEO overconfidence is associated with increased option intensity and that option intensity increases monotonically with the degree of overconfidence. Columns 1 to 3 show that overconfident CEOs have significantly higher levels of option intensity and equity intensity and lower levels of cash intensity. These results are inconsistent with the weak-incentive hypothesis (Hypothesis 1a) but consistent with both the exploitation hypothesis and the strong-incentive hypothesis (Hypothesis 1b). The results are economically significant. For example, being overconfident is associated with an increase of 3.7% in option intensity in absolute terms. Given the unconditional mean of 39% (Table 1, Panel A), this represents an almost 10% proportional increase in option intensity.

In Columns 1 to 3 we use *Holder67* as our measure of overconfidence. However, the weak-incentive hypothesis may be more apt to describing the incentive compensation of moderately overconfident managers as in GHO. That is, moderately overconfident CEOs will have lower option intensity than their rational counterparts. Similar in spirit to Campbell et al (2012), we measure various degrees of overconfidence by using a range of cutoffs for the *Confidence* variable defined earlier when computing our *Holder* variable. For example, the variable *Holder30-Holder67* represents CEOs whose *Confidence* variable (option moneyness) is between 30% and 67%. In Models 4 to 6 of Table 2 we include a range of overconfidence measures and set the base case to the low overconfidence (i.e. sub-*Holder30*) group. We find a monotonically increasing relation between overconfidence and option intensity as evidenced by

the significant coefficients on the gradations of overconfidence. Thus, we do not find support for moderate levels of overconfidence leading to smaller option intensity relative to the rational group (weak-incentive hypothesis).

The results in relation to the control variables are largely consistent with the literature (e.g., Hill and Phan 1991, Hayes et al 2012, Skantz 2012). The CEO's stock *Ownership* is negatively associated with option and equity intensity but positively associated with cash intensity. *Tenure* and *Age* are significantly and negatively related to equity/option-based compensation but are positively related to cash-based compensation. *Firm size* is associated with greater option/stock intensity. Interestingly, highly levered firms (*Financial Leverage*) tend to pay compensation in the form of cash, rather than equity. Higher growth firms tend to feature higher levels of option/stock intensity and lower levels of cash intensity (see e.g. the coefficients on *Market-to-Book, R&D,* and *PP&E*). These results are consistent with the prediction that managers at higher growth firms might be more likely to take risky compensation, and such firms prefer to incentivize managers for encouraging growth (see e.g. GHO). Similarly, risky firms tend to feature higher levels of option/stock intensity and lower levels of cash intensity (see the coefficient on *Stock Volatility* and *Free Cash Flows*).

4.2 Impact of innovativeness and risk

Hypothesis 2 predicts corporate innovativeness and risk are associated with higher levels of option and equity intensity for overconfident CEOs. We interact the *Holder67* measure with the cumulative number of citations scaled by the cumulative number of patents up to year *t* from the beginning of the NBER patent database (*Cites/Patents*) and over the prior five years (*Cites/Patents (5yrs)*). In both cases, we scale the number by 100. We measure risk by the

volatility of the firm's stock returns over the prior year (*Volatility*). Again, we report both models with year and industry fixed effects (Columns 1-3) and models with year and firm fixed effects (Columns 4-6) in Table 3. However, we note that the models with firm fixed effects are difficult to interpret because both *Holder67* and our innovation measures vary only infrequently within firms.

The key finding in Columns 1-3 is that overconfident managers have even greater option intensity and equity intensity in innovative firms (as shown by the coefficients on *Holder67*Cites/Patents* and *Holder67*Cites/Patents (5 yrs)*). This result is consistent with the argument that overconfident managers are more willing to accept a risky contract in an innovative firm as they are more likely to believe they can generate corporate value and benefit from an equity-linked contract.[13] Similarly, *Holder67*Volatility* is positively related to *Option Intensity*, implying that overconfidence is even more positively associated with option-based compensation in risky firms. These results are consistent with both the exploitation hypothesis and the strong-incentive hypothesis. Columns 4-6 show that the results are significantly weaker in the models that use firm fixed effects. This likely reflects the relatively low degree of variation in *Holder67* and the firm's degree of innovation (relative to other firms) over time.

4.3 Impact of SOX

We expect SOX will be associated with a shift away from incentive compensation in general (Hypothesis 4a), but that this effect will be weaker for overconfident CEOs (Hypothesis 4b). We test these hypotheses by constructing a *SOX* dummy that equals one if the observation is in 2003 or later and equals zero otherwise. We interact this *SOX* dummy with *Holder67*. When doing this

[13] The level of *Cites/Patents (5 yrs)* is positively and significantly related to option intensity, whereas the level of *Cites/Patents* is not. This suggests recent innovative performance is more linked to the use of incentive-based pay.

analysis we restrict the sample to observations from 1998 to 2004 to mitigate the confounding effects of FAS 123R. We also require CEOs to hold non-zero options before SOX to allow for option holdings to change in both directions. As before, we report results with industry and year fixed effects, and with firm and year fixed effects separately. Since *SOX* is a time period indicator variable, to facilitate its interpretation, we also report results with or without year fixed effects. The various combinations of year, industry, and firm fixed effects are indicated in the Column footer.

The results, reported in Table 4, support our predictions. In all models, the *SOX* coefficient is significantly negative, indicating SOX is associated with a reduction in option intensity (Hypothesis 4a). The interaction term *Holder67*SOX* is positively and significantly related to option intensity, i.e. overconfident CEOs experience smaller reductions in option-based compensation following SOX relative to non-overconfident CEOs (Hypothesis 4b). We find similar, albeit weaker, supporting evidence on equity intensity.

4.4 Non-CEO executive overconfidence and compensation

We expect that overconfident executives in general (i.e. executives other than the CEO) will feature similar compensation traits to overconfident CEOs (Hypothesis 5). For each executive in Execucomp we calculate the *Holder67* measure. We also split the sample based on whether the CEO is overconfident or not.

The results are in Table 5. Consistent with Hypothesis 5, we find in Columns 1-3 that overconfidence affects executive compensation in a similar manner to which it impacts CEO compensation. Specifically, overconfident executives feature greater option and stock intensity and lower cash intensity. Second, Columns 4-6 analyze firms where the CEO is overconfident

and Columns 7-9 analyze firms where the CEO is not overconfident. The main finding is that the coefficient on *Exec Holder67* is of the same sign, and of similar magnitude and statistical significance in both sub-samples. Importantly, this suggests that the impact of executive confidence does not depend on whether the CEO is also overconfident. That is, the compensation contract accounts for individual behavioral traits such as overconfidence in addition to firm-level characteristics.

In unreported tests, we analyze samples that contain only the most overconfident or the highest paid executive in each firm and find similar results to the reported regressions.[14] We also analyze whether the results we obtain for overconfident CEOs in Tables 3 and 4 similarly extend to overconfident executives. We find the results generally carry over. In particular, we find option and equity intensity significantly increases and cash intensity significantly reduces for overconfident executives in innovative firms and riskier firms. We also find SOX reduces option and equity intensity and increases cash intensity for all executives. Overall, both the reported and unreported results highlight that compensation practices are similar at both the CEO and executive level, presumably being driven by the same economic rationale.

4.5 Impact of bargaining power

The results so far are consistent with both the exploitation and strong-incentive hypothesis, but inconsistent with the weak-incentive hypothesis. We next examine the impact of bargaining power on overconfident CEOs' compensation contracts to differentiate between the exploitation and strong-incentive hypothesis. The exploitation hypothesis (Hypothesis 3a) implies that a reduction in the CEO's bargaining power reduces option intensity whereas an increase in

[14] In these tests, we retain only one executive at each company. To identify the most confident executive we use the continuous measure of confidence underlying *Holder67*. That is, we keep the executive with the highest value of *Value-Per-Option*/*Average-Strike-Price*.

bargaining power increases option intensity. The strong-incentive hypothesis predicts that a reduction in bargaining power increases option and equity intensity (Hypothesis 3b).

We capture the CEO's bargaining power using two sets of variables. We first create an indicator that equals one if the CEO's total compensation is in the top 25% of the sample for that year (Panel A of Table 4a), which would connote a strong bargaining position. We also create three pay-slice measures, being the CEO's total compensation scaled by the sum, average, or median of the total compensation of the top-three highest remunerated non-CEO executives. We then create indicators for whether the CEO's pay slice measure is in the top quartile of all firms in that year (Table 4a, Panels B-D). The results indicate that an increase in CEO bargaining power is associated with an increase in option intensity. This result is consistent with the exploitation hypothesis (per Gervais et al., 2011), but inconsistent with the strong-incentive hypothesis.

The second set of bargaining power variables relate to labor market competition in the CEO's state and industry. We capture this by analyzing whether the CEO is in a state and four-digit (or two-digit) SIC industry that has experienced compensation growth in the top 25% (or conversely, bottom 25%) in that year. The results reported in Table 4b generally indicate that overconfident CEOs in industries/states that experience significant compensation-growth experience significantly higher levels of option intensity. That is, an overconfident CEO's option intensity increases with his/her bargaining power. This result is again consistent with the exploitation hypothesis, but inconsistent with the strong-incentive hypothesis.

5 Overconfidence, compensation and performance: evidence from a natural experiment

We next analyze whether the greater option intensity of overconfident CEOs is associated with increased performance. Ideally, we would directly measure the relation between a performance proxy and *Option Intensity*. However, performance and compensation are likely endogeneously determined, with expected performance likely influencing compensation contracts, thereby inducing reverse causality concerns. We mitigate this concern by using the passage of FAS 123R as a natural experiment. As mentioned previously, FAS 123R increased the accounting cost of option compensation and resulted in a significant reduction in option-based pay (Hayes et al., 2012, Skantz, 2012) We thus use FAS 123R to analyze the impact on firm value of reducing option compensation for overconfident CEOs.[15]

We first analyze the impact of FAS 123R on the compensation of overconfident CEOs. We create a *FAS 123R* dummy that equals one if the observation occurs in 2005 or later and zero otherwise, and interact *FAS 123R* with *Holder67*. When doing these tests we restrict the sample to observations from 2003 to 2007 to mitigate the influence of SOX.

Table 7 reports the results. Columns 1-4 contain year and industry fixed effects; columns 5-8 contain only industry fixed effects. Consistent with Hayes et al (2012) and Skantz (2012), FAS 123R significantly reduces option intensity. The interaction term *Holder67*FAS 123R* is negative but statistically insignificant, suggesting that FAS 123R does not affect overconfident CEOs significantly worse than non-overconfident ones. However, when we examine the relationship between FAS 123R, overconfidence, and stock/cash compensation, we find that overconfident CEOs experience significantly greater increases in the level of cash and the level of cash than do other CEOs. This suggests that while overconfident CEOs might have suffered a

[15] Unlike SOX, FAS 123R is not associated with changes in corporate governance (Coates, 2007; Dah et al., 2014), and provides a cleaner exogenous shock to CEO compensation.

similar reduction in option-compensation, because overconfident CEOs value options more than do other CEOs, they require an even greater compensating increase in stock-based or cash-based incentives.

To examine the impact of compensating overconfident CEOs with options on firm value we use FAS 123R as an exogenous shock and the current level of Tobin's *Q* (i.e. the firm's current market-to-book ratio) as our measure of firm value. Specifically, we run regressions with *Q* as the dependent variable on a set of control variables including the lagged market-to-book ratio, along with the *FAS 123R* dummy, our CEO overconfidence measure *Holder67* and the interaction of the two, *Holder67*FAS 123R*.. We restrict the sample to 2003 to 2007. We further analyze sub-samples of firms the sample based on whether the CEO's option intensity was in the top 50% or bottom 50% of the sample in 2004 (the year prior to FAS 123R), and whether or not the CEO received option compensation in 2004.

The results are in Table 8 and indicate that FAS 123R did not worsen the relationship between overconfidence and performance. That is, the reduction in option compensation does not lead to overconfident CEOs performing significantly worse. This is most consistent with the exploitation hypothesis in Gervais et al (2011), whereby the CEO's incentive-contract has incentive-slack, such that a reduction in option compensation does not have a significant incentive-effect on the CEO.

6 Additional robustness tests

This section contains additional robustness tests. For brevity, we mainly report the robustness results in relation to the baseline models as shown in Table 2.

6.1 Systemic differences: Propensity score and weighting regressions

One possible concern is that there are systemic differences in firms that hire overconfident CEOs versus non-overconfident CEOs. We address this issue in two ways.

First, we use a propensity score matching method. We estimate a first stage logit model that estimates the likelihood of a CEO being classified as overconfident (reported in Model 1 of Table 9). Next, we obtain the propensity scores from this model. Then, for the overconfident executives, we generate a distribution of propensity scores and obtain the critical point that marks the lower 10% tail. Finally, we re-run the models excluding any non-overconfident executive/firm whose propensity score is below this 10% cut-off point. We obtain similar results if we use a 5% or 20% cut-off. The results are reported in Models 2-4 of Table 9. Importantly, *Holder67* has the same relation with option, equity, and cash intensity as in the baseline models.

Second, we use a weighting approach following Busso et al., (Forthcoming). We estimate the first stage logit model as with the propensity score method. We next obtain a weighting measure as follows: *Weight* = *Holder67* + (1-*Holder67*)*Pr(*Holder67*)/(1+Pr(*Holder67*)), where Pr(*Holder67*) is the propensity score from the first stage model. We then weight each observation by this propensity score, assigning a greater weight to an observation if it is more likely that observation is an overconfident type. This implicitly down-weights observations that are dissimilar from those run by overconfident CEOs. The results are reported in Models 5-7 of Table 9. Again, *Holder67* is still positively and significantly related to option intensity and equity intensity. These results, coupled with the propensity score results, suggest that the relation between CEO overconfidence and compensation is not driven by selection bias.

6.2 Anti-takeover provisions and general ability index

We next test whether the results are robust to controlling for the presence of anti-takeover provisions (ATPs) as managerial entrenchment possibly influences CEO compensation. We control for ATPs by using the Gompers et al (2003) index of 24 ATPs (*GIM*), the Bebchuk et al (2009) index of six ATPs (*BCF*), and an indicator that equals one if the firm has a classified board (*CBOARD*). We also examine interactions of the ATP measures with *Holder67*. The additional data requirements reduce sample size; however, the results, reported in Panels A-C of Table 10, are consistent with the baseline results in Table 2. Specifically, *Holder67* continues to be positively related to option intensity and equity intensity. In addition, ATPs do not influence the impact of overconfidence on compensation, as indicated by the statistically insignificant coefficients on the *Holder67* and ATP interaction terms. Overall, our results are robust to accounting for ATPs.

Custodio et al (2013) develop a general ability index (*GA Index*) to measure a CEO's general ability and find *GA Index* impacts CEO compensation. To address concerns that our results are driven by the CEO's general ability rather than overconfidence, we rerun our regressions controlling for *GA Index*. We present the results in Panel D of Table 10. The key findings are threefold. First, the main results in relation to CEO overconfidence and compensation remain after controlling for the CEO's general ability. Second, CEOs with a higher general ability index have greater equity intensity, consistent with the results in Custodio et al (2013). Third, the CEO's general ability does not influence the impact of overconfidence on compensation, as indicated by the statistically insignificant coefficient on *Holder67*GA Index*. In unreported tests we also find similar results if we create an indicator that equals one if the CEO's *GA Index* is above the median.

6.3 The measure of overconfidence, including additional measures of overconfidence

We examine whether the results are robust to using alternative measures of CEO overconfidence. We find qualitatively similar results to those reported in Table 2 if we measure overconfidence as the natural log of the number of vested but unexercised options (see Panel A of Table 11a). The main takeaway is that the relation between the alternative measures of overconfidence and compensation is qualitatively similar to those reported in Table 2.

We also address potential concerns with the Holder67 measure. One concern is that it is possible for the CEO to appear overconfident by holding highly in-the-money options even if they are of an economically negligible amount. We address this (in Panel B of Table 11a) by re-running the results using the set of CEOs whose option holdings are in the top 50% of the sample for the year. The results are qualitatively similar in this sub-sample. An additional concern is that a manager could also be overconfident if he/she exercises his/her options and then maintains a significant stock holding. However, we find (in Panel C of Table 11a) that the results are qualitatively similar if we restrict the sample to contain the set of CEOs who had not exercised options in year t or year $t-1$.

We also examine media-based measures of overconfidence. The media based measures follow the approach in Hirshleifer et al (2012). We create the measures by counting the number of news reports that refer to the CEO as overconfident versus the number that refer to the CEO as non-overconfident. We use Factiva to search for articles referring to the CEO in The New York Times (NYT), Business Week (BW), Financial Times (FT), The Economist, Forbes Magazine, Fortune Magazine and the Wall Street Journal. For each CEO and year, we count the number of articles that contain the 'overconfident' words "overconfidence", "over confident", "optimistic", or "optimism". We also count the number of articles that contain the 'non-overconfident' words "cautious", "conservative", "practical", "frugal", or "steady". We further check the number of

articles that contain the words "not confident" or "not optimistic" and distinguish between these and articles that use the words "optimistic" or "confident" by themselves.

We then create three media-based measures of overconfidence. First, Panel A of Table 11b contains an indicator that equals one if the number of overconfident articles exceeds the number of non-overconfident ones. Second, Panel B of Table 11b uses a 'net news' measure, which is the number of overconfident articles less the number of non-overconfident ones. Third, Panel C of Table 11b uses a net news ratio, which is defined as (Overconfident Articles – Non-overconfident Articles)/(Overconfident Articles + Non-overconfident Articles). The key finding is that all three news-based measures of overconfidence are positively associated with Option Intensity, supporting the baseline results in Table 2.

6.4 Fama-Macbeth, and Tobit regressions

Our main results control for firm or industry (and year) fixed effects. As a further robustness test, in Models 1-3 of Table 12, we undertake Fama and MacBeth (1973) type regressions and once again our main inferences are unaffected. Since the dependent variables are intensity variables that range between 0 and 1 by construction, we show in Models 4-6 that the results are qualitatively similar if we use tobit models with a lower bound of 0 and an upper bound of 1. In unreported robustness tests we also ensure that the results are robust to using industry fixed effects based on two-, three-, or four-digit SIC industry (as opposed to the Fama-French 48 industry classification scheme).

6.5 Pay-to-performance sensitivity

An alternative way to investigate whether overconfident CEOs receive greater incentives, as predicted by our theoretical analysis, is to explore the pay-to-performance sensitivity. Thus, we assess how CEO overconfidence impacts the relation between the current level of compensation and the prior year's performance as measured by ROA and stock return. In Table 13, we find CEO overconfidence positively enhances the sensitivity of compensation to both ROA and stock returns.[16] This is consistent with our prediction and supports the general idea that overconfident CEOs tend to receive compensation contracts that are more sensitive to corporate performance.

7 Conclusion

We analyze the relation between CEO overconfidence and compensation. Prior theoretical literature suggests it is optimal to pay overconfident CEOs with incentive-linked compensation as overconfident CEOs are more bullish about their own ability and their company's prospects, thus overvaluing such compensation (GHO). We term this the exploitation hypothesis. We develop an alternative hypothesis by extending this prior work to show that firms may offer more option-intensive contracts to overconfident CEOs (relative to non-overconfident CEOs) due to the incentive effects of such contracts. We call this the strong-incentive hypothesis. We then empirically test whether, and when, overconfident CEOs receive compensation contracts that are more option-intensive. Further, we use FAS 123R as a natural experiment to test the value implications of such contracts.

We find overconfident CEOs do receive more option-intensive compensation contracts. Moreover, option intensity is greater for overconfident CEOs at riskier or more innovative firms.

[16] Stock returns are positively related to compensation in all models. ROA is not significantly related to compensation in the reported models. However, if we omit the interaction term, *Holder67* x *ROA*, then we do find that ROA increases compensation.

These findings are consistent with both the exploitation hypothesis and the strong-incentive hypothesis. To alleviate endogeneity concerns, we use the passage of SOX as an exogenous shock to the optimal compensation contract. Consistent with both hypotheses, we find overconfident CEOs experience a less severe reduction in option intensity after SOX. We investigate the impact of labor market competition and find, consistent with the exploitation hypothesis only, option intensity increases for overconfident CEOs with greater bargaining power.

The results also present implications for non-CEO executives. We find that overconfidence impacts compensation-structures similarly for non-CEO executives as it does for CEOs. That is, overconfidence increases the level of option intensity in a non-CEO executive's contract. This highlights that firms do set compensation contracts with regard to the characteristics of individual managers.

We use the passage of FAS 123R as a natural experiment through which to examine the value implications of granting overconfident CEOs option-intensive contracts. FAS 123R increased the accounting cost of paying CEOs with options, resulting in a significant reduction in the use of option compensation (Hayes et al., 2012, Skantz, 2012). Consistent with the exploitation hypothesis only, we find this reduction in option use has an insignificant impact on firm value for overconfident CEOs. Overall, our results shed light on the motivation for paying overconfident CEOs with options. The results are most consistent with the exploitation hypothesis, promulgated in GHO, suggesting that firms award options to overconfident CEOs in order to take advantage of their overconfident perspective on firm value.

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Appendix 1: Incentive contracting with overconfident CEOs

We provide a more detailed discussion of our simple model discussed in Section 2.1. Our objective is to show that *exploitation*, i.e., compensating the CEO in the form of risker contracts she overvalues is not the only reason to offer strong incentive contracts to overconfident managers. We observe that exploitative incentive contracts, by their nature, will have "slack" i.e., incentives can be reduced a little with negligible effect on managerial actions. On the other hand, if an incentive contract does not have slack, a small reduction in incentives could have a more meaningful value impact. We also discuss the effect of bargaining power on incentive contracts of overconfident managers.

Single-Round:

We begin by considering a project that requires a single round of investment. All managers are assumed to have rational beliefs about the project's cash flows. Subsequently we introduce a second round of investment and allow for a difference in managerial beliefs. The project requires the investment of \$1 along with managerial effort E_0. The project succeeds with probability θ_1 and produces a payoff of s_1 next period; with complementary probability $1-\theta_1$, the payoff is 0. A priori, i.e., without additional information, the project is negative NPV: $\theta_1\sigma_1 - 1 < 0$. There is no discounting between the investment and payoff stages of the project.

What allows the project to undertaken is that, prior to the investment decision, the CEO receives a signal S: either positive (S+) or negative (S-) with (unconditional) probabilities λ^+ and $1-\lambda^+$, respectively. Our assumption is that there is no disagreement in terms of signal interpretation between overconfident and rational CEOs in the first-round project. Either type of manager would rationally interpret S+ as indicating probability of success to be $\pi_1 > \theta_1$, where $\pi_1\sigma_1 - 1 > 0$. We follow GHO and capture risk-version by assuming that the value placed on σ_1 by the CEO is $\rho\sigma_1$ where $\rho < 1$ (indicating a decreasing marginal utility of wealth). Further, the reservation wage of the CEO is denoted by *R*.

In this context, an optimal contract has the following attributes: (1) it is incentive-compatible (IC): it induces the manager to invest (not invest) when the signal is positive (negative); (2) the participation-constraint (PC) is satisfied i.e., the manager expects to receive at least R plus expected effort costs; (3) The contract maximizes the payoff to the firm, while satisfying the PC and IC.

The optimal contract here is simply the compensation that the CEO receives in three possible states: project succeeds (σ_1), project fails (0) or the project is not undertaken (\$1). We follow GHO and assume that if the project fails, the firm is worth zero and so is the CEO's compensation. If the project succeeds, we denote her payment by β_1. If the CEO does not take up the project, she receives α_0.

We can express the IC conditions for the rational CEO as:

$$\beta_1\pi_1\rho - \alpha_0 \geq E_0 \qquad \textit{(IC.1)}$$

$$\beta_1(1-\pi_1)\rho - \alpha_0 \leq E_0 \qquad \textit{(IC.2)}$$

Here, *(IC.1)* is the condition that the CEO chooses to undertake the project upon receiving the positive signal (instead of not undertaking the project), while *(IC.2)* is the condition that the project is not chosen when the signal is

negative. An inspection of the two IC conditions indicates that there can be an optimal incentive contract only when $\pi_1 > 1 - \pi_1$, which we will assume to be the case. Let us denote the value of β_1 that satisfies *(IC.1)*, as an equality by β_{11} and *(IC.2)* as an equality by β_{12}. Since $\pi_1 > 1 - \pi_1$, it follows that $\beta_{12} > \beta_{11}$ and that any β_1 such that $\beta_{12} \geq \beta_1 \geq \beta_{11}$ will satisfy the IC conditions. The optimal choice of β_1 will minimize the cost of compensating the CEO, conditional on satisfying the participation constraint:

$$\lambda^+ \beta_1 \rho \pi_1 + (1 - \lambda^+)\alpha_0 = R + \lambda^+ E_0 \qquad \textit{(PC.1)}$$

The left-hand-side of *(PC.1)* is the expected payoff to the rational manager; this is set equal to $R + \lambda^+ E_0$ since the firm has no reason to give the manager anything more than she needs to participate. This basic set-up is sufficient to yield that, given $\rho < 1$ the rational CEO values payoffs in the successful state at less than the firm does. Hence, it is cheapest for the firm to give the manager the minimum incentive necessary to satisfy (IC.1) as an equality i.e., to set $\beta_1 = \beta_{11}$, with an α_0 that satisfies the *(PC.1)* condition.

Second-round

As discussed in Section 2.1, we next consider the possibility of project expansion after the CEO knows that the first-round investment is going to be successful – and examine the effect that a second stage would have on the initial compensation contract. To keep the analysis simple, it is assumed that the incremental investment takes the form of additional managerial effort E^*. An overconfident CEO is more bullish with regard to the expansion project than a rational CEO.

The relation between the two rounds is that if the first-round project is successful, then a second-round expansion project becomes available. This expansion project, if successful, produces an additional payoff of σ_2 with a (rational) probability η_2. However, the overconfident manager expects the expansion project to succeed with probability $\eta_2^* > \eta_2$. We assume that $\rho^2 \eta_2^* < \eta_2$ (we term this the "non-exploitation" assumption), in order to rule out the possibility of certain extreme contracts e.g., the possibility that the CEO is compensated entirely in pay that is contingent on the success of both projects. The expansion is positive NPV from the perspective of the firm as well from that of the overconfident CEO, i.e., $\eta_2 \sigma_2 > E^*$ and $\rho \eta_2^* \sigma_2 > E^*$. However, the expansion is assumed to not be worthwhile for the rational manager, i.e., $\rho \eta_2 \sigma_2 < E^*$. With this condition it is never optimal to induce a rational CEO to take the expansion project since the additional compensation the CEO requires exceeds the value produced. On the other hand, because the overconfident manager is overly positive about the success of the expansion it is optimal to incentivize her to invest in the expansion round.

One way to structure the incentives for the overconfident CEO is to provide options with an exercise price of σ_1 - the incremental incentive needs to be provided only after success in the initial round is assured. The incentive compatibility *(IC)* condition is simply to provide options (with exercise price σ_1) that deliver a payoff of β_2 if the expansion project succeeds. The cash flows from the second round are also discounted by a risk-aversion factor of ρ:

$$\beta_2 \rho \eta_2 = E^* \qquad \textit{(IC.3)}$$

From the perspective of the CEO at the initial date (i.e. prior to the first investment round), the CEO's participation constraint (PC) can be expressed as follows. Note that we are assuming that her reservation wage is R and the compensation is adjusted to compensate for the CEO's expected effort.

$$\lambda^{+}\rho\pi_1(\beta_1 + (\beta_2\rho\eta_2 - E^{*})) + (1-\lambda^{+})\alpha_0 = R + \lambda^{+}E_0 \qquad \textit{(PC.2)}$$

or

$$\lambda^{+}\beta_1\rho\pi_1 + (1-\lambda^{+})\alpha_0 = R + \lambda^{+}E_0$$

The second equation is obtained upon substituting E^{*} from *(IC.3)*; it shows that, since the expected payoff to the overconfident CEO is equal to the effort cost in the expansion project, the participation condition remains unchanged from before *(PC.1≡PC.2).* Hence, the α_0, β_1 offered to the overconfident and rational manager are the same; the only difference is that the overconfident CEO is offered stronger incentives in the form of options that induce the manager to take up the expansion.

The implications of the above discussion relative to the GHO model's implications are:

1. Stronger incentive contracts could be offered to overconfident managers to provide them the incentive to, for instance, expand or take-up projects – that it would not be optimal to induce a rational manager to undertake. This we have referred to as the strong-incentive hypothesis. Hence, unlike in GHO, where managerial overconfidence does not affect the types of projects undertaken, the options in our set-up allow for there to be differences in project take-up, depending on managerial overconfidence.
2. Unlike in GHO, the stronger incentives offered to an overconfident CEO may not indicate incentive slack. Such an incentive slack would arise if there is exploitation of overconfident CEOs, offering them incentive pay that they overvalued, relative to rational CEOs. Hence, there may be value consequences to weakening the incentives of overconfident managers – greater value consequences than might be expected if there was incentive slack.

In our empirical analysis we examine the differences in incentive pay for CEOs who are overconfident. We also examine the value consequences of changes in the incentive contracting as firms seek to move away from option-based incentive pay with the introduction of FAS 123R.

CEO Labor market:

GHO considers the impact of increasing an overconfident CEO's bargaining power under the exploitation hypothesis. They show that an increase in the demand for CEOs could increase their bargaining power, resulting in overconfident CEOs being offered even greater incentive pay. The rationale is that since an overconfident CEO values incentive pay more than the firm, increases in her bargaining power and compensation would take the form of relatively more incentive pay.

This argument can, however, be reversed, when the overconfident CEO is not being exploited. For instance, treating the CEO's reservation wage *R* as a measure of CEO bargaining power, we can examine the effect that an increase in bargaining power would have on the fraction of the CEO's compensation in the form of incentive pay. As *R* increases i.e., the CEO is in a stronger bargaining position, it follows from the IC and PC conditions that the only change would be in terms of an increase in α_0. This is since there is no *incentive slack*, the incentive pay

remains unchanged in order to induce appropriate actions on part of the CEO, even as R increases.[17] The firm would rather pay the CEO in the form of fixed compensation, as opposed to risker pay that is discounted by the CEO. In the context of the expansion project, since α_0, β_1 are the same for the OC and the rational manager, the difference in their incentive intensity is given from *(PC.2)* and can be expressed as $\frac{/^{+}\rho_1 E^{*}}{R + /^{+}E_0 + /^{+}\rho_1 E^{*}}$.

Therefore, an increase in R will have the effect of decreasing the difference in incentive intensity between overconfident and rational CEOs. This is opposite of the prediction from the "exploitation" case in which the CEO's overvaluation of incentive pay is so large that an increase in bargaining power leads to even more incentive pay.

[17] Note: this requires the "non-exploitation" assumption we have made, i.e. $\rho^2 \eta_2^* < \eta_2$. Without this assumption, it would be cheaper for the firm to compensate the overconfident manager only in the form of options that paid off when both projects succeeded. The form of the contract would no longer depend on bargaining power, only the amount of options would increase as the bargaining power of the CEO increased.

Appendix 2: variable definitions

Variable	Definition
Compensation variables (CEOs)	
Cash Intensity	The proportion of total CEO compensation that comes from cash. This is the amount of cash (Execucomp: "total_curr") scaled by total compensation (Execucomp: "tdc1")
Equity Intensity	The proportion of total CEOcompensation that comes from option grants and stock. This is the value of option awards (Execucomp; "option_awards_blk_value") plus the value of stock grants (Execucomp: "stock_awards_fv") scaled by the amount of total compensation (Execucomp: "tdc1")
Option Intensity	The proportion of total CEO compensation that comes from option grants. This is the value of option awards (Execucomp; "option_awards_blk_value") scaled by the amount of total compensation (Execucomp: "tdc1")
Compensation variables (non-CEO executives)	
Exec Cash Intensity	The proportion of total compensation that comes from cash for each non-CEO executive. This is the amount of cash (Execucomp: "total_curr") scaled by total compensation (Execucomp: "tdc1")
Exec Equity Intensity	The proportion of total compensation that comes from option grants and stock for each non-CEO executive. This is the value of option awards (Execucomp; "option_awards_blk_value") plus the value of stock grants (Execucomp: "stock_awards_fv") scaled by the amount of total compensation (Execucomp: "tdc1")
Exec Option Intensity	The proportion of total compensation that comes from option grants for each non-CEO executive. This is the value of option awards (Execucomp; "option_awards_blk_value") scaled by the amount of total compensation (Execucomp: "tdc1")
Overconfidence measures (CEOs)	
Holder67	The Holder67 measure computed following the procedure in Malmendier et al (2011). Specifically, it starts by computing a 'Confidence' variable, which is defined as the 'value per vested option' scaled by the 'average strike price' of those options. The 'value per vested option' in year t is the total value of the vested but unexercised options (Execucomp: "opt_unex_exer_est_val") scaled by the number of those options (Exeucomp: "opt_unex_exer_num"). The average strike price is the stock price at the time the option-value is determined (CRSP: "prcc_f") less the value-per-vested option. This works on the premise that the value-per-vested option is essentially $S_t - X$, where S_t is the stock price at time t and X is the strike price. Holder67 is then an indicator that equals one from the first year in which the 'Confidence' variable equals 0.67 if this 'Confidence' variable equals at least 0.67 on at least two occasions.
Holder30	The Holder30 measure is constructed in the same way as the Holder67 measure, but requires that the confidence variable equal at least 0.3.
Holder100	The Holder100 measure is constructed in the same way as the Holder67 measure, but requires that the confidence variable equal at least 1.0.
Holder30-Holder67	An indicator that equals one if Holder30 equals one but Holder67 equals zero. This captures a low-to-moderate degree of overconfidence.
Holder67-Holder100	An indicator that equals one if Holder67 equals one but Holder100 equals zero. This captures a relatively high degree of overconfidence.
ln(Num Opt)	The natural log of the number of vested but unexercised options.
Overconfidence measure (non-CEO executives)	
Exec Holder67	The executive's Holder67 measure. It is constructed in the same was as for CEOs.
Prop Exec Overconfident	The proportion of executives who are overconfident (i.e., with Exec Holder67=1).
Innovation and risk measures	
Cites/Patents	The number of cites to the patents received in year t. The data is from the NBER patent database and uses the NBER weighting to weight cites based on the age of the patents. This data is available only up until 2006.
Cites/Patents (5yrs)	The number of cites to patents received over the past five years. The data is from the NBER patent database and uses the NBER weighting to weight cites based on the age of the patents. This data is available only up until 2006.
Stock Volatility	The firm's stock return volatility as obtained by calculating the volatility of the firm's daily stock returns over the year.
Bargaining power variables	
Total Compensation Top 25%	An indicator that equals one if the CEO's total compensation is in the top quartile of the

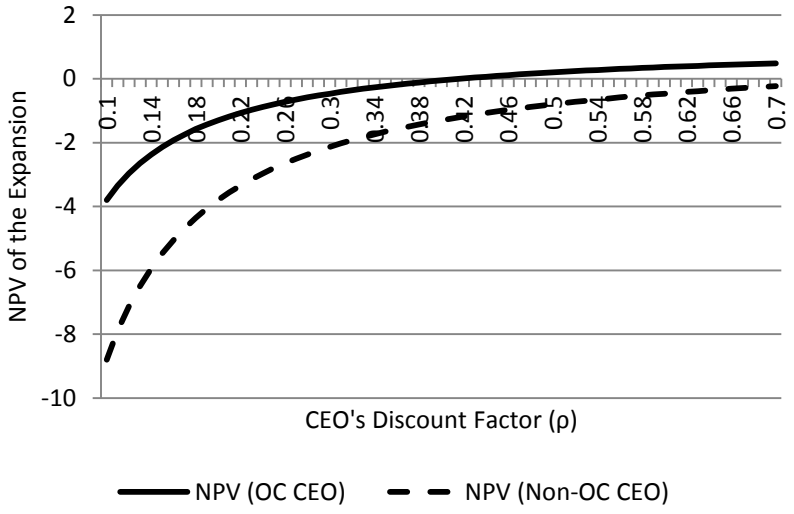
	sample for that year and equals zero otherwise.
Compensation Slice (M1) Top 25%	An indicator that equals one if the CEO's pay-slice (as measured by the CEO's total compensation scaled by the sum of the total compensation of the top-three highest remunerated non-CEO executives) is in the top quartile of the sample for that year and equals zero otherwise.
Compensation Slice (M2) Top 25%	An indicator that equals one if the CEO's pay-slice (as measured by the CEO's total compensation scaled by the average of the total compensation of the top-three highest remunerated non-CEO executives) is in the top quartile of the sample for that year and equals zero otherwise.
Compensation Slice (M3) Top 25%	An indicator that equals one if the CEO's pay-slice (as measured by the CEO's total compensation scaled by the median of the total compensation of the top-three highest remunerated non-CEO executives) is in the top quartile of the sample for that year and equals zero otherwise.
Δ State & 4D-Industry Compensation Top 25%	An indicator that equals one if the CEO is in a state and four-digit SIC industry that has experienced compensation growth in the top quartile in that year and equals zero otherwise.
Δ State & 4D-Industry Compensation Bottom 25%	An indicator that equals one if the CEO is in a state and four-digit SIC industry that has experienced compensation growth in the bottom quartile in that year and equals zero otherwise.
Δ State & 2D-Industry Compensation Top 25%	An indicator that equals one if the CEO is in a state and two-digit SIC industry that has experienced compensation growth in the top quartile in that year and equals zero otherwise.
Δ State & 2D-Industry Compensation Bottom 25%	An indicator that equals one if the CEO is in a state and two-digit SIC industry that has experienced compensation growth in the bottom quartile in that year and equals zero otherwise.
Exogenous shocks	
FAS 123R	An indicator that equals one if the observation occurs in 2005 or later and equals zero otherwise.
SOX	An indicator that equals one if the observation occurs in 2003 or later and equals zero otherwise.
Anti-takeover provision (ATP) and general ability measures	
BCF	The Bebchuk et al (2009) index of six key anti-takeover provisions as derived from IRRC/Risk Metrics.
CBOARD	An indicator that equals one if the firm has a classified board and equals zero otherwise. The data is from IRRC/Risk Metrics.
GA Index	The general ability index as used in Custodio et al (2013).
GIM	The Gompers et al (2003) index of anti-takeover provisions as obtained by IRRC/Risk Metrics. IRRC/Risk Metrics only report data for some of the years in our sample. For missing years, we back-fill with the most recent prior year.
Control variables	
Age	The CEO's age as reported in Execucomp
Financial Leverage	The firm's financial leverage, defined as its debt divided by its assets (in Compustat terms: "(dltt+dlc)/at")
Firm Age	The firm's age, defined as the time between year *t* and the year on which the firm is first recorded in the CRSP stock database
Firm Size	The natural log of the firm's total assets (Compustat: "at")
Free Cash Flows	The firm's free cash flows scaled by its market cap. In CRSP/Compustat codes this is "(oancf-capx)/(prcc_f*csho)"
HHI	The HHI for the firm's Fama-French industry. This is based on the sum of squared percentage market shares in sales.
Market-to-Book/Tobin's Q	The firm's market-to-book, defined in CRSP/Compustat codes as "(prcc_f*csho+lt)/(ceq+lt)"
Ownership(%)	The CEO's percentage ownership in the firm. This is derived by dividing the CEO's stock ownership (Execucomp: "shrown") by the number of shares outstanding (CRSP/Compustat: "csho")
PP&E	The firm's property, plant and equipment (Compustat: "ppegt") scaled by its assets (Compustat: "at")
R&D	An indicator that equals one if the firm performance R&D (i.e. has a non-zero "xrd" variable in Compustat). This coincides with having an above-median level of R&D (as the median R&D expenditure is USD 1.3m and 51% of companies have non-zero R&D).
High CAPEX	An indicator that equals one if the firm's capital expenditure (Compustat: "capex") is above the median.

ROA	The firm's return on assets, defined as the net income scaled by total assets (in Compustat codes: "ni/at")
Stock Return	The firm's stock return over the year.
Tenure	The CEO's tenure, defined as the time between year t and the year in which the CEO became CEO.

Figures

Figure 1: NPV

This figure contains the simulated NPV to the firm from providing the overconfident and non-overconfident CEO's with option compensation according to the model in Section 2.1. The project has a payoff of 6. The probability of success (η_2) is 0.2 . The overconfident CEO believes the probability of success is 0.4 (i.e. $\eta_2^* = 0.4$). The cost of effort (to the CEO) is 1. Thus, the overconfident CEO must receive compensation of at least $\rho\eta_2^*\beta_2^{oc} = 1$ and the non-overconfident CEO must receive compensation of at least $\rho\eta_2\beta_2^{noc} = 1$, where ρ is the discount rate, through which we iterate. The NPV of the project is then $0.2 \times (6 - \beta_2)$, where β_2 denotes the compensation paid to the CEO.



Tables

Table 1a: Summary statistics – CEO compensation sample

This table contains sample means for the full sample (Column 1), companies run by overconfident CEOs (Column 2) and non-overconfident CEOs (Column 3). Column 4 contains the difference in means between Column 2 and Column 3. ***, **, and * denote significance at 1%, 5%, and 10%, respectively. See Appendix 2 for variable definitions.

Sample	All Firms	Overconfident (Holder67 =1)	Non-Overconfident (Holder67 =0)	Difference
	[1]	[2]	[3]	[4]=[2]-[3]
Option Intensity	0.309	0.347	0.270	0.077***
Equity Intensity	0.430	0.456	0.403	0.054***
Cash Intensity	0.434	0.413	0.456	-0.043***
log(Cash)	6.848	6.875	6.820	0.055***
log(Total Pay)	7.923	8.021	7.821	0.200***
Holder67	0.508			
Ownership(%)	0.019	0.024	0.015	0.009***
Tenure	7.509	9.264	5.697	3.568***
Age	54.726	55.024	54.418	0.606***
Firm Size	7.250	7.116	7.389	-0.272***
Financial Leverage	0.226	0.205	0.248	-0.043***
Firm Age	26.131	22.547	29.830	-7.283***
Stock Volatility	0.028	0.030	0.027	0.002***
Stock Return	0.217	0.317	0.113	0.205***
Market-to-Book	2.045	2.402	1.676	0.726***
HHI	1,307	1,335	1,273	62***
Free Cash Flows	0.027	0.027	0.027	0.000
R&D	0.507	0.513	0.502	0.010
PP&E	0.565	0.512	0.619	-0.106***
ln(Ind & State Num Exec)	2.635	2.676	2.592	0.084***
ln(Ind Num Exec)	3.958	4.011	3.904	0.107***
Cites/Patents	18.050	19.724	16.350	3.374***
Cites/Patents (5yrs)	14.025	15.729	12.262	3.467***

Table 1b: Summary statistics – non-CEO characteristics

This table contains sample means for the non-CEO executive characteristics (Column 1), companies run by overconfident CEOs (Column 2) and non-overconfident CEOs (Column 3). Column 4 contains the difference in means between Column 2 and Column 3. ***, **, and * denote significance at 1%, 5%, and 10%, respectively. See Appendix 2 for variable definitions.

Sample	All Firms	Exec Overconfident (Exec Holder67 =1)	Exec Non-Overconfident (Exec Holder67 =0)	Difference
	[1]	[2]	[3]	[4]=[2]-[3]
Exec Option Intensity	0.269	0.305	0.238	0.067***
Exec Equity Intensity	0.373	0.393	0.348	0.045***
Exec Cash Intensity	0.500	0.494	0.517	-0.024***
Exec Holder67	0.442			

Table 2: Baseline Regression Results

This table contains OLS regression results for the relation between overconfidence and CEO compensation. Columns 1-6 include year and Fama-French 48 industry fixed effects. Columns 7-12 include firm and year fixed effects. All models include a constant (suppressed) and use standard errors clustered by firm. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Holder67	0.037***	0.018***	-0.024***				0.042***	0.034***	-0.031***			
	[0.000]	[0.007]	[0.000]				[0.000]	[0.000]	[0.000]			
Holder30-Holder67				0.030***	0.018**	-0.015*				0.036***	0.027***	-0.027***
				[0.000]	[0.030]	[0.060]				[0.000]	[0.004]	[0.003]
Holder67-Holder100				0.035***	0.023**	-0.033***				0.047***	0.034***	-0.035***
				[0.000]	[0.021]	[0.000]				[0.000]	[0.004]	[0.001]
Holder100				0.057***	0.028***	-0.031***				0.068***	0.056***	-0.051***
				[0.000]	[0.001]	[0.000]				[0.000]	[0.000]	[0.000]
Ownership(%)	-0.319***	-0.455***	0.483***	-0.316***	-0.454***	0.482***	-0.221*	-0.225	0.223	-0.222*	-0.226	0.223
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.091]	[0.137]	[0.141]	[0.087]	[0.133]	[0.138]
Tenure	-0.000	-0.001**	0.002***	-0.000	-0.002***	0.002***	-0.001	-0.003***	0.002**	-0.002**	-0.003***	0.003***
	[0.889]	[0.015]	[0.002]	[0.574]	[0.009]	[0.002]	[0.120]	[0.006]	[0.011]	[0.050]	[0.002]	[0.005]
Age	-0.003***	-0.004***	0.002***	-0.003***	-0.004***	0.002***	-0.004***	-0.005***	0.002***	-0.004***	-0.005***	0.003***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.002]
Firm Size	0.042***	0.063***	-0.071***	0.042***	0.063***	-0.071***	0.036***	0.036***	-0.045***	0.036***	0.036***	-0.045***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.085***	-0.078***	0.062***	-0.083***	-0.077***	0.061***	-0.073**	-0.079***	0.101***	-0.067**	-0.074**	0.097***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.003]	[0.015]	[0.009]	[0.000]	[0.027]	[0.014]	[0.001]
Firm Age	-0.001***	-0.002***	0.001***	-0.001***	-0.002***	0.001***	-0.027*	-0.029*	0.014	-0.027*	-0.029*	0.014
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.081]	[0.069]	[0.276]	[0.080]	[0.068]	[0.281]
Stock Volatility	1.753***	0.871***	-0.737***	1.802***	0.911***	-0.780***	1.209***	-0.077	-0.457	1.213***	-0.081	-0.460
	[0.000]	[0.002]	[0.005]	[0.000]	[0.001]	[0.003]	[0.000]	[0.807]	[0.139]	[0.000]	[0.798]	[0.137]
Stock Return	-0.001	0.004	-0.012***	-0.002	0.004	-0.012***	-0.002	0.000	-0.010**	-0.002	0.000	-0.010**
	[0.793]	[0.361]	[0.003]	[0.696]	[0.401]	[0.004]	[0.610]	[0.918]	[0.013]	[0.608]	[0.911]	[0.014]
Market-to-Book	0.036***	0.031***	-0.025***	0.034***	0.030***	-0.024***	0.029***	0.026***	-0.019***	0.028***	0.025***	-0.017***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000**	-0.000	-0.000	-0.000**	-0.000	-0.000
	[0.110]	[0.369]	[0.671]	[0.115]	[0.363]	[0.691]	[0.015]	[0.340]	[0.568]	[0.016]	[0.349]	[0.564]
Free cash flows	-0.062***	-0.073***	0.031	-0.062***	-0.073***	0.032	-0.026	-0.024	0.009	-0.026	-0.024	0.009
	[0.006]	[0.003]	[0.189]	[0.005]	[0.003]	[0.180]	[0.236]	[0.329]	[0.704]	[0.241]	[0.334]	[0.711]
R&D	0.026**	0.019*	-0.031***	0.027***	0.020*	-0.031***	-0.012	-0.015	0.009	-0.012	-0.015	0.009
	[0.013]	[0.077]	[0.003]	[0.010]	[0.073]	[0.003]	[0.566]	[0.543]	[0.714]	[0.570]	[0.555]	[0.720]
PP&E	-0.028**	-0.028**	0.026**	-0.025**	-0.027**	0.025**	-0.045*	-0.089***	0.086***	-0.043*	-0.087***	0.084***
	[0.023]	[0.034]	[0.036]	[0.035]	[0.039]	[0.038]	[0.060]	[0.000]	[0.000]	[0.072]	[0.000]	[0.000]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Firm Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,772	12,772	12,772	12,810	12,810	12,810	12,810	12,810	12,810
R-squared	0.238	0.197	0.305	0.240	0.197	0.305	0.152	0.064	0.196	0.154	0.065	0.197

Table 3: Impact of innovation and risk

This table contains OLS regressions that examine how innovation and risk influence the relation between overconfidence and CEO compensation. The models include all control variables from Table 2 (suppressed). Columns 1-3 include year and Fama-French 48 industry fixed effects, and a constant (suppressed). Columns 4-6 include firm and year fixed effects. All models use standard errors clustered by firm.. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Cites/Patents						
Holder67	0.015	-0.002	-0.012	0.018	0.017	-0.026**
	[0.151]	[0.858]	[0.210]	[0.196]	[0.207]	[0.028]
Cites/Patents (/100)	-0.008	-0.001	-0.007	0.067**	0.113***	-0.152***
	[0.549]	[0.905]	[0.601]	[0.016]	[0.000]	[0.000]
Holder67*Cites/Patents (/100)	0.089***	0.119***	-0.094***	0.086*	0.087**	-0.060
	[0.001]	[0.000]	[0.000]	[0.050]	[0.050]	[0.131]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	6,677	6,677	6,677	6,701	6,701	6,701
R-squared	0.255	0.211	0.294	0.168	0.076	0.162
Cites/Patents (5yrs)						
Holder67	0.025**	0.003	-0.019*	0.038**	0.025*	-0.025**
	[0.027]	[0.776]	[0.054]	[0.014]	[0.070]	[0.036]
Cites/Patents (5yrs) (/100)	0.042***	0.042**	-0.049***	0.064***	0.081***	-0.088***
	[0.010]	[0.031]	[0.003]	[0.005]	[0.000]	[0.000]
Holder67*Cites/Patents (5yrs) (/100)	0.063*	0.102***	-0.079***	0.051	0.071	-0.112***
	[0.062]	[0.001]	[0.006]	[0.258]	[0.109]	[0.004]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	5,800	5,800	5,800	5,823	5,823	5,823
R-squared	0.256	0.206	0.291	0.170	0.065	0.146
Stock Volatility						
Holder67	0.017	-0.010	-0.002	0.034**	0.022	-0.015
	[0.187]	[0.412]	[0.899]	[0.012]	[0.107]	[0.228]
Volatility	1.339***	0.283	-0.260	1.069***	-0.305	-0.127
	[0.000]	[0.402]	[0.432]	[0.006]	[0.456]	[0.756]
Holder67*Stock Volatility	0.759**	1.057***	-0.836**	0.270	0.417	-0.589
	[0.048]	[0.007]	[0.029]	[0.518]	[0.329]	[0.166]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,810	12,810	12,810
R-squared	0.238	0.197	0.306	0.152	0.064	0.196

Table 4: Impact of SOX

This table contains OLS regressions that examine how the passage of the Sarbanes-Oxley Act of 2002 (SOX) influences the relation between overconfidence and CEO compensation. The sample in this model goes from 1998 to 2004. The SOX dummy equals one if the observation occurs in 2003 or after and equals zero otherwise. The models include fixed effects as denoted in the Column footer and all models include standard errors clustered by firm. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Holder67	0.020*	0.008	-0.020*	0.021*	0.008	-0.020*	0.036*	0.029	-0.041**	0.035*	0.028	-0.040**
	[0.085]	[0.482]	[0.084]	[0.078]	[0.494]	[0.085]	[0.065]	[0.131]	[0.021]	[0.072]	[0.157]	[0.025]
SOX	-0.084***	-0.036**	0.036**	-0.090***	-0.042***	0.036***	-0.117***	-0.082***	0.054***	-0.093***	-0.047***	0.028**
	[0.000]	[0.017]	[0.013]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.014]
Holder67*SOX	0.041***	0.027*	-0.009	0.040***	0.028*	-0.010	0.031**	0.025	-0.006	0.033**	0.024	-0.006
	[0.007]	[0.080]	[0.521]	[0.008]	[0.072]	[0.506]	[0.039]	[0.107]	[0.668]	[0.031]	[0.125]	[0.711]
Ownership(%)	-0.530***	-0.595***	0.545***	-0.525***	-0.592***	0.541***	-0.572**	-0.396	0.274	-0.539*	-0.383	0.263
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.047]	[0.174]	[0.399]	[0.063]	[0.196]	[0.425]
Tenure	-0.001	-0.001*	0.002**	-0.001	-0.001*	0.002**	-0.006***	-0.006***	0.003	-0.006***	-0.006***	0.003
	[0.389]	[0.092]	[0.029]	[0.383]	[0.093]	[0.030]	[0.004]	[0.002]	[0.103]	[0.003]	[0.003]	[0.113]
Age	-0.003***	-0.003***	0.002**	-0.003***	-0.003***	0.002**	-0.002	-0.003	0.002	-0.002	-0.003	0.002
	[0.001]	[0.000]	[0.032]	[0.001]	[0.000]	[0.034]	[0.307]	[0.108]	[0.157]	[0.273]	[0.111]	[0.158]
Firm Size	0.050***	0.061***	-0.068***	0.050***	0.062***	-0.069***	0.025	0.029*	-0.046***	0.031**	0.046***	-0.059***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.144]	[0.087]	[0.006]	[0.037]	[0.003]	[0.000]
Financial Leverage	-0.134***	-0.101***	0.086***	-0.132***	-0.100***	0.085***	-0.110**	-0.099*	0.138***	-0.105**	-0.099*	0.136***
	[0.000]	[0.001]	[0.005]	[0.000]	[0.001]	[0.006]	[0.035]	[0.060]	[0.005]	[0.044]	[0.061]	[0.006]
Firm Age	-0.068***	-0.062***	0.043***	-0.067***	-0.061***	0.042***	-0.054	-0.040	0.058	-0.052	-0.032	0.052
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.165]	[0.368]	[0.136]	[0.193]	[0.465]	[0.184]
Stock Volatility	1.684***	1.182***	-0.992**	1.828***	1.381***	-1.088***	-0.945*	-0.893	0.485	0.149	0.159	-0.366
	[0.000]	[0.008]	[0.022]	[0.000]	[0.001]	[0.004]	[0.090]	[0.119]	[0.370]	[0.760]	[0.747]	[0.423]
Stock Return	0.003	0.005	-0.007	0.002	0.005	-0.008	-0.001	0.002	-0.005	-0.004	0.003	-0.005
	[0.651]	[0.432]	[0.213]	[0.789]	[0.375]	[0.176]	[0.818]	[0.749]	[0.465]	[0.514]	[0.671]	[0.417]
Market-to-Book	0.034***	0.034***	-0.026***	0.034***	0.034***	-0.026***	0.027***	0.025***	-0.024***	0.029***	0.027***	-0.025***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	[0.296]	[0.783]	[0.455]	[0.246]	[0.888]	[0.423]	[0.146]	[0.750]	[0.607]	[0.131]	[0.891]	[0.521]
Free cash flows	-0.099***	-0.099***	0.062*	-0.097***	-0.097***	0.062*	-0.048	-0.048	0.039	-0.042	-0.046	0.036
	[0.005]	[0.005]	[0.065]	[0.005]	[0.006]	[0.059]	[0.196]	[0.225]	[0.298]	[0.247]	[0.242]	[0.337]
R&D	0.010	-0.000	-0.026*	0.009	-0.001	-0.025*	-0.067	-0.072	0.068	-0.068	-0.075*	0.070
	[0.502]	[0.987]	[0.090]	[0.524]	[0.932]	[0.097]	[0.132]	[0.107]	[0.124]	[0.122]	[0.089]	[0.111]
PP&E	-0.030	-0.031	0.030	-0.029	-0.031	0.029	-0.050	-0.087*	0.092*	-0.053	-0.081	0.086*
	[0.107]	[0.110]	[0.103]	[0.113]	[0.110]	[0.104]	[0.329]	[0.096]	[0.058]	[0.295]	[0.115]	[0.069]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Firm Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,479	5,479	5,479	5,479	5,479	5,479	5,487	5,487	5,487	5,487	5,487	5,487
R-squared	0.235	0.215	0.220	0.234	0.214	0.219	0.073	0.045	0.041	0.066	0.039	0.036

Table 5: Executive compensation

This table contains models that examine the relation between non-CEO executive overconfidence and compensation. The unit of analysis is the company executive. *Exec Holder67* is the executive's Holder 67 measure. Columns 1-3 examine the full sample of executives. Columns 4-6 and 7-9 analyze executives at firms where the CEO is, or is not (respectively), overconfident. The models include all firm-level control variables from Table 2, year and industry fixed effects, and a constant (suppressed). See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Sample	All Executives			All Execs when CEO is overconfident			All Execs when CEO is not overconfident		
VARIABLES									
	Exec Option Intensity	Exec Equity Intensity	Exec Cash Intensity	Exec Option Intensity	Exec Equity Intensity	Exec Cash Intensity	Exec Option Intensity	Exec Equity Intensity	Exec Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Exec Holder67	0.021***	0.016***	-0.019***	0.014***	0.013**	-0.015***	0.012**	0.010*	-0.016***
	[0.000]	[0.000]	[0.000]	[0.005]	[0.012]	[0.003]	[0.016]	[0.099]	[0.005]
Firm Size	0.044***	0.065***	-0.074***	0.045***	0.066***	-0.074***	0.040***	0.062***	-0.072***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.066***	-0.086***	0.068***	-0.046*	-0.073***	0.049**	-0.089***	-0.097***	0.087***
	[0.000]	[0.000]	[0.000]	[0.066]	[0.003]	[0.040]	[0.000]	[0.000]	[0.000]
Firm Age	-0.002***	-0.002***	0.001***	-0.002***	-0.002***	0.001***	-0.001***	-0.002***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	1.878***	1.049***	-0.911***	1.918***	1.429***	-1.375***	1.725***	0.390	-0.181
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.214]	[0.547]
Stock Return	0.001	0.004	-0.010***	-0.000	0.002	-0.007	0.003	0.006	-0.015***
	[0.818]	[0.296]	[0.002]	[0.959]	[0.633]	[0.134]	[0.500]	[0.264]	[0.002]
Market-to-Book	0.039***	0.035***	-0.031***	0.035***	0.033***	-0.029***	0.041***	0.035***	-0.032***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	-0.000	0.000	-0.000	-0.000	0.000	-0.000	-0.000	0.000	-0.000
	[0.814]	[0.540]	[0.224]	[0.582]	[0.801]	[0.500]	[0.849]	[0.856]	[0.540]
Free Cash Flows	-0.032*	-0.031	0.002	0.001	-0.001	-0.062*	-0.049**	-0.044*	0.042*
	[0.064]	[0.109]	[0.934]	[0.974]	[0.973]	[0.054]	[0.015]	[0.064]	[0.094]
R&D	0.028***	0.022**	-0.033***	0.043***	0.030**	-0.038***	0.014	0.017	-0.028***
	[0.001]	[0.011]	[0.000]	[0.001]	[0.019]	[0.008]	[0.132]	[0.108]	[0.006]
PP&E	-0.027***	-0.025**	0.019*	-0.018	-0.009	0.008	-0.032***	-0.036***	0.022*
	[0.005]	[0.021]	[0.067]	[0.224]	[0.577]	[0.582]	[0.002]	[0.003]	[0.065]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	48,703	48,703	48,703	26,821	26,821	26,821	21,882	21,882	21,882
R-squared	0.272	0.212	0.308	0.270	0.199	0.256	0.225	0.206	0.374

Table 6a: Impact of bargaining power

This table contains models that analyze the relationship between CEO bargaining power and compensation-structure. Columns 1-6 include year and Fama-French 48 industry fixed effects, and a constant (suppressed). Columns 7-12 include firm and year fixed effects. All models use standard errors clustered by firm. Appendix 2 contains the variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Panel A						
Holder67	0.027***	0.007	-0.020***	0.017*	0.010	-0.021**
	[0.000]	[0.310]	[0.005]	[0.072]	[0.292]	[0.018]
Total Compensation Top 25%	0.100***	0.184***	-0.218***	0.118***	0.205***	-0.240***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Total Compensation Top 25%	0.035**	0.034***	-0.004	0.061***	0.050***	-0.005
	[0.017]	[0.008]	[0.668]	[0.000]	[0.001]	[0.665]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,810	12,810	12,810
R-squared	0.262	0.263	0.383	0.198	0.167	0.308
Panel B						
Holder67	0.027***	0.013*	-0.028***	0.031***	0.030***	-0.037***
	[0.000]	[0.063]	[0.000]	[0.001]	[0.001]	[0.000]
Compensation Slice (M1) Top 25%	0.069***	0.130***	-0.168***	0.079***	0.138***	-0.169***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Compensation Slice (M1) Top 25%	0.035***	0.012	0.023**	0.044***	0.020	0.017
	[0.004]	[0.325]	[0.026]	[0.000]	[0.121]	[0.109]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,810	12,810	12,810
R-squared	0.257	0.242	0.366	0.182	0.125	0.267
Panel C						
Holder67	0.026***	0.013*	-0.027***	0.031***	0.030***	-0.038***
	[0.000]	[0.078]	[0.000]	[0.001]	[0.001]	[0.000]
Compensation Slice (M2) Top 25%	0.071***	0.132***	-0.171***	0.084***	0.143***	-0.174***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Compensation Slice (M2) Top 25%	0.036***	0.012	0.020**	0.043***	0.019	0.017
	[0.004]	[0.309]	[0.047]	[0.000]	[0.146]	[0.109]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,810	12,810	12,810
R-squared	0.259	0.243	0.369	0.185	0.129	0.272
Panel D						
Holder67	0.028***	0.016**	-0.028***	0.031***	0.031***	-0.038***
	[0.000]	[0.033]	[0.000]	[0.001]	[0.001]	[0.000]
Compensation Slice (M3) Top 25%	0.072***	0.141***	-0.174***	0.081***	0.148***	-0.175***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Compensation Slice (M3) Top 25%	0.033***	0.007	0.018*	0.048***	0.024*	0.010
	[0.008]	[0.597]	[0.074]	[0.000]	[0.058]	[0.339]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,810	12,810	12,810
R-squared	0.258	0.247	0.372	0.185	0.137	0.278

Table 6b: Labor market competition and industry-changes in compensation

This table contains models that analyze the relationship between CEO labor market competition (as proxied by changes in the compensation in the CEO's state and industry) and compensation-structure. Columns 1-6 include year and Fama-French 48 industry fixed effects, and a constant (suppressed). Columns 7-12 include firm and year fixed effects. All models use standard errors clustered by firm. Appendix 2 contains the variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Panel A						
Holder67	0.031***	0.012	-0.023***	0.031***	0.024***	-0.026***
	[0.000]	[0.103]	[0.001]	[0.001]	[0.006]	[0.002]
Δ State & 4D-Industry Compensation Top 25%	0.034***	0.058***	-0.084***	0.040***	0.072***	-0.092***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Δ State & 4D-Industry Compensation Top 25%	0.028***	0.030***	-0.009	0.038***	0.032***	-0.014
	[0.005]	[0.004]	[0.325]	[0.000]	[0.003]	[0.142]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,762	12,762	12,762	12,800	12,800	12,800
R-squared	0.244	0.210	0.324	0.167	0.094	0.233
Panel B						
Holder67	0.045***	0.023***	-0.025***	0.046***	0.035***	-0.030***
	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
Δ State & 4D-Industry Compensation Bottom 25%	-0.037***	-0.076***	0.090***	-0.045***	-0.085***	0.098***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Δ State & 4D-Industry Compensation Bottom 25%	-0.026**	-0.012	-0.000	-0.021**	-0.009	-0.003
	[0.010]	[0.269]	[0.988]	[0.033]	[0.386]	[0.755]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,762	12,762	12,762	12,800	12,800	12,800
R-squared	0.244	0.212	0.325	0.164	0.093	0.231
Panel C						
Holder67	0.034***	0.013*	-0.022***	0.035***	0.025***	-0.026***
	[0.000]	[0.079]	[0.002]	[0.000]	[0.004]	[0.002]
Δ State & 2D-Industry Compensation Top 25%	0.015**	0.033***	-0.052***	0.020***	0.039***	-0.057***
	[0.029]	[0.000]	[0.000]	[0.004]	[0.000]	[0.000]
Holder67 x Δ State & 2D-Industry Compensation Top 25%	0.017*	0.027***	-0.011	0.024**	0.030***	-0.016*
	[0.079]	[0.008]	[0.237]	[0.012]	[0.003]	[0.088]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,769	12,769	12,769	12,807	12,807	12,807
R-squared	0.239	0.202	0.313	0.156	0.076	0.212
Panel D						
Holder67	0.044***	0.023***	-0.023***	0.046***	0.036***	-0.029***
	[0.000]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]
Δ State & 2D-Industry Compensation Bottom 25%	-0.021***	-0.043***	0.064***	-0.026***	-0.049***	0.065***
	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Holder67 x Δ State & 2D-Industry Compensation Bottom 25%	-0.022**	-0.013	-0.010	-0.019**	-0.010	-0.009
	[0.023]	[0.223]	[0.301]	[0.048]	[0.341]	[0.339]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,769	12,769	12,769	12,807	12,807	12,807
R-squared	0.240	0.202	0.313	0.157	0.075	0.209

Table 7: Impact of FAS 123R on compensation

This table contains OLS regressions that examine how FAS 123R influences the relation between CEO overconfidence and compensation. The sample in this model goes from 2003 to 2007. The FAS 123R dummy equals one if the observation occurs in 2005 or later and equals zero otherwise. The models include fixed effects as indicated in the table footer. All models use standard errors clustered by firm. All models include a constant (suppressed). See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	ln(Cash)	ln(Stock)	ln(Cash+Stock)	Option Intensity	ln(Cash)	ln(Stock)	ln(Cash+Stock)
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Holder67	0.080***	-0.019	-0.445	0.038	0.079***	-0.025	-0.405	0.040
	[0.000]	[0.653]	[0.156]	[0.529]	[0.000]	[0.601]	[0.209]	[0.498]
FAS 123R	-0.137***	-0.381***	2.341***	0.158***	-0.101***	-0.144***	0.975***	0.086**
	[0.000]	[0.000]	[0.000]	[0.007]	[0.000]	[0.000]	[0.000]	[0.023]
Holder67 *FAS 123R	-0.018	0.036	0.681***	0.084*	-0.009	0.083**	0.482*	0.081*
	[0.338]	[0.271]	[0.007]	[0.088]	[0.621]	[0.017]	[0.061]	[0.092]
Ownership(%)	-0.402	0.096	-2.590	0.542	-0.341	0.398	-3.453	0.607
	[0.391]	[0.919]	[0.483]	[0.599]	[0.503]	[0.623]	[0.356]	[0.559]
Tenure	-0.006	0.005	-0.064	-0.000	-0.008**	-0.006	-0.024	-0.001
	[0.105]	[0.455]	[0.228]	[0.965]	[0.031]	[0.387]	[0.678]	[0.896]
Age	-0.003	0.007	-0.029	-0.000	-0.004	0.003	-0.017	-0.001
	[0.391]	[0.156]	[0.575]	[0.995]	[0.268]	[0.557]	[0.744]	[0.937]
Firm Size	0.038	-0.019	-1.029**	-0.214***	-0.017	-0.310***	0.106	-0.218***
	[0.189]	[0.719]	[0.010]	[0.010]	[0.517]	[0.000]	[0.765]	[0.005]
Financial Leverage	-0.069	0.189	-1.393	-0.127	-0.058	0.258**	-1.786*	-0.145
	[0.319]	[0.110]	[0.136]	[0.482]	[0.409]	[0.044]	[0.056]	[0.425]
Firm Age	0.019	0.141	-0.387	0.257	-0.004	0.024	0.013	0.247
	[0.647]	[0.114]	[0.411]	[0.124]	[0.924]	[0.803]	[0.979]	[0.131]
Stock Volatility	2.689***	-1.690	-36.732***	-6.650***	2.350***	-1.831	-50.569***	-8.933***
	[0.002]	[0.237]	[0.002]	[0.003]	[0.004]	[0.166]	[0.000]	[0.000]
Stock Return	0.003	0.042**	0.335***	0.101***	0.019**	0.106***	0.277**	0.134***
	[0.732]	[0.011]	[0.004]	[0.000]	[0.026]	[0.000]	[0.014]	[0.000]
Market-to-Book	0.049***	-0.014	-0.312**	-0.038	0.045***	-0.034*	-0.245*	-0.040
	[0.000]	[0.430]	[0.017]	[0.178]	[0.000]	[0.085]	[0.056]	[0.156]
HHI	0.000	-0.000	0.000	-0.000	0.000**	0.000**	-0.000	-0.000
	[0.543]	[0.179]	[0.764]	[0.319]	[0.025]	[0.023]	[0.586]	[0.924]
Free Cash Flows	0.019	0.017	-0.864	0.011	0.001	-0.031	-1.111	-0.062
	[0.735]	[0.862]	[0.302]	[0.940]	[0.986]	[0.756]	[0.176]	[0.670]
R&D	-0.052	0.005	-0.237	-0.074	-0.067	-0.061	-0.154	-0.106
	[0.346]	[0.958]	[0.747]	[0.572]	[0.204]	[0.546]	[0.840]	[0.411]
PP&E	-0.100	0.233**	-0.703	-0.036	-0.135*	0.040	0.207	-0.009
	[0.175]	[0.047]	[0.536]	[0.859]	[0.074]	[0.767]	[0.854]	[0.966]
Year Fixed Effects	Yes	Yes	Yes	Yes	No	No	No	No
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,393	3,393	3,393	3,393	3,393	3,393	3,393	3,393
R-squared	0.200	0.300	0.144	0.075	0.164	0.095	0.111	0.062

Table 8: CEO overconfidence and performance

This table contains OLS models that examine the impact of an exogenous drop in option compensation (as motivated by FAS 123R) on the relation between CEO overconfidence and firm performance (measured by Tobin's Q). All models include firm and year fixed effects and cluster standard errors by firm. See Appendix 2 for variable definitions. The column header states the sample that is under analysis. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	All Firms	Option Intensity (2004) = 0	Option Intensity (2004) > 0	Option Intensity (2004) Bottom 50%	Option Intensity (2004) Top 50%
Time Period	2003-2007	2003-2007	2003-2007	2003-2007	2003-2007
Model	[1]	[2]	[3]	[4]	[5]
Holder67	0.112***	0.116*	0.094*	0.048	0.150**
	[0.010]	[0.092]	[0.061]	[0.414]	[0.019]
FAS 123R	0.145**	-0.048	0.195***	0.054	0.167
	[0.025]	[0.770]	[0.004]	[0.486]	[0.152]
Holder67 *FAS 123R	0.012	0.059	0.004	0.134*	-0.055
	[0.838]	[0.462]	[0.957]	[0.073]	[0.476]
Ownership(%)	0.503	-0.725	0.855	-0.228	0.280
	[0.403]	[0.544]	[0.218]	[0.892]	[0.614]
Tenure	-0.021*	-0.008	-0.030**	-0.018	-0.016
	[0.061]	[0.685]	[0.023]	[0.230]	[0.210]
Age	0.005	0.033	0.002	0.001	0.005
	[0.552]	[0.216]	[0.857]	[0.917]	[0.716]
Firm Size	-0.527***	-0.345	-0.539***	-0.669***	-0.392**
	[0.000]	[0.188]	[0.000]	[0.001]	[0.023]
Financial Leverage	0.070	-0.712*	0.245	0.269	0.070
	[0.771]	[0.074]	[0.367]	[0.297]	[0.855]
Firm Age	-0.042***	-0.022	-0.048***	0.020	-0.096***
	[0.009]	[0.508]	[0.008]	[0.436]	[0.000]
Stock Volatility	2.454	9.421*	-0.210	5.161	-0.029
	[0.288]	[0.060]	[0.936]	[0.103]	[0.994]
Stock Return	0.017	0.066	0.003	0.057	-0.008
	[0.566]	[0.136]	[0.934]	[0.167]	[0.839]
Market-to-Book	0.158***	-0.040	0.182***	0.064	0.248***
	[0.003]	[0.810]	[0.001]	[0.547]	[0.000]
HHI	-0.000	-0.000*	-0.000	-0.000**	-0.000
	[0.148]	[0.091]	[0.297]	[0.040]	[0.379]
Free Cash Flows	-0.157	-0.117	-0.126	-0.045	-0.177
	[0.169]	[0.627]	[0.342]	[0.773]	[0.436]
R&D	0.061	-0.539	0.160**	-0.064	0.269***
	[0.593]	[0.260]	[0.029]	[0.725]	[0.000]
PP&E	-0.630**	0.054	-0.824**	-0.580*	-0.437
	[0.041]	[0.869]	[0.037]	[0.098]	[0.448]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	No	No	No
Observations	3,951	811	3,140	1,597	1,688
R-squared	0.100	0.095	0.122	0.091	0.149

Table 9: Propensity score and weighting models

This table contains first-stage Logit and second-stage OLS models that use either propensity score techniques or weighting techniques (as described in Section 6.1) to mitigate concerns about systemic differences between companies run by overconfident CEOs and those run by non-overconfident CEOs. The Logit model include all control variables from Table 2. The OLS models include all control variables from Table 2, year and industry fixed effects, and a constant (suppressed). See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Method	First Stage	Propensity Score			Weighting		
Dependent Variable	Holder67	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Holder67		0.036***	0.018***	-0.023***	0.036***	0.018***	-0.025***
		[0.000]	[0.008]	[0.000]	[0.000]	[0.007]	[0.000]
Ownership(%)	-2.082***	-0.295***	-0.426***	0.456***	-0.332***	-0.480***	0.504***
	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	0.085***	-0.000	-0.002***	0.002***	-0.000	-0.001**	0.002***
	[0.000]	[0.759]	[0.009]	[0.001]	[0.789]	[0.028]	[0.008]
Age	0.008**	-0.003***	-0.004***	0.002***	-0.003***	-0.004***	0.003***
	[0.022]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firm Size	0.142***	0.042***	0.062***	-0.070***	0.042***	0.063***	-0.070***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.658***	-0.087***	-0.082***	0.063***	-0.087***	-0.085***	0.060***
	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.001]	[0.008]
Firm Age	-0.025***	-0.001***	-0.002***	0.001***	-0.002***	-0.002***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	8.593***	1.802***	0.856***	-0.756***	1.857***	1.215***	-1.015***
	[0.000]	[0.000]	[0.003]	[0.005]	[0.000]	[0.000]	[0.001]
Stock Return	0.148***	-0.001	0.004	-0.012***	0.000	0.005	-0.012***
	[0.000]	[0.779]	[0.340]	[0.004]	[0.933]	[0.302]	[0.005]
Market-to-Book	0.601***	0.035***	0.030***	-0.024***	0.033***	0.028***	-0.022***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	0.000***	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
	[0.000]	[0.110]	[0.284]	[0.893]	[0.197]	[0.619]	[0.601]
Free Cash Flows	-0.102	-0.065***	-0.078***	0.027	-0.048*	-0.052*	-0.004
	[0.571]	[0.008]	[0.003]	[0.282]	[0.090]	[0.095]	[0.870]
R&D	-0.371***	0.024**	0.017	-0.031***	0.032**	0.023*	-0.035***
	[0.000]	[0.027]	[0.129]	[0.005]	[0.010]	[0.064]	[0.005]
PP&E	-0.426***	-0.029**	-0.023*	0.018	-0.025*	-0.018	0.020
	[0.000]	[0.024]	[0.093]	[0.152]	[0.094]	[0.255]	[0.152]
Year Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,772	11,727	11,727	11,727	12,772	12,772	12,772
R-squared	0.1503	0.229	0.189	0.290	0.238	0.188	0.274

Table 10: Controlling for anti-takeover provisions and general ability index

This table contains OLS models that examine the relationship between overconfidence and CEO compensation after controlling for anti-takeover provisions and general ability index. The models include all control variables from Table 2 (suppressed), year and industry fixed effects, and a constant (suppressed). See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Panel A: Anti-takeover provisions: GIM Index						
Holder67	0.039***	0.019**	-0.026***	0.070***	0.053**	-0.041
	[0.000]	[0.011]	[0.000]	[0.007]	[0.039]	[0.103]
GIM	0.000	0.002	-0.005***	0.002	0.004*	-0.006***
	[0.817]	[0.276]	[0.002]	[0.222]	[0.053]	[0.004]
Holder67*GIM				-0.003	-0.004	0.002
				[0.192]	[0.158]	[0.508]
Observations	10,518	10,518	10,518	10,518	10,518	10,518
R-Squared	0.247	0.205	0.323	0.247	0.205	0.323
Panel B: Anti-takeover provisions: BCF Index						
Holder67	0.038***	0.018**	-0.025***	0.041***	0.024	-0.022
	[0.000]	[0.014]	[0.001]	[0.008]	[0.124]	[0.139]
BCF	0.007**	0.009***	-0.016***	0.008**	0.010***	-0.016***
	[0.021]	[0.005]	[0.000]	[0.029]	[0.009]	[0.000]
Holder67*BCF				-0.001	-0.002	-0.001
				[0.826]	[0.670]	[0.811]
Observations	10,518	10,518	10,518	10,518	10,518	10,518
R-Squared	0.247	0.206	0.326	0.247	0.206	0.326
Panel C: Anti-takeover provisions: Classified Board						
Holder67	0.039***	0.019**	-0.026***	0.041***	0.024***	-0.033***
	[0.000]	[0.010]	[0.000]	[0.000]	[0.004]	[0.000]
CBOARD	-0.001	-0.000	-0.002	-0.001	0.001	-0.004*
	[0.673]	[0.994]	[0.312]	[0.805]	[0.614]	[0.083]
Holder67*CBOARD				-0.001	-0.002	0.003**
				[0.656]	[0.136]	[0.019]
Observations	10,518	10,518	10,518	10,518	10,518	10,518
R-Squared	0.247	0.205	0.321	0.247	0.205	0.322
Panel D: General Ability Index						
Holder67	0.033***	0.018**	-0.029***	0.033***	0.018**	-0.029***
	[0.000]	[0.020]	[0.000]	[0.000]	[0.016]	[0.000]
GA Index	0.001	0.014***	-0.021***	0.005	0.018***	-0.021***
	[0.739]	[0.001]	[0.000]	[0.326]	[0.002]	[0.000]
Holder67*GA Index				-0.007	-0.007	-0.000
				[0.334]	[0.383]	[0.954]
Observations	9,890	9,890	9,890	9,890	9,890	9,890
R-Squared	0.243	0.199	0.276	0.243	0.199	0.276

Table 11a: Alternative measures of overconfidence

This table contains OLS models that examine the relation between CEO compensation and alternative measures of overconfidence. The models include all control variables from Table 2 (suppressed). Columns 1-3 contain year and industry fixed effects. Columns 4-6 use firm and year fixed effects. All models use standard errors clustered by firm. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Panel A						
ln(Num Options)	0.022***	0.018***	-0.020***	-0.005	-0.007*	0.001
	[0.000]	[0.000]	[0.000]	[0.125]	[0.054]	[0.699]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,771	12,771	12,771	12,809	12,809	12,809
R-squared	0.242	0.201	0.310	0.149	0.062	0.194
Panel B: Num Options Held in top 50%						
Holder67	0.039***	0.016*	-0.022**	0.040***	0.029**	-0.026**
	[0.000]	[0.080]	[0.014]	[0.003]	[0.027]	[0.033]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	6,830	6,830	6,830	6,849	6,849	6,849
R-squared	0.223	0.167	0.263	0.180	0.067	0.148
Panel C: Did not exercise options in year t or t-1						
Holder67	0.024**	0.005	-0.008	0.035**	0.025*	-0.018
	[0.014]	[0.611]	[0.440]	[0.028]	[0.099]	[0.223]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	4,810	4,810	4,810	4,820	4,820	4,820
R-squared	0.207	0.195	0.324	0.104	0.050	0.173

Table 11b: News-based measures of overconfidence

This table contains media-based measures of overconfidence. The measures are available for the years 2000-2006. Panel A uses an indicator that equals one if the number of 'overconfident' media reports is greater than the number of 'non-overconfident' ones. Panel B uses the difference between the number of overconfident reports and the number of non-overconfident ones. Panel C uses a net news ratio, which is defined as (Overconfident News – Non-Overconfident News)/(Overconfident News + Non-Overconfident News). All models contain the control variables from Table 2, use fixed effects as stated in the table footer, and use standard errors clustered by firm. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Panel A						
Positive News Indicator	0.070***	0.063***	-0.059***	0.050***	0.057***	-0.064***
	[0.000]	[0.000]	[0.000]	[0.007]	[0.005]	[0.001]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	4,946	4,946	4,946	4,953	4,953	4,953
R-squared	0.269	0.215	0.240	0.153	0.048	0.085
Panel B						
Net News	0.009***	0.006***	-0.008***	0.008***	0.008***	-0.011***
	[0.000]	[0.002]	[0.000]	[0.001]	[0.000]	[0.000]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	4,946	4,946	4,946	4,953	4,953	4,953
R-squared	0.268	0.213	0.239	0.154	0.049	0.087
Panel C						
News Ratio	0.045***	0.032**	-0.045***	0.066***	0.066***	-0.085***
	[0.003]	[0.034]	[0.002]	[0.000]	[0.000]	[0.000]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	No	No	No
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	4,906	4,906	4,906	4,913	4,913	4,913
R-squared	0.265	0.210	0.236	0.153	0.047	0.087

Table 12: Fama-Macbeth, and Tobit Regressions

This table contains panel models that use alternative specifications to examine the relation between CEO overconfidence and performance. Columns 1-3 use firm and year fixed effects. Columns 4-6 use Fama-Macbeth regressions. Columns 7-9 use Tobit models that have a lower bound of zero and, where relevant, an upper bound of one. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Model	Fama-Macbeth			Tobit		
Dependent Variable	Option Intensity	Equity Intensity	Cash Intensity	Option Intensity	Equity Intensity	Cash Intensity
Model	[1]	[2]	[3]	[4]	[5]	[6]
Holder67	0.038***	0.022***	-0.026***	0.042***	0.020***	-0.025***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]
Ownership(%)	-0.281***	-0.483***	0.500***	-0.494***	-0.602***	0.502***
	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	-0.000	-0.001***	0.002***	-0.001	-0.002***	0.002***
	[0.699]	[0.009]	[0.003]	[0.423]	[0.006]	[0.002]
Age	-0.003***	-0.004***	0.003***	-0.004***	-0.004***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firm Size	0.041***	0.061***	-0.069***	0.053***	0.069***	-0.071***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.094***	-0.092***	0.061***	-0.101***	-0.087***	0.062***
	[0.000]	[0.000]	[0.005]	[0.001]	[0.001]	[0.003]
Firm Age	-0.002***	-0.002***	0.001***	-0.002***	-0.002***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	2.277***	1.498**	-0.718	1.651***	0.764**	-0.725***
	[0.000]	[0.014]	[0.237]	[0.000]	[0.019]	[0.007]
Stock Return	-0.005	0.004	-0.016**	-0.003	0.004	-0.012***
	[0.564]	[0.598]	[0.019]	[0.541]	[0.451]	[0.003]
Market-to-Book	0.035***	0.029***	-0.021***	0.040***	0.032***	-0.025***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	-0.000***	-0.000***	0.000**	-0.000	-0.000	-0.000
	[0.003]	[0.000]	[0.024]	[0.127]	[0.482]	[0.658]
Free Cash Flows	-0.065*	-0.051	0.016	-0.065**	-0.080***	0.030
	[0.069]	[0.210]	[0.649]	[0.046]	[0.009]	[0.222]
R&D	0.044***	0.037***	-0.035***	0.035**	0.023*	-0.032***
	[0.000]	[0.000]	[0.000]	[0.014]	[0.067]	[0.003]
PP&E	-0.030***	-0.024***	0.028**	-0.024	-0.025*	0.025**
	[0.000]	[0.001]	[0.012]	[0.139]	[0.095]	[0.042]
Year Fixed Effects	No	No	No	Yes	Yes	Yes
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,772	12,772	12,772
R-squared	0.162	0.191	0.238	0.2077	0.2309	1.2597
Number of Year Groups	17	17	17			

Table 13: Pay-to-performance sensitivity

This table contains OLS models that examine the relation between CEO overconfidence and pay-to-performance sensitivity. The models include all control variables from Table 2, year and industry fixed effects, and a constant (suppressed). See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Dependent Variable	log(Cash)	log(Cash)	log(Cash)	log(Total Pay)	log(Total Pay)	log(Total Pay)
Model	[1]	[2]	[3]	[4]	[5]	[6]
Holder67	0.075***	0.067***	0.065***	0.120***	0.115***	0.111***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Return	0.001***		0.001***	0.000		-0.000
	[0.009]		[0.005]	[0.867]		[0.959]
Holder67*Stock Return	0.037***		0.035***	0.058***		0.056***
	[0.000]		[0.000]	[0.000]		[0.000]
ROA		-0.022	-0.033		0.106	0.104
		[0.635]	[0.491]		[0.193]	[0.201]
Holder67*ROA		0.266***	0.265***		0.186*	0.172
		[0.003]	[0.003]		[0.077]	[0.103]
Ownership(%)	-0.703***	-0.714***	-0.714***	-1.480***	-1.489***	-1.498***
	[0.005]	[0.005]	[0.005]	[0.000]	[0.000]	[0.000]
Tenure	0.003	0.002	0.003	-0.000	-0.000	-0.000
	[0.125]	[0.136]	[0.120]	[0.918]	[0.855]	[0.909]
Age	0.006***	0.006***	0.006***	-0.001	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.771]	[0.809]	[0.816]
Firm Size	0.252***	0.250***	0.252***	0.478***	0.476***	0.476***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.042	-0.022	-0.027	-0.232***	-0.213***	-0.208***
	[0.441]	[0.689]	[0.632]	[0.001]	[0.002]	[0.002]
Firm Age	0.003***	0.003***	0.003***	-0.001	-0.001	-0.001
	[0.000]	[0.000]	[0.000]	[0.449]	[0.477]	[0.479]
Stock Volatility	-2.644***	-2.204***	-2.270***	1.735**	2.681***	2.512***
	[0.000]	[0.000]	[0.000]	[0.032]	[0.002]	[0.003]
Market-to-Book	0.031***	0.031***	0.027***	0.135***	0.134***	0.130***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
HHI	0.000*	0.000*	0.000*	0.000	0.000	0.000
	[0.070]	[0.067]	[0.073]	[0.310]	[0.313]	[0.337]
Free Cash Flows	0.292***	0.271***	0.266***	0.223***	0.185***	0.175***
	[0.000]	[0.000]	[0.000]	[0.001]	[0.006]	[0.010]
R&D	0.024	0.025	0.026	0.089***	0.093***	0.094***
	[0.321]	[0.298]	[0.269]	[0.007]	[0.005]	[0.005]
PP&E	-0.025	-0.024	-0.025	-0.161***	-0.157***	-0.159***
	[0.396]	[0.414]	[0.394]	[0.000]	[0.000]	[0.000]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,815	12,843	12,815	12,815	12,843	12,815
R-squared	0.494	0.494	0.495	0.561	0.560	0.562