Overconfidence and Incentive Compensation

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Abstract

We examine the impact of overconfidence on incentive compensation. Existing theory suggests incentive-heavy compensation contracts are offered to overconfident CEOs to take advantage of their overly-positive view of firm prospects (the *exploitation hypothesis*). We argue theoretically that the need to provide incentives – rather than exploitation – can also make it optimal to compensate overconfident CEOs with more incentive-based pay (the *strong-incentive hypothesis*). Our empirical evidence is more consistent with the strong-incentive hypothesis. We also find overconfidence is associated with non-CEO executives being compensated with more option incentives, independent of CEO overconfidence. Finally, we find that compensating overconfident CEOs and executives with strong incentives can be value-enhancing. Our results indicate that boards offer compensation contracts tailored to individual behavioral traits such as overconfidence.

1 Introduction

There is a burgeoning literature on the impact of CEO overconfidence on corporate policies. The literature suggests overconfident CEOs are prone to overestimate returns to investments and to underestimate risks (Dittrich et al., 2005). As with many CEO attributes, CEO overconfidence is neither inherently good nor bad for firm value. On the plus side, overconfident CEOs are associated with more innovative outcomes and a willingness to take risks (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). On the downside, overconfident managers tend to overinvest, often in projects that reduce shareholder wealth (Kolasinski and Li, forthcoming; Malmendier and Tate, 2005 and 2008). This raises an important question: are there mechanisms, such as incentive contracts, that firms can use to better channel the effort of overconfident CEOs to create, rather than destroy, shareholder value?

A substantial body of work emphasizes the role of managerial incentive contracts as a means of aligning the interests of managers with those of shareholders. Under the assumption that managers and firms (i.e. the boards) are both rational, appropriately structured incentive-based compensation contracts can induce managers to make better decisions and devote more effort to maximize firm value. The caveat is that risk-averse managers may require higher compensation for the greater uncertainty associated with incentive pay. However, if some managers are overconfident, with excessively confident beliefs about future firm value or their own ability, a compensation contract that is 'optimal' for an overconfident manager could be different from one that is offered to a manager with rational beliefs. Little is known about the nature of incentive contracts offered to overconfident managers or the impact on firm performance, or even whether firms tend to "fine-tune" their contracts to match a manager's personality traits. We fill this gap.

Our objective is to study whether, and how, overconfidence influences compensation contracts and whether these incentives serve to increase firm value. We begin by focusing on the CEO's compensation contract. We develop and test hypotheses about optimal contracting in the context of overconfident CEOs, drawing upon the limited theory that exists in the literature. While we expect compensation contracts to differ for overconfident CEOs, the nature of these differences is not obvious. For instance, compared to rational managers an overconfident manager might need weaker incentives in the form of options or restricted stock, given the higher probability the manager associates with a successful outcome. 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 as well, since such incentives could exacerbate risk-taking by an already overconfident manager. We refer to this as the *weak-incentive hypothesis*.

On the other hand, Gervais, Heaton and Odean (2011) [hereafter GHO] argue 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. From a rational perspective, this would lower the total compensation paid to overconfident managers. We call this the *exploitation hypothesis*.

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

Aside from the prediction regarding equity intensity, the exploitation hypothesis has two important testable implications. The first is that the compensation contract offered to an overconfident CEO will have *incentive slack*. 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). A second implication, as discussed in GHO, involves the effect of an increase in the CEO's bargaining power on account of, say, an increase in competition for CEOs. Since overconfident CEOs place a higher (than rational) value on cash flows promised in successful states, an increase in CEO compensation takes the form of even more equity-based pay.

A question, though, is whether the only reason to give overconfident managers equity-intensive contracts is to exploit their overvaluation. We develop a simple extension of GHO's model, in effect a counter-example, to argue that the need to provide incentives – rather than exploitation – also leads to overconfident managers being offered compensation contracts with greater incentives. We refer to this as the *strong-incentive hypothesis*. While both the exploitation and strong-incentive hypotheses imply that overconfident CEOs will be compensated with greater equity incentives, there are key differences. Whereas the exploitation hypothesis suggests an incentive-slack; and, hence, little value consequence from a modest decrease in incentive pay, the strong-incentive hypothesis predicts a reduction in equity intensity will lead to a reduction in firm value. Another key difference relates to the effect of an increase in the CEO's bargaining position with the firm: while the exploitation hypothesis predicts an increase in option intensity, the strong-incentive hypothesis predicts a decrease in option intensity due to there not being any incentive slack.

We conduct empirical tests to explore the relation between CEO overconfidence and 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.

Consistent with both the exploitation and strong-incentive hypotheses, but inconsistent with the weak-incentive hypothesis, CEO overconfidence increases option and stock intensity, measured as the proportion of compensation that comes from options and stock, respectively. We next examine two factors that potentially affect the relation between CEO compensation and overconfidence. First, we hypothesize and find overconfident CEOs feature even greater option (and stock) intensity in innovative and risky firms. This is consistent with both the exploitation and strong-incentive hypotheses. Second, consistent with the strong-incentive hypothesis only, we find a negative relation between CEO bargaining power and option (and stock) intensity for overconfident CEOs. In particular, we find in the face of increased labor market competition (i.e. reduced CEO bargaining power), firms prefer to reduce fixed compensation in relative terms rather than incentive compensation, consistent with such incentives being designed to direct overconfident CEOs' investments.

We then use the passage of the Sarbanes-Oxley Act of 2002 (SOX) as an exogenous shock to the optimal compensation contract to help alleviate endogeneity concerns. SOX exposed CEOs to significantly more risk and firms must be cognizant of the CEO's risk exposure

[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).

when designing optimal incentive contracts (Aggarwal, 2008). We find increased board oversight post-SOX substitutes for incentive compensation, with SOX being associated with a reduction in option intensity. However, this reduction is less severe for overconfident CEOs, consistent with both the exploitation hypothesis and the strong-incentive hypothesis (as firms are reluctant to cut compensation that serves as an effective incentive mechanism).

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 in addition to firm-level characteristics.

We next use the passage of SFAS 123(R) as a natural experiment to explore the efficiency of incentive-intensive compensation contracts. SFAS 123(R) 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 SFAS 123(R). We find this disproportionately affects overconfident CEOs, who we document tend to have higher levels of option-based compensation in general. Using the passage of SFAS 123(R), we examine the relation between incentive compensation for overconfident CEOs and firm value. We find the exogenous increase in the accounting cost of option compensation and the resulting decrease in

[4] Prior to the implementation of SFAS 123(R) 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.

option use has a negative effect on firm value for overconfident CEOs. We find similar results for overconfident non-CEO executives. These results are consistent with option-intensive compensation packages having important value implications for overconfident CEOs and executives, i.e. option-intensive compensation packages represent an efficient way to compensate overconfident managers.

We take steps to mitigate various econometric concerns. The two natural experiments (SOX and SFAS 123(R)) help to mitigate endogeneity concerns as both are exogenous shocks that affect the optimal 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 mitigate selection bias concerns. Our results are also robust to using firm-year fixed effects regressions, tobit regressions and Fama and MacBeth (1973) type regressions. In addition, our results are robust to controlling for other potential explanations. Our inferences are unaffected when we control for the general ability of CEOs (Custodio et al, 2013) and anti-takeover provisions. Our results are also robust to alternative measures of overconfidence and alternative measures of incentive compensation.

Our analysis of overconfidence contributes to the literature in several ways.[5] We show theoretically firms can use incentive contracts to better channel the effort of overconfident CEOs to create, rather than destroy, shareholder value. This contrasts with the arguments in GHO who contend, rather than to incentivize managers, option compensation is a means by which a firm can take advantage of a CEO's overconfidence. We fill a gap in the overconfidence literature by directly linking CEO overconfidence to compensation both theoretically and empirically.

[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).

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, in addition to firm-level characteristics.

Our results also speak to the efficiency of option compensation. Hayes et al (2012) question whether options provide any incentive effects for CEOs or create shareholder value. They find option use decreases after SFAS 123(R) without significant changes in firm financial and investment policies related to risk taking. Thus, they question why option compensation continues to be used. Our analysis offers one explanation. At least for a subset of CEOs, i.e. for overconfident CEOs – and for overconfident executives more broadly – options are an efficient means to incentivize managers.

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.

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 CEO believes the expansion has a probability of success $\eta_2^* = 0.4$. The overconfident (OC) CEO

[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.

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 "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 5), 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, SFAS 123(R) provides a way to analyze the relation between the compensation structure for overconfident CEOs and firm value. SFAS 123(R) requires firms to report option-based compensation at fair value on their income statement, rather

than intrinsic value which was often zero. Thus, SFAS 123(R) 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 SFAS 123(R) disproportionately affects CEOs who receive more options. To the extent overconfident CEOs have higher latent levels of option-based compensation, SFAS 123(R) will affect overconfident CEOs more. This suggests SFAS 123(R) 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 1992 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.

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]

Labor market competition*:* We capture labor market competition by calculating the natural log of the number of other executives in year t in the firm's SIC four-digit industry (*ln(Num Ind Exec)*) or SIC four-digit industry and state (*ln(Ind & State Num Exec)*).

[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.

SOX and SFAS 123(R): We define *SOX* as an indicator variable that equals one if the observation is after 2002 and equals zero otherwise. *SFAS 123(R)* is an indicator variable that equals one if the observation occurs in 2005 or later and zero otherwise.[8] When analyzing SOX, we restrict the sample period to 1999 to 2004.[9] When analyzing SFAS 123(R), we restrict the sample to contain only observations from 2003 to 2008.[10] 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.[11] In Panel A we also present summary statistics for the overconfident (*Holder67*=1) and non-overconfident (*Holder67*=0) CEO samples separately.

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

[9] 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.

[10] 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.

[11] 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 SFAS 123(R), the median LTIP value both before and after SFAS 123(R) 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. We include year and industry fixed effects and cluster standard errors by firm.[12]

Table 2 reports regression results testing the first set of hypotheses relating CEO overconfidence to incentive compensation (Hypotheses 1a and 1b). The main finding of Models 1 to 3 is 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

[12] We use industry fixed effects rather than firm fixed effects because CEO overconfidence is a behavioral trait that mainly changes with CEO turnover (i.e. *Holder67* is often time-invariant for firms, potentially changing only if the CEO changes). Nonetheless, in Section 6.4 we show that the results are robust to using firm fixed effects and to using Fama and Macbeth (1973) type regressions.

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 Models 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 (rational) 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*). As in Section 4.1, the models are OLS models that include year and industry fixed effects and cluster standard errors by firm.

The results are in Table 3. The key result 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 risk is even more positively associated with option-based compensation for overconfident CEOs. These results are consistent with both the exploitation hypothesis and the strong-incentive hypothesis.

4.3 Impact of labor market competition

We next examine the impact of labor market competition on overconfident CEOs' compensation contracts. The exploitation hypothesis implies that an increase in labor market competition (i.e. reduction in the CEO's bargaining power) reduces option intensity (Hypothesis 3a). The strong-incentive hypothesis predicts that an increase in labor market competition increases option and equity intensity (Hypothesis 3b).

We use as proxies for labor market competition the number of executives in the CEO's industry and/or state. Specifically, we capture labor market competition by obtaining the natural log of the number of executives (both CEO and non-CEO) in the company's SIC four-digit industry (*ln(Ind Num Exec)*) and SIC four-digit industry and state (*ln(Ind & State Num Exec)*). We run similar models to those used in the baseline regressions but include the interaction of *Holder67* and the labor market competition variables. The results are in Table 4. The interaction terms *Holder67*ln(Ind Num Exec)* and *Holder67*ln(Ind & State Num Exec)* are significantly and positively related to option intensity and equity intensity (see Panels A and B, respectively). We also use a labor competition indicator variable in Panel C that equals one if the number of executives in a firm's industry is in the top quartile for that year and interact this variable with *Holder67*, our CEO overconfidence measure. We use a similar approach in Panel D where we

[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.

use an indicator variable that takes the value one when the number of executives in a firm's industry and state is in the top quartile for that year. In both cases, we find the significant and positive impact of labor market competition on option and equity intensity for overconfident CEOs from Panels A and B are even more pronounced in Panels C and D. Thus, increases in labor market competition (i.e. decreases in CEO bargaining power) increase option and equity intensity for overconfident CEOs. These results are inconsistent with the exploitation hypothesis but consistent with our strong-incentive hypothesis.

4.4 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 analysis we restrict the sample to observations from 1999 to 2004 to mitigate the confounding effects of SFAS 123(R).

The results, reported in Table 5, support our predictions. Columns 1-3 contain models that include both year fixed effects and industry fixed effects. Columns 4-6 contain models that include only industry fixed effects. 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).

4.5 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 6. Consistent with Hypothesis 5, we find 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, Models 4-6 analyze firms where the CEO is overconfident and Models 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, 4 and 5 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 find some evidence that labor market competition increases option and equity intensity and reduces cash intensity for overconfident executives but this evidence is weaker than the corresponding evidence for

[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*.

overconfident CEOs. 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.

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 SFAS 123(R) as a natural experiment. As mentioned previously, SFAS 123(R) 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 SFAS 123(R) to analyze the impact on firm value of reducing option compensation for overconfident CEOs.[15]

We first analyze the impact of SFAS 123(R) on the compensation of overconfident CEOs. We create a *SFAS 123(R)* dummy that equals one if the observation occurs in 2005 or later and zero otherwise and interact *SFAS 123(R)* with *Holder67*. When doing these tests we restrict the sample to observations from 2003 to 2008 to mitigate the influence of SOX. Further, to compare with Hayes et al (2012), we examine *Stock Intensity* in addition to *Equity Intensity*, where the *Stock Intensity* of compensation is the proportion of total compensation that comes from stock grants.

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

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), SFAS 123(R) significantly reduces option intensity. Further, the interaction term *Holder67*SFAS 123(R)* is significantly negative, consistent with the expectation that SFAS 123(R) results in a larger reduction in option intensity for overconfident CEOs, who generally have relatively high levels of option compensation to begin with (Table 1, Panel A). In the models that examine the impact of *SFAS 123(R)* on *Stock Intensity* (as opposed to *Equity Intensity*, i.e. (stock + options)/total pay), we find *SFAS 123(R)* significantly increases *Stock Intensity*, consistent with the findings in Hayes et al (2012) and Skantz (2012). Moreover, we do not find CEO overconfidence to moderate this effect. Thus, while overconfident CEOs experienced a larger reduction in option intensity than their rational counterparts, this was not offset by a commensurate increase in stock compensation. Hence, overconfident CEOs experienced a significant reduction in equity intensity relative to non-overconfident CEOs after SFAS 123(R) (see Model 3). In unreported tests, we also analyze the impact of SFAS 123(R) on overconfident executives (as opposed to CEOs) and find similar results. Overall, these results highlight that *SFAS 123(R)* led to a significant reduction in option-based compensation for overconfident CEOs and executives. We next explore the value implications of such a reduction.

To examine the impact of compensating overconfident CEOs with options on firm value we use SFAS 123(R) 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 *SFAS 123(R)* dummy, our CEO overconfidence measure *Holder67* and the interaction of the two, *Holder67*SFAS 123(R)*. As explained earlier, we restrict the sample to

2003 to 2008. The baseline model is an OLS regression with year and industry fixed effects. As the model controls for lagged market-to-book, we also ensure the results are robust to using an Arellano and Bond (1991) model and a System GMM model (per Arellano and Bover, 1995; Blundell and Bond, 1998).

Table 8 presents the results. In Model 1 we find SFAS 123(R) has a significantly negative impact on *Q*. Moreover, we find the interaction term *Holder67*SFAS 123(R)* is also significantly negative, i.e. SFAS 123(R) has a greater negative impact on firm value for overconfident CEOs, inconsistent with the exploitation hypothesis (Hypothesis 6a) but consistent with the strong-incentive hypothesis (Hypothesis 6b). These results are robust to using Arellano-Bond and System GMM regressions (Models 2 and 3, respectively). In Model 4 we analyze the impact of SFAS 123(R) on overconfident CEOs whose option intensity is below the median of all CEOs in 2003. The idea here is that as these CEOs have relatively low option intensity prior to the accounting rule change, the impact of SFAS 123(R) should be less severe. This is precisely what we find. The coefficients on the interaction term *Holder67*SFAS 123(R)* is insignificant. Conversely, for overconfident CEOs whose option intensity is above the median in 2003, the coefficient on the interaction term *Holder67*SFAS 123(R)* significantly negative (Model 5). Overall, the results from Table 8 suggest the reduction in option intensity associated with the exogenous accounting rule change has a greater negative effect on value for overconfident CEOs. That is, paying overconfident CEOs with options has value implications.

Given that the accounting rule change did not impact the underlying economic benefits of option compensation, an interesting question that naturally arises is why firms would choose to reduce incentive compensation if such compensation was optimal to begin with. Both Hayes et al (2011) and Skantz (2012) find the perceived accounting costs of option expensing (Murphy,

2002, Hall and Murphy, 2003) was a driving force behind the change in option use. For example, Hayes et al (2011) find firms that would face higher accounting charges under SFAS 123(R) reduced their reliance on stock options the most. Thus, we conjecture at least some firms believed the accounting costs of option expensing after SFAS 123(R) outweighed the benefits.

We next explore some of the channels through which SFAS 123(R) potentially impacts the relation between CEO overconfidence and firm value. To do this, we investigate the value of *R&D,* risk (as proxied by stock price *Volatility*) and large capital expenditures (*CAPEX*). We run regressions with Tobin's *Q* as the dependent variable and the SFAS 123(R) dummy interacted with either *R&D, Volatility* or *CAPEX*. We partition the sample by *Holder67*, i.e. for firms with overconfident CEOs (*Holder67*=1) and non-overconfident CEOs (*Holder67*=0). We also run regressions that include both sub-samples and incorporate a triple interaction term. The coefficient on the triple interaction term indicates the impact SFAS 123(R) has on the value of either *R&D, Volatility* or *CAPEX* for overconfident CEOs.

The results are in Table 9. Models 1-3 focus on *R&D,* Models 4-6 on *Volatility,* and Models 7-9 on *CAPEX*. Several findings emerge. First, Models 1 to 3 indicate the market's valuation of *R&D* undertaken by overconfident CEOs significantly decreased following SFAS 123(R). In a similar vein, Models 4 to 6 indicate the market's valuation of firm risk as measured by *Volatility* for overconfident CEOs significantly decreased following SFAS 123(R). We obtain weaker results in Models 7 to 9 when we focus on *CAPEX*. However, as the average expenditure on *CAPEX* is larger for overconfident CEOs, when we consider the coefficients on the interaction term from Models 7 and 8 it is likely the economic effect is also larger. The key take-away from Table 9 is that the channel through which SFAS 123(R) potentially impacts the

relation between CEO overconfidence and firm value is though a reduction in the market's valuation of a firm's R&D, risk and possibly capital expenditures.

In Table 8 above we used the passage of SFAS 123(R) to investigate the value implications of incentive compensation for overconfident CEOs and in Table 9 we explored potential channels through which the valuation impact might occur. We now turn our focus to overconfident executives and investigate the value implications of compensating overconfident executives with options. We follow a similar research design to that we employed in Table 8. As each firm has multiple executives and our dependent variable is Tobin's *Q*, we create *Prop Exec Overconfident*, which measures the proportion of the firm's non-CEO executives for whom *Exec Holder67* equals one. This ensures for each firm we have one summary measure of executive overconfidence (larger values of *Prop Exec Overconfident* indicate the firm has a greater proportion of overconfident executives).

Table 10 presents the results. We find similar results to those we report for overconfident CEOs in Table 8. In particular, the interaction term *Prop Exec Overconfidence*SFAS 123(R)* in Model 1 of Table 10 is significantly negative indicating SFAS 123(R) has a greater negative impact on firm value when there is a greater proportion of overconfident executives. This is inconsistent with the exploitation hypothesis (Hypothesis 7a) but consistent with the strong-incentive hypothesis (Hypothesis 7b). Once again, these results are robust to using Arellano-Bond and System GMM regressions (Models 2 and 3, respectively).

To see if CEO overconfidence impacts the results, we repeat the analysis of Models 1 to 3 for cases when the CEO is overconfident (Models 4 to 6) and for cases when the CEO is not overconfident (Models 7 to 10). Not surprisingly, we find the overall value effects of SFAS 123(R) for overconfident executives are more pronounced when the CEO is also overconfident.

The key take-away from Table 10 is that the reduction in option intensity associated with the exogenous accounting rule change has a greater negative effect on firm value for overconfident executives (just as it did with overconfident CEOs in Table 8). That is, paying overconfident executives with options also has value implications.

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 11). 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 11. 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 11. 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 12, 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 12. 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 Additional measures of overconfidence

We examine whether the results are robust to using alternative measures of CEO overconfidence. The reported results so far use *Holder67*. If we use *Holder100*, which is similar to *Holder67*, except that it uses a 100% cut-off rather than a 67% cut-off, we find qualitatively similar results as reported in Panel A of Table 13 (we suppress control variables, for brevity). This *Holder100* measure captures the impact of particularly high levels of overconfidence. Further, we ensure that the results are robust to measuring overconfidence as the natural log of the number of vested but unexercised options (see Panel B). The main takeaway is that the relation between the alternative measures of overconfidence and compensation is qualitatively similar to those reported in Table 2.

6.4 Fixed effects, Fama-Macbeth, and Tobit regressions

Our main results control for industry (and year) fixed effects. We exclude firm fixed effects as CEO overconfidence is generally a behavioral trait that will mainly change if the CEO

changes. Nonetheless, Models 1-3 of Table 14 contain baseline models that include firm fixed effects. Our main inferences are unaffected. As a further robustness test, in Models 4-6 of Table 14 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 7-9 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 15, 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.

[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.

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 SFAS 123(R) 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. 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 strong-incentive hypothesis only, option intensity increases for overconfident CEOs with labor-market-competition.

We use the passage of SFAS 123(R) as a natural experiment through which to examine the value implications of granting overconfident CEOs option-intensive contracts. SFAS 123(R) 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 strong-

incentive hypothesis only, we find this reduction in option use has a greater negative effect on firm value for overconfident CEOs. Overall, our results indicate option-based compensation is an efficient way to compensate overconfident CEOs. This seems to occur by way of a reduction in the value of risky investments (i.e. R&D) undertaken by overconfident CEOs.

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. There is some evidence that SFAS 123(R) similarly impacted non-CEO executives, resulting in executive overconfidence becoming more negatively associated with firm value (although this effect concentrates in companies where the CEO is also overconfident).

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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 SFAS 123(R).

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 $\frac{/^{+}p_1E^{*}}{R+/^{+}E_0+/^{+}p_1E^{*}}$.

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

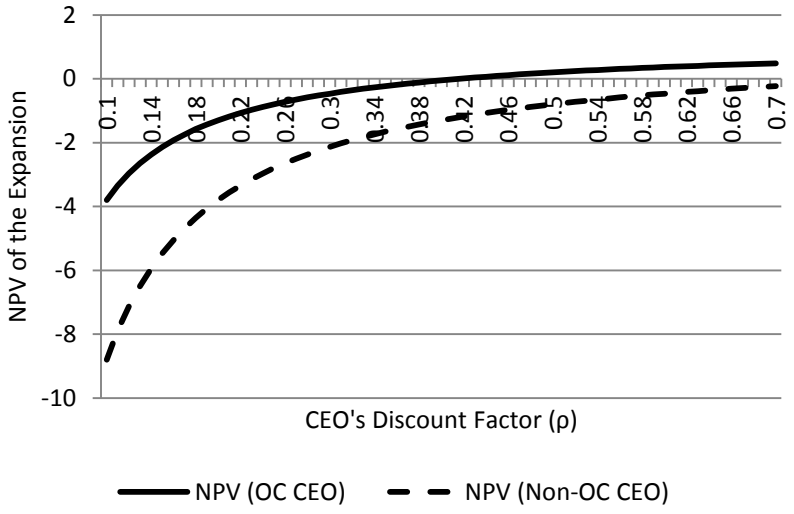
Variable	Definition
Compensation variables (CEOs)	
Cash Intensity	The proportion of total CEO compensation that comes from cash. This is the amount of cash (Execucomp: "total_curr") scaled by total compensation (Execucomp: "tdc1")
Equity Intensity	The proportion of total CEOcompensation that comes from 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 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.
Labor market competition variables	
ln(Ind & State Num Exec)	The natural log of the number of executives in the Execucomp universe in the subject firm's year, state and four-digit SIC industry.
ln(Ind Num Exec)	The natural log of the number of executives in the Execucomp universe in the firm's year

	and SIC four-digit industry.
Ind Num Exec Top 25%	An indicator that equals one if the firm's "ln(Ind Num Exec)" in that year is in the top quartile and equals zero otherwise.
Ind & State Num Exec Top 25%	An indicator that equals one if the firm's "ln(Ind & State Num Exec)" in that year is in the top quartile and equals zero otherwise.
Exogenous shocks	
SFAS 123(R)	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.
Stock Volatility	The firm's stock return volatility as obtained by calculating the volatility of the firm's daily stock returns 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. The models include 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
Column	[1]	[2]	[3]	[4]	[5]	[6]
Holder67	0.037***	0.018***	-0.024***			
	[0.000]	[0.007]	[0.000]			
Holder30-Holder67				0.030***	0.018**	-0.015*
				[0.000]	[0.030]	[0.060]
Holder67-Holder100				0.035***	0.023**	-0.033***
				[0.000]	[0.021]	[0.000]
Holder100				0.057***	0.028***	-0.031***
				[0.000]	[0.001]	[0.000]
Ownership(%)	-0.319***	-0.455***	0.483***	-0.316***	-0.454***	0.482***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	-0.000	-0.001**	0.002***	-0.000	-0.002***	0.002***
	[0.889]	[0.015]	[0.002]	[0.574]	[0.009]	[0.002]
Age	-0.003***	-0.004***	0.002***	-0.003***	-0.004***	0.002***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firm Size	0.042***	0.063***	-0.071***	0.042***	0.063***	-0.071***
	[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***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.003]
Firm Age	-0.001***	-0.002***	0.001***	-0.001***	-0.002***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	1.753***	0.871***	-0.737***	1.802***	0.911***	-0.780***
	[0.000]	[0.002]	[0.005]	[0.000]	[0.001]	[0.003]
Stock Return	-0.001	0.004	-0.012***	-0.002	0.004	-0.012***
	[0.793]	[0.361]	[0.003]	[0.696]	[0.401]	[0.004]
Market-to-Book	0.036***	0.031***	-0.025***	0.034***	0.030***	-0.024***
	[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
	[0.110]	[0.369]	[0.671]	[0.115]	[0.363]	[0.691]
Free cash flows	-0.062***	-0.073***	0.031	-0.062***	-0.073***	0.032
	[0.006]	[0.003]	[0.189]	[0.005]	[0.003]	[0.180]
R&D	0.026**	0.019*	-0.031***	0.027***	0.020*	-0.031***
	[0.013]	[0.077]	[0.003]	[0.010]	[0.073]	[0.003]
PP&E	-0.028**	-0.028**	0.026**	-0.025**	-0.027**	0.025**
	[0.023]	[0.034]	[0.036]	[0.035]	[0.039]	[0.038]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,772	12,772	12,772
R-squared	0.238	0.197	0.305	0.240	0.197	0.305

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), 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
Model	[1]	[2]	[3]
Cites/Patents			
Holder67	0.015	-0.002	-0.012
	[0.151]	[0.858]	[0.210]
Cites/Patents (/100)	-0.008	-0.001	-0.007
	[0.549]	[0.905]	[0.601]
Holder67*Cites/Patents (/100)	0.089***	0.119***	-0.094***
	[0.001]	[0.000]	[0.000]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	6,677	6,677	6,677
R-squared	0.255	0.211	0.294
Cites/Patents (5yrs)			
Holder67	0.025**	0.003	-0.019*
	[0.027]	[0.776]	[0.054]
Cites/Patents (5yrs) (/100)	0.042***	0.042**	-0.049***
	[0.010]	[0.031]	[0.003]
Holder67*Cites/Patents (5yrs) (/100)	0.063*	0.102***	-0.079***
	[0.062]	[0.001]	[0.006]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	5,800	5,800	5,800
R-squared	0.256	0.206	0.291
Volatility			
Holder67	0.017	-0.010	-0.002
	[0.187]	[0.412]	[0.899]
Volatility	1.339***	0.283	-0.260
	[0.000]	[0.402]	[0.432]
Holder67*Volatility	0.759**	1.057***	-0.836**
	[0.048]	[0.007]	[0.029]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,772	12,772	12,772
R-squared	0.238	0.197	0.306

Table 4: Impact of labor market competition

This table contains OLS regressions that examine how labor market competition influences the relation between overconfidence and CEO compensation. 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
Model	[1]	[2]	[3]
Panel A: ln(Ind Num Exec)			
Holder67	-0.029	-0.056**	0.038*
	[0.223]	[0.017]	[0.093]
ln(Ind Num Exec)	0.002	0.002	0.001
	[0.732]	[0.653]	[0.762]
Holder67*ln(Ind Num Exec)	0.017***	0.020***	-0.016***
	[0.003]	[0.001]	[0.003]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,771	12,771	12,771
R-squared	0.239	0.199	0.306
Panel B: ln(Ind & State Num Exec)			
Holder67	-0.011	-0.039**	0.022
	[0.544]	[0.028]	[0.194]
ln(Ind & State Num Exec)	0.002	0.002	-0.004
	[0.752]	[0.695]	[0.345]
Holder67*ln(Ind & State Num Exec)	0.019***	0.023***	-0.019***
	[0.003]	[0.000]	[0.002]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,771	12,771	12,771
R-squared	0.240	0.199	0.308
Panel C: Ind Num Exec Top 25%			
Holder67	0.026***	0.009	-0.017**
	[0.001]	[0.237]	[0.019]
Ind Num Exec Top 25%	-0.016	-0.011	0.010
	[0.162]	[0.359]	[0.364]
Holder67*Ind Num Exec Top 25%	0.056***	0.049***	-0.036***
	[0.000]	[0.000]	[0.005]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,772	12,772	12,772
R-squared	0.239	0.197	0.306
Panel D: Ind & State Num Exec Top 25%			
Holder67	0.031***	0.009	-0.017**
	[0.000]	[0.191]	[0.020]
Ind & State Num Exec Top 25%	0.005	-0.003	-0.001
	[0.608]	[0.771]	[0.939]
Holder 67*Ind & State Num Exec Top 25%	0.034**	0.046***	-0.040***
	[0.018]	[0.002]	[0.002]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,772	12,772	12,772
R-squared	0.239	0.198	0.307

Table 5: 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 1999 to 2004. The SOX dummy equals one if the observation occurs in 2003 or after and equals zero otherwise. Columns 1-3 include year and industry fixed effects (Columns 4-6 only include 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
Column	[1]	[2]	[3]	[4]	[5]	[6]
Holder67	0.022*	0.011	-0.020	0.023*	0.010	-0.020
	[0.084]	[0.415]	[0.109]	[0.078]	[0.423]	[0.109]
SOX	-0.102***	-0.045***	0.042***	-0.090***	-0.045***	0.038***
	[0.000]	[0.003]	[0.003]	[0.000]	[0.000]	[0.000]
Holder67*SOX	0.040***	0.026*	-0.010	0.040**	0.026*	-0.010
	[0.010]	[0.099]	[0.500]	[0.010]	[0.090]	[0.488]
Ownership(%)	-0.625***	-0.692***	0.609***	-0.618***	-0.688***	0.605***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	-0.001	-0.001	0.002**	-0.001	-0.001	0.002**
	[0.501]	[0.129]	[0.044]	[0.493]	[0.131]	[0.045]
Age	-0.002**	-0.003***	0.001	-0.002**	-0.003***	0.001
	[0.013]	[0.003]	[0.114]	[0.013]	[0.004]	[0.119]
Firm Size	0.051***	0.062***	-0.069***	0.051***	0.062***	-0.069***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.141***	-0.101***	0.083**	-0.140***	-0.100***	0.082**
	[0.000]	[0.002]	[0.011]	[0.000]	[0.002]	[0.012]
Firm Age	-0.071***	-0.066***	0.046***	-0.070***	-0.065***	0.045***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	1.630***	1.063**	-0.894**	1.781***	1.221***	-0.954**
	[0.000]	[0.021]	[0.047]	[0.000]	[0.005]	[0.022]
Stock Return	-0.000	0.002	-0.004	-0.001	0.003	-0.005
	[0.979]	[0.724]	[0.506]	[0.835]	[0.613]	[0.408]
Market-to-Book	0.035***	0.034***	-0.026***	0.035***	0.034***	-0.027***
	[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
	[0.343]	[0.750]	[0.770]	[0.281]	[0.848]	[0.744]
Free cash flows	-0.071**	-0.072**	0.034	-0.070**	-0.071**	0.036
	[0.048]	[0.045]	[0.325]	[0.048]	[0.045]	[0.292]
R&D	0.014	0.004	-0.031**	0.014	0.003	-0.031**
	[0.344]	[0.786]	[0.046]	[0.363]	[0.835]	[0.049]
PP&E	-0.022	-0.022	0.023	-0.021	-0.022	0.023
	[0.256]	[0.259]	[0.222]	[0.270]	[0.258]	[0.222]
Year Fixed Effects	Yes	Yes	Yes	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,805	4,805	4,805	4,805	4,805	4,805
R-squared	0.241	0.217	0.221	0.239	0.216	0.220

Table 6: 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 7: Impact of SFAS 123(R) on compensation

This table contains OLS regressions that examine how SFAS 123(R) influences the relation between CEO overconfidence and compensation. The sample in this model goes from 2003 to 2008. The SFAS 123(R) dummy equals one if the observation occurs in 2005 or later and equals zero otherwise. Columns 1-4 include year and industry fixed effects. Columns 5-8 include industry fixed effects (but no year fixed effects). 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	Stock Intensity	Equity Intensity	Cash Intensity	Option Intensity	Stock Intensity	Equity Intensity	Cash Intensity
Column	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Holder67	0.054***	-0.012	0.041***	-0.045***	0.054***	-0.013	0.041***	-0.045***
	[0.000]	[0.183]	[0.003]	[0.001]	[0.000]	[0.175]	[0.003]	[0.001]
SFAS 123(R)	-0.108***	0.104***	-0.004	-0.132***	-0.082***	0.109***	0.027**	-0.133***
	[0.000]	[0.000]	[0.789]	[0.000]	[0.000]	[0.000]	[0.021]	[0.000]
Holder67 *SFAS 123(R)	-0.028*	-0.004	-0.032**	0.031**	-0.027*	-0.005	-0.033**	0.033**
	[0.065]	[0.747]	[0.035]	[0.031]	[0.072]	[0.663]	[0.032]	[0.026]
Ownership(%)	-0.460***	-0.164*	-0.624***	0.660***	-0.455***	-0.164*	-0.619***	0.661***
	[0.000]	[0.070]	[0.000]	[0.000]	[0.000]	[0.071]	[0.000]	[0.000]
Tenure	0.002**	-0.002***	-0.001	0.001	0.002**	-0.002***	-0.000	0.001
	[0.039]	[0.000]	[0.525]	[0.339]	[0.043]	[0.001]	[0.583]	[0.381]
Age	-0.003***	-0.000	-0.003***	0.002**	-0.003***	-0.000	-0.003***	0.002***
	[0.000]	[0.773]	[0.000]	[0.014]	[0.000]	[0.590]	[0.000]	[0.010]
Firm Size	0.038***	0.025***	0.063***	-0.069***	0.038***	0.026***	0.064***	-0.072***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.073**	0.034	-0.039	0.048	-0.075**	0.037	-0.038	0.044
	[0.019]	[0.175]	[0.214]	[0.108]	[0.016]	[0.143]	[0.231]	[0.149]
Firm Age	-0.032***	-0.016*	-0.048***	0.022**	-0.032***	-0.015*	-0.047***	0.021**
	[0.003]	[0.083]	[0.000]	[0.026]	[0.003]	[0.098]	[0.000]	[0.031]
Stock Volatility	1.764***	-1.060***	0.707	0.303	1.906***	-1.013***	0.895*	0.107
	[0.001]	[0.008]	[0.203]	[0.567]	[0.000]	[0.007]	[0.091]	[0.835]
Stock Return	-0.010	0.012**	0.002	-0.017**	-0.009	0.009*	0.000	-0.007
	[0.181]	[0.024]	[0.784]	[0.024]	[0.220]	[0.080]	[0.989]	[0.337]
Market-to-Book	0.043***	-0.016***	0.027***	-0.020***	0.043***	-0.015***	0.028***	-0.021***
	[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
	[0.805]	[0.516]	[0.752]	[0.127]	[0.545]	[0.687]	[0.855]	[0.860]
Free Cash Flows	-0.073*	0.019	-0.055	0.028	-0.067*	0.018	-0.049	0.024
	[0.070]	[0.599]	[0.247]	[0.530]	[0.091]	[0.609]	[0.291]	[0.591]
R&D	0.028*	-0.011	0.017	-0.028**	0.028**	-0.014	0.015	-0.025*
	[0.052]	[0.384]	[0.232]	[0.030]	[0.048]	[0.285]	[0.290]	[0.053]
PP&E	-0.033*	0.006	-0.026	0.012	-0.029*	0.001	-0.028	0.018
	[0.051]	[0.688]	[0.132]	[0.471]	[0.082]	[0.950]	[0.110]	[0.259]
Year Fixed Effects	Yes	Yes	Yes	Yes	No	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,134	5,134	5,134	5,134	5,134	5,134	5,134	5,134
R-squared	0.206	0.184	0.187	0.298	0.193	0.156	0.182	0.257

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 SFAS 123(R)) on the relation between CEO overconfidence and firm performance (measured by Tobin's Q). The OLS models include year and industry fixed effects, and a constant (suppressed). The Arellano Bond and System GMM models are panel models that include year fixed effects. 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.

Estimation Technique	OLS	Arellano-Bond	System GMM	OLS	OLS
Sample	All	All	All	Option Intensity: Below Median in 2003	Option Intensity: Above Median in 2003
Dependent Variable	Q	Q	Q	Q	Q
	[1]	[2]	[3]	[4]	[5]
SFAS 123(R)	-0.301***	-0.302***	-0.381***	-0.240***	-0.077
	[0.000]	[0.000]	[0.000]	[0.000]	[0.202]
Holder67	0.119***	0.367***	0.343***	0.038	0.138***
	[0.000]	[0.000]	[0.000]	[0.340]	[0.007]
Holder67*SFAS 123(R)	-0.106***	-0.128***	-0.141***	-0.021	-0.107**
	[0.002]	[0.007]	[0.003]	[0.649]	[0.040]
Ownership(%)	-0.023	0.035	0.179	-0.232	0.682*
	[0.909]	[0.959]	[0.799]	[0.321]	[0.094]
Tenure	-0.000	-0.092	0.036**	-0.001	-0.003
	[0.811]	[0.129]	[0.019]	[0.772]	[0.248]
Age	-0.002	0.011	0.152***	-0.003	0.000
	[0.237]	[0.674]	[0.000]	[0.129]	[0.823]
Firm Size	0.005	-0.712***	-0.499***	-0.011	0.002
	[0.517]	[0.000]	[0.000]	[0.254]	[0.872]
Financial Leverage	0.032	0.319**	0.285**	0.097	-0.126
	[0.647]	[0.020]	[0.041]	[0.325]	[0.247]
Firm Age	0.000	0.262***	0.018**	-0.000	0.001
	[0.898]	[0.000]	[0.012]	[0.814]	[0.550]
Stock Volatility	2.169*	4.354***	6.248***	3.529**	4.116*
	[0.094]	[0.005]	[0.000]	[0.030]	[0.061]
Market-to-Book	0.761***	-0.144***	-0.043***	0.836***	0.770***
	[0.000]	[0.000]	[0.004]	[0.000]	[0.000]
HHI	-0.000*	-0.000	-0.000	-0.000**	-0.000
	[0.076]	[0.393]	[0.680]	[0.034]	[0.941]
Free Cash Flows	-0.060	0.001	-0.057	-0.113	-0.004
	[0.473]	[0.995]	[0.599]	[0.339]	[0.980]
R&D	0.081***	0.103	0.202**	0.058*	0.119***
	[0.001]	[0.335]	[0.045]	[0.051]	[0.003]
PP&E	0.008	-0.681***	0.019	-0.035	-0.024
	[0.815]	[0.000]	[0.888]	[0.479]	[0.668]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	No	No	Yes	Yes
Observations	4,747	3,507	4,461	1,829	1,946
R-squared	0.712			0.743	0.725
Number of Firm Panels		1,106	1,341		

Table 9: Drivers of the relation between overconfidence, SFAS 123(R), and corporate value

This table contains OLS models that examine the avenues through which SFAS 123(R) influences the relation between overconfidence and firm value. The dependent variable in all regressions is the firm's Tobin's Q from year t, where all regressors date from year $t-1$. All models include year and industry fixed effects, and the same controls as in Table 2. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Sample	Holder67=1	Holder67=0	ALL	Holder67=1	Holder67=0	ALL	Holder67=1	Holder67=0	ALL
Dependent Variable	Q	Q	Q	Q	Q	Q	Q	Q	Q
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
SFAS 123(R)	-0.339***	-0.152***	-0.275***	-0.147*	-0.074	-0.181**	-0.370***	-0.133***	-0.260***
	[0.000]	[0.000]	[0.000]	[0.081]	[0.478]	[0.037]	[0.000]	[0.002]	[0.000]
Holder67			0.063**			0.157*			0.115***
			[0.044]			[0.053]			[0.006]
Holder67*SFAS 123(R)			-0.046			0.048			-0.087*
			[0.199]			[0.640]			[0.059]
R&D*SFAS 123(R)	-0.190***	-0.054	-0.059						
	[0.000]	[0.221]	[0.218]						
R&D*Holder67			0.103*						
			[0.084]						
Holder67*R&D*SFAS 123(R)			-0.118*						
			[0.074]						
Volatility*SFAS 123(R)				-11.121***	-4.556	-4.161			
				[0.000]	[0.252]	[0.263]			
Volatility*Holder67						-1.494			
						[0.629]			
Holder67*Volatility*SFAS 123(R)						-7.653*			
						[0.091]			
High CAPEX*SFAS 123(R)							-0.102**	-0.096**	-0.085*
							[0.038]	[0.044]	[0.081]
High CAPEX*Holder67									-0.007
									[0.913]
High CAPEX*Holder67*SFAS 123(R)									-0.021
									[0.763]
R&D	0.204***	0.121***	0.107**	0.071*	0.087***	0.080***	0.073*	0.089***	0.080***
	[0.000]	[0.004]	[0.016]	[0.065]	[0.009]	[0.001]	[0.061]	[0.007]	[0.001]
Stock Volatility	-0.887	3.996*	1.607	3.589*	5.444*	5.566**	0.118	4.349**	2.288*
	[0.628]	[0.051]	[0.215]	[0.085]	[0.056]	[0.029]	[0.948]	[0.037]	[0.078]
High CAPEX	-0.029	0.030	-0.009	-0.029	0.031	-0.008	0.039	0.091**	0.058
	[0.270]	[0.255]	[0.631]	[0.267]	[0.238]	[0.666]	[0.372]	[0.030]	[0.171]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,754	1,991	4,745	2,754	1,991	4,745	2,754	1,991	4,745
R-squared	0.720	0.675	0.713	0.720	0.675	0.714	0.719	0.675	0.712

Table 10: Non-CEO Executive overconfidence and performance

This table analyzes the relationship between the overconfidence of the firm's non-CEO executives and performance. The dependent variable is the firm's Tobin's Q in the subsequent year. All regressors pre-date the dependent variable. The main regressor-of-interest is "Prop Exec Overconfident", which is the proportion of the firm's non-CEO executives for whom Holder67 equals one. The model-technique is stated in the column header. Columns 1-3 use the full sample of firms. Columns 4-6 (respectively, 7-8) analyze the sample of firms run by overconfident CEOs (respectively, non-overconfident CEOs). All models include year fixed effects and the OLS models also include industry fixed effects. See Appendix 2 for variable definitions. Brackets contain p-values and superscripts ***, **, and * denote significance at 1% 5%, and 10%, respectively.

Model	OLS	Arellano-Bond	System-GMM	OLS	Arellano-Bond	System-GMM	OLS	Arellano-Bond	System-GMM
Sample		All		Companies with Overconfident CEOs			Companies with non-overconfident CEOs		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
SFAS 123(R)	-0.242***	-0.283***	-0.379***	-0.029	-0.584***	-0.741***	-0.123***	-0.313***	-0.323***
	[0.000]	[0.000]	[0.000]	[0.634]	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]
Prop Exec Overconfident	0.327***	0.582***	0.671***	0.363***	0.572***	0.682***	0.242***	0.267**	0.261**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.029]	[0.038]
Prop Exec Overconfident*SFAS 123(R)	-0.217***	-0.212***	-0.205***	-0.198***	-0.261***	-0.247***	-0.198**	-0.027	-0.039
	[0.000]	[0.001]	[0.001]	[0.008]	[0.005]	[0.009]	[0.041]	[0.777]	[0.691]
Ownership(%)	0.007	0.038	0.177	-0.112	0.269	-0.173	0.364	0.539	0.275
	[0.972]	[0.956]	[0.801]	[0.707]	[0.779]	[0.858]	[0.115]	[0.551]	[0.758]
Tenure	-0.000	-0.083	0.050***	0.000	-0.139**	0.043**	-0.002	0.217*	0.010
	[0.800]	[0.169]	[0.001]	[0.854]	[0.048]	[0.028]	[0.337]	[0.075]	[0.614]
Age	-0.002	0.017	0.154***	-0.003	0.024	0.182***	-0.002	-0.011	0.125***
	[0.157]	[0.530]	[0.000]	[0.212]	[0.469]	[0.000]	[0.335]	[0.788]	[0.000]
Firm Size	0.009	-0.673***	-0.466***	0.020*	-0.622***	-0.414***	0.006	-0.626***	-0.535***
	[0.236]	[0.000]	[0.000]	[0.077]	[0.000]	[0.000]	[0.571]	[0.000]	[0.000]
Financial Leverage	0.033	0.273**	0.247*	-0.037	0.377**	0.295*	0.086	0.182	0.010
	[0.642]	[0.046]	[0.075]	[0.654]	[0.033]	[0.098]	[0.466]	[0.358]	[0.960]
Firm Age	0.000	0.261***	0.016**	0.000	0.318***	0.008	0.001	-0.047	0.029***
	[0.480]	[0.000]	[0.023]	[0.793]	[0.000]	[0.475]	[0.399]	[0.686]	[0.002]
Stock Volatility	2.806**	4.630***	6.645***	1.324	3.328	5.163**	4.154*	2.021	5.599***
	[0.030]	[0.003]	[0.000]	[0.472]	[0.118]	[0.013]	[0.051]	[0.323]	[0.006]
Market-to-Book	0.753***	-0.140***	-0.046***	0.757***	-0.108***	-0.023	0.721***	-0.249***	-0.081***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.201]	[0.000]	[0.000]	[0.002]
HHI	-0.000*	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000***	-0.000	-0.000
	[0.054]	[0.342]	[0.586]	[0.948]	[0.376]	[0.678]	[0.001]	[0.318]	[0.155]
Free Cash Flows	-0.088	0.027	-0.021	-0.049	0.069	0.074	-0.052	0.103	-0.037
	[0.298]	[0.799]	[0.842]	[0.701]	[0.697]	[0.683]	[0.658]	[0.351]	[0.741]
R&D	0.080***	0.078	0.214**	0.075*	0.233	0.448***	0.086***	-0.132	0.128
	[0.001]	[0.468]	[0.033]	[0.056]	[0.161]	[0.002]	[0.009]	[0.255]	[0.252]
PP&E	-0.009	-0.711***	-0.045	-0.022	-0.795***	-0.088	0.026	-0.288*	-0.136
	[0.789]	[0.000]	[0.743]	[0.673]	[0.000]	[0.653]	[0.472]	[0.094]	[0.434]
Observations	4,747	3,507	4,461	2,756	2,349	2,641	1,991	1,274	1,820
R-squared	0.715			0.722			0.677		
Number of Firm panels		1,106	1,341		745	854		509	687

Table 11: 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 12: 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 13: 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), 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
Model	[1]	[2]	[3]
Panel A: Holder100			
Holder100	0.037***	0.015**	-0.016**
	[0.000]	[0.036]	[0.023]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,772	12,772	12,772
R-squared	0.238	0.196	0.304
Panel B: Number of options			
ln(Num Opt)	0.022***	0.018***	-0.020***
	[0.000]	[0.000]	[0.000]
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	12,771	12,771	12,771
R-squared	0.242	0.201	0.310

Table 14: Firm-Year Fixed Effects, 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	Firm-Year Fixed Effects			Fama-Macbeth			Tobit		
Dependent Variable	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]
Holder67	0.042***	0.034***	-0.031***	0.038***	0.022***	-0.026***	0.042***	0.020***	-0.025***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]
Ownership(%)	-0.221*	-0.225	0.223	-0.281***	-0.483***	0.500***	-0.494***	-0.602***	0.502***
	[0.091]	[0.137]	[0.141]	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	-0.001	-0.003***	0.002**	-0.000	-0.001***	0.002***	-0.001	-0.002***	0.002***
	[0.120]	[0.006]	[0.011]	[0.699]	[0.009]	[0.003]	[0.423]	[0.006]	[0.002]
Age	-0.004***	-0.005***	0.002***	-0.003***	-0.004***	0.003***	-0.004***	-0.004***	0.002***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firm Size	0.036***	0.036***	-0.045***	0.041***	0.061***	-0.069***	0.053***	0.069***	-0.071***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Financial Leverage	-0.073**	-0.079***	0.101***	-0.094***	-0.092***	0.061***	-0.101***	-0.087***	0.062***
	[0.015]	[0.009]	[0.000]	[0.000]	[0.000]	[0.005]	[0.001]	[0.001]	[0.003]
Firm Age	-0.027*	-0.029*	0.014	-0.002***	-0.002***	0.001***	-0.002***	-0.002***	0.001***
	[0.081]	[0.069]	[0.276]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Stock Volatility	1.209***	-0.077	-0.457	2.277***	1.498**	-0.718	1.651***	0.764**	-0.725***
	[0.000]	[0.807]	[0.139]	[0.000]	[0.014]	[0.237]	[0.000]	[0.019]	[0.007]
Stock Return	-0.002	0.000	-0.010**	-0.005	0.004	-0.016**	-0.003	0.004	-0.012***
	[0.610]	[0.918]	[0.013]	[0.564]	[0.598]	[0.019]	[0.541]	[0.451]	[0.003]
Market-to-Book	0.029***	0.026***	-0.019***	0.035***	0.029***	-0.021***	0.040***	0.032***	-0.025***
	[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
	[0.015]	[0.340]	[0.568]	[0.003]	[0.000]	[0.024]	[0.127]	[0.482]	[0.658]
Free Cash Flows	-0.026	-0.024	0.009	-0.065*	-0.051	0.016	-0.065**	-0.080***	0.030
	[0.236]	[0.329]	[0.704]	[0.069]	[0.210]	[0.649]	[0.046]	[0.009]	[0.222]
R&D	-0.012	-0.015	0.009	0.044***	0.037***	-0.035***	0.035**	0.023*	-0.032***
	[0.566]	[0.543]	[0.714]	[0.000]	[0.000]	[0.000]	[0.014]	[0.067]	[0.003]
PP&E	-0.045*	-0.089***	0.086***	-0.030***	-0.024***	0.028**	-0.024	-0.025*	0.025**
	[0.060]	[0.000]	[0.000]	[0.000]	[0.001]	[0.012]	[0.139]	[0.095]	[0.042]
Year Fixed Effects	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Observations	12,772	12,772	12,772	12,772	12,772	12,772	12,772	12,772	12,772
R-squared	0.152	0.064	0.196	0.162	0.191	0.238	0.2077	0.2309	1.2597
Number of Firm Panels	2,103	2,103	2,103						
Number of Year Groups				17	17	17			

Table 15: 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