

# CEO OVERCONFIDENCE: THE MODERATING ROLE OF INSIDE DEBT

Xiang Long <sup>\*</sup>, Kevin Krieger <sup>\*\*</sup>

<sup>\*</sup> Corresponding author, University of West Florida, Pensacola, USA

Contact details: University of West Florida, 11000 University Parkway, Pensacola, FL 32514, USA

<sup>\*\*</sup> University of West Florida, Pensacola, USA



## Abstract

**How to cite this paper:** Long, X., & Krieger, K. (2026). CEO overconfidence: The moderating role of inside debt. *Corporate Ownership & Control*, 23(1), 52–64. <https://doi.org/10.22495/cocv23i1art5>

Copyright © 2026 The Authors

This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). <https://creativecommons.org/licenses/by/4.0/>

**ISSN Online:** 1810-3057

**ISSN Print:** 1727-9232

**Received:** 27.11.2025

**Revised:** 24.01.2026; 02.02.2026

**Accepted:** 20.02.2026

**JEL Classification:** G32, G41, J33

**DOI:** 10.22495/cocv23i1art5

This paper investigates the interplay between chief executive officer (CEO) overconfidence, a prominent behavioral bias, and the governance role of inside debt. We argue that the well-documented effects of CEO overconfidence on corporate risk-taking and firm value are moderated by the structure of CEO compensation, specifically deviations from a firm-specific optimal level of inside debt, which is a structure of deferred and/or pensions meant to align CEOs with the risk facing traditional debtholders. Using a large panel of the United States (U.S.) firms, we find that overconfident CEOs are associated with larger negative deviations from optimal inside debt levels. Our results show that positive deviations from optimal inside debt mitigate the risk-taking behavior of overconfident CEOs, particularly in research and development (R&D) investment. Conversely, negative deviations amplify their risk-taking tendencies. Furthermore, we find that the positive effect of overconfidence on firm value is significantly stronger when constrained by above-optimal inside debt. These findings contribute to the behavioral corporate finance literature by highlighting the importance of tailoring executive compensation to the psychological traits of managers.

**Keywords:** CEO Overconfidence, Inside Debt, Corporate Governance, Behavioral Finance, Risk-Taking

**Authors' individual contribution:** Conceptualization — X.L.; Methodology — X.L.; Software — X.L. and K.K.; Validation — X.L.; Formal Analysis — X.L.; Investigation — X.L. and K.K.; Resources — X.L.; Data Curation — X.L.; Writing — Original Draft — X.L. and K.K.; Writing — Review & Editing — X.L. and K.K.; Visualization — X.L.; Supervision — X.L.; Project Administration — X.L.; Funding Acquisition — X.L. and K.K.

**Declaration of conflicting interests:** The Authors declare that there is no conflict of interest.

## 1. INTRODUCTION

While traditional finance theory often models chief executive officers (CEOs) as rational, utility-maximizing agents, a growing body of research in behavioral finance suggests a more nuanced reality: CEOs, like all humans, are susceptible to cognitive biases that can profoundly shape corporate strategy and performance. Among the most pervasive and consequential of these biases is overconfidence.

Overconfidence, broadly defined as an individual's subjective confidence in their judgments being greater than the objective accuracy of those judgments, is one of the most robust findings in the psychology of judgment (Moore & Healy, 2008). It manifests in several forms: overestimation of one's abilities and performance, overplacement of one's performance relative to others (the "better-than-average" effect), and overprecision in one's beliefs, leading to an underestimation of risks. While a healthy dose of

confidence can be a catalyst for innovation and successful leadership, excessive confidence can lead to disastrous outcomes, from ill-fated mergers to value-destroying investments.

And CEOs may be particularly prone to overconfidence. The very process of climbing the corporate ladder and winning the “tournament” to become CEO can reinforce a sense of superiority and invincibility. High compensation and positive feedback from boards and the media can further fuel this bias. Moreover, the nature of the CEO’s role, which involves making high-stakes decisions under uncertainty, can foster an illusion of control, the belief that they can influence outcomes that are, in fact, beyond their control (Langer, 1975). This is often compounded by the Dunning-Kruger effect, a cognitive bias where individuals with low ability at a task overestimate their ability (Kruger & Dunning, 1999), as their early experiences have not yet provided nuance. Research has shown that the common measures of CEO overconfidence are negatively correlated with general ability, suggesting that the Dunning-Kruger effect may be particularly at work.

The corporate landscape has a history of examples of the destructive power of CEO overconfidence. The infamous AOL-Time Warner merger, hailed at the time as a visionary move, is now a textbook case of hubris leading to massive value destruction. Overconfident CEOs are more likely to engage in value-destroying mergers and acquisitions (Malmendier & Tate, 2008), overpay for targets, and pursue risky projects with negative net present values. They tend to overinvest when their firms are flush with cash, yet shy away from external financing because they believe the market undervalues their firms’ prospects. This leads to a heightened sensitivity of investment to internal cash flow, a well-documented anomaly in corporate finance (Malmendier & Tate, 2005).

Given the profound impact of CEO overconfidence, a critical question for corporate governance is how to mitigate its negative consequences. Traditional governance mechanisms, such as board monitoring and equity-based compensation, may be insufficient. Overconfident CEOs, believing they are acting in the best interests of shareholders, may not be swayed by dissenting voices on the board. Furthermore, equity-based compensation, with its convex payoff structure, can actually exacerbate the risk-taking tendencies of an already overconfident executive (Tang & Chang, 2024).

This paper explores an alternative governance mechanism: inside debt. Inside debt, which primarily consists of deferred compensation and pension benefits, has a debt-like payoff structure that makes a CEO’s wealth sensitive to firm default risk. By aligning the CEO’s interests with those of debtholders, inside debt can serve as a powerful counterbalance to the risk-seeking incentives of equity compensation. We argue that inside debt can act as a crucial “brake” on the behavioral biases of overconfident managers, forcing them to internalize the downside risks they might otherwise ignore.

While prior research has examined the separate effects of CEO overconfidence and inside debt on a firm’s risk-taking behavior, this study is the first to

investigate how deviations from the firm-specific optimal inside debt ratio moderate the influence of CEO overconfidence on corporate risk and value. This focus on the level of inside debt relative to a firm-specific optimum is complemented by recent research, such as Lee et al. (2021), which provides a more granular analysis of the underlying risk-mitigation mechanism by showing how inside debt differentially impacts the systematic and idiosyncratic components of firm risk. We hypothesize that when a firm’s compensation structure fails to account for its CEO’s behavioral traits, the resulting deviations from optimal inside debt levels will either unleash or constrain the effects of overconfidence. Specifically, we predict that positive deviations (more inside debt than optimal) will mitigate the risk-taking of overconfident CEOs, while negative deviations (less inside debt than optimal) will amplify it. We further predict that these effects will have tangible consequences for firm value.

By providing a more nuanced understanding of the interplay between a key behavioral bias and a critical governance tool, this study offers important implications for both behavioral finance theory and the practical design of executive compensation. Our findings suggest that a “one-size-fits-all” approach to executive compensation is suboptimal. Instead, compensation committees should consider the psychological profile of the CEO, tailoring incentive packages to mitigate the potential negative effects of behavioral biases like overconfidence. The term “psychological profile of the CEO” refers to the integrated framework of cognitive biases, affective dispositions, and stable personality traits that govern how an executive filters information and interprets the firm’s strategic environment. Grounded in upper echelons theory, this profile encompasses constructs such as overconfidence (the miscalibration of abilities), optimism (affective sentiment regarding future outcomes), and narcissism (the desire for personal superiority), all of which serve as perceptual filters that influence risk assessment and decision-making. By understanding this profile, governance mechanisms can be tailored to address the specific behavioral distortions inherent in a given leader’s cognitive makeup.

The remainder of this paper is organized as follows. Section 2 reviews the literature and develops our hypotheses. Section 3 describes the data and empirical design. Section 4 reports the results of our primary tests and robustness checks. Section 5 provides a discussion, and Section 6 concludes the paper.

## 2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The theoretical framework outlined above leads to a set of testable hypotheses regarding the interaction between CEO overconfidence and deviations from optimal inside debt. The core premise is that inside debt acts as a moderating force, either constraining or amplifying the behavioral tendencies of overconfident managers.

## 2.1. Mitigation of risk-taking

An overconfident CEO systematically overestimates the potential returns of investment projects and underestimates the associated risks. This cognitive bias naturally pushes him/her toward riskier corporate policies. However, when such a CEO holds an amount of inside debt that is above the firm's optimal level (a positive deviation), their personal wealth becomes highly sensitive to the firm's default risk. The concave, debt-like payoff structure of their pension and deferred compensation might create a powerful, personal disincentive against engaging in excessively risky projects, as the potential loss of this wealth looms large. This direct financial threat to the CEO's personal portfolio is expected to counteract his/her cognitive bias, forcing a more conservative stance on discretionary investments like research and development (R&D) and on financial policies. Therefore, excess inside debt may rein in the overconfident CEO.

The theoretical channel for this risk-mitigation effect is clarified by recent research on the specific risk incentives of inside debt. Lee et al. (2021) find that while inside debt reduces both systematic and idiosyncratic firm risk, its effect is significantly larger on the idiosyncratic component. Since discretionary R&D projects are a primary source of non-diversifiable, firm-specific idiosyncratic risk, a compensation package with above-optimal inside debt makes a CEO's personal wealth acutely sensitive to the unique success or failure of these ventures. This transforms the abstract notion of "downside risk" into a tangible threat to the CEO's undiversified personal portfolio, directly counteracting the overconfident manager's tendency to underestimate such firm-specific perils. Furthermore, Lee et al. (2021) caution that excessive debt-based pay can divert executives from productive R&D, which aligns directly with our hypothesis that an above-optimal level of inside debt will mitigate risky investment, even to an excessive degree.

*H1: Positive deviations from the optimal inside debt level mitigate the risk-taking activities of firms with overconfident CEOs.*

## 2.2. Escalation of risk-taking

Conversely, when an overconfident CEO's inside debt holdings are below the optimal level (a negative deviation), his/her compensation structure is disproportionately weighted toward equity. The convex payoff structure of stocks and options rewards upside potential, which aligns perfectly with the overconfident CEO's optimistic view of future outcomes. In this scenario, the downside risk of aggressive investments is borne primarily by external debtholders, while the CEO's equity-heavy portfolio is positioned to capture the full upside from successful high-risk ventures. The lack of a sufficient debt-like "brake" on the CEO's incentives removes a critical constraint, thereby leading to an escalation of risk-taking behavior.

*H2: Negative deviations from the optimal inside debt level escalate the risk-taking activities of firms with overconfident CEOs.*

## 2.3. The impact on firm value

The net effect of CEO overconfidence on firm value is theoretically ambiguous. On one hand, it could be value-enhancing by encouraging innovation and overcoming the underinvestment problems associated with overly cautious, rational managers. On the other hand, it could be value-destroying through overinvestment in value-destroying projects and costly mergers. We argue that deviations from optimal inside debt tilt this balance. A positive deviation, by curbing the excessive risk-taking of an overconfident CEO, may prevent value-destroying projects and preserve or even enhance firm value by forcing more disciplined capital allocation. A negative deviation, by encouraging excessive risk-taking, may lead to investments that destroy firm value for an overconfident CEO. This implies that the "optimal" compensation structure is not just firm-specific, but also CEO-trait-specific. For an overconfident CEO, a compensation package with a stronger debt-like component may be necessary to align his/her biased decision-making with long-term value creation.

*H3: Positive deviations from the optimal inside debt level are associated with an increase in firm value for firms with overconfident CEOs, while negative deviations are associated with a decrease in firm value.*

## 3. DATA AND EMPIRICAL DESIGN

### 3.1. Sample construction

To test our hypotheses, we construct a sample of the United States (U.S.) public firms by merging data from two primary sources: Compustat for firm-level financial data and ExecuComp for CEO compensation and characteristics. The sample period spans from 2006 to 2017. The start date of 2006 is dictated by the U.S. Securities and Exchange Commission's enhanced disclosure requirements, which made comprehensive data on CEO pension benefits and deferred compensation publicly available for the first time. Following standard practice in the literature, we exclude firms operating in the financial (Standard Industrial Classification (SIC) codes 6000-6999) and utility (SIC codes 4900-4999) sectors due to their unique regulatory environments and capital structures. After deleting observations with missing data for key variables and winsorizing all continuous variables at the 1st and 99th percentiles to mitigate the influence of outliers, our final sample consists of 9,736 firm-year observations for 1,706 unique firms and 2,449 CEOs.

### 3.2. Measuring key constructs

#### 3.2.1. CEO overconfidence

Our primary measure of CEO overconfidence is the "Longholder" proxy, developed by Malmendier and Tate (2005) and widely used in the behavioral finance literature. A CEO is classified as overconfident if, at any point during his/her tenure, they hold vested stock options until the year of

expiration, provided those options are at least 67% in-the-money at the beginning of that year. This threshold is based on the calculation by Hall and Murphy (2002) that a risk-averse, undiversified executive should exercise such options early. The logic is that an overconfident CEO overestimates his/her firm's future stock performance and is, therefore, willing to bear the idiosyncratic risk of holding the options longer in anticipation of further gains. We create a dummy variable, overconfidence, which equals one if a CEO is ever classified as a Longholder, and zero otherwise. This classification is time-invariant for each CEO, as overconfidence is considered a persistent personality trait.

It is important to acknowledge the construct validity of this measure. While it is designed to capture overconfidence, recent research using direct psychological assessments of executives has found that the Longholder measure is also significantly and negatively correlated with measures of general ability or talent (Kaplan et al., 2020). This is consistent with the Dunning-Kruger effect, which posits that less competent individuals are more prone to overestimating their abilities. Therefore, our overconfidence proxy may capture a combination of pure overconfidence and lower general ability. However, since both traits are theoretically predicted to lead to similar patterns of over-investment and risk-taking, this does not undermine our tests but adds an important nuance to the interpretation of our results.

### 3.2.2. CEO inside debt and deviations

We employ two established measures of a CEO's debt-like incentives relative to the firm's.

$$\ln(k) \text{ or } \ln(k^*) = \gamma_0 + \gamma_1 \text{ Firm \& CEO Controls} + \varepsilon \quad (3)$$

The control variables include *book leverage*, *bond rating*, *idiosyncratic risk*, *market-to-book ratio*, *R&D intensity*, *asset tangibility*, *firm size*, *CEO age*, and *CEO tenure*. The fitted values from this regression,  $k^\wedge$  and  $k^{*\wedge}$ , represent our estimate of the target or optimal inside debt ratio for each firm-year. Finally, we calculate our key independent variables, the deviations from the optimal level as:

$$DISD_1 = \text{Actual } k - \text{Optimal } k^\wedge \quad (4)$$

$$DISD_2 = \text{Actual } k^* - \text{Optimal } k^{*\wedge} \quad (5)$$

### 3.2.3. Firm risk-taking and value

We follow prior literature in operationalizing risk-taking and firm value. For investment risk, we employ R&D expenditures scaled by total assets ( $R\&D / TA$ ) and capital expenditures scaled by total assets ( $CAPEX / TA$ ).  $R\&D / TA$  is widely recognized as a proxy for discretionary, idiosyncratic risk because it involves highly uncertain future payoffs and significantly higher earnings volatility compared to

*CEO relative leverage ratio (k)*: Following Edmans and Liu (2011), this ratio compares the CEO's personal leverage to the firm's leverage. It is calculated as:

$$k = \frac{(D_{CEO} / E_{CEO})}{(D_{Firm} / E_{Firm})} \quad (1)$$

where,

- $D_{CEO}$  is the value of the CEO's inside debt (pensions and deferred compensation);
- $E_{CEO}$  is the value of the CEO's inside equity (stock and options);
- and  $D_{Firm}$  and  $E_{Firm}$  are the book value of the firm's debt and market value of its equity, respectively.

*CEO relative incentive ratio (k\*)*: Following Wei and Yermack (2011), this ratio captures the sensitivity of the CEO's wealth to changes in firm value, which may be more relevant for marginal decisions. It is calculated as:

$$k^* = \frac{(\Delta D_{CEO} / \Delta E_{CEO})}{(\Delta D_{Firm} / \Delta E_{Firm})} \quad (2)$$

This measures how a \$1 change in firm value affects the CEO's debt claims versus his/her equity claims, relative to the same effect on the firm's external stakeholders.

To estimate the optimal level of these ratios for each firm-year, we follow Campbell et al. (2016) and use a predictive model based on firm and CEO characteristics that are known to influence how compensation contracts are designed. The model is specified as:

tangible investments.  $CAPEX / TA$  is used to capture investment intensity and the potential for overinvestment associated with managerial hubris. For financial policy risk, we follow the established practice of using total leverage and cash holdings to represent risk-sensitive financial decisions. Finally, we measure firm value using the market-to-book ratio of assets ( $MV / TA$ ), a standard proxy for Tobin's Q that reflects the market's valuation of the firm's growth opportunities and intangible assets. This approach allows us to determine whether the interaction between overconfidence and inside debt ultimately preserves or erodes shareholder wealth.

## 3.3. Empirical models

To test our hypotheses, we estimate a series of panel regression models with firm and year fixed effects to control for unobserved time-invariant firm heterogeneity and economy-wide shocks. Our primary model for testing the effect on risk-taking ( $H1$  and  $H2$ ) is:

$$\text{RiskTaking}_{i,t} = \beta_0 + \beta_1 \text{DISD}_{i,t-1} + \beta_2 \text{Overconfidence}_i + \beta_3 (\text{DISD}_{i,t-1} \times \text{Overconfidence}_i) + \Gamma' \text{Controls}_{i,t-1} + \alpha_i + \delta_t + \varepsilon_{i,t} \quad (6)$$

where, *RiskTaking* is one of our proxies (e.g.,  $R\&D / TA$ ). The key coefficient of interest is  $\beta_3$  on the interaction term, which captures the moderating effect of inside debt deviations on the behavior of overconfident CEOs. A significant  $\beta_3$  would indicate that the effect of overconfidence on risk-taking depends on the level of the inside debt

deviation. We also test the hypotheses by splitting the sample into positive and negative deviation subsamples.

To test the effect on firm value (*H3*), we use a valuation model based on Fama and French (1998), augmented with our variables of interest:

$$MV/TA_{i,t} = \beta_0 + \beta_1 DISD_{i,t-1} + \beta_2 Overconfidence_i + \beta_3 (DISD_{i,t-1} \times Overconfidence_i) + \Gamma' Fama-French Controls_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t} \tag{7}$$

Control variables in all models include *firm size*, *CEO tenure*, *cash flow*, *leverage*, *market-to-book ratio*, *firm age*, *sales growth*, *stock returns*, and *governance measures*, consistent with prior literature.

broadly consistent with those reported in prior studies of U.S. public firms. The mean CEO relative leverage ratio (*k*) is 0.30, while the mean CEO relative incentive ratio (*k\**) is 9.06. The significant difference between the mean and median for these ratios indicates a right-skewed distribution, a common feature of compensation data. Our main variables of interest, the deviations from the optimal inside debt ratios ( $DISD_1$  and  $DISD_2$ ), have means close to zero, by construction, with significant variation across the sample.

#### 4. EMPIRICAL ANALYSIS

##### 4.1. Descriptive statistics and univariate tests

Table 1 presents the descriptive statistics for our sample. The firm- and CEO-level variables are

**Table 1.** Descriptive statistics

Variable	N	Mean	Std. dev.	25th pctl.	Median	75th pctl.
<b>Firm characteristics</b>						
Firm leverage (Book)	8,941	0.2122	0.1924	0.0784	0.1887	0.3024
Market-to-book ratio	8,525	1.7254	0.9302	1.1465	1.4553	1.9859
Ln(Assets)	8,941	7.9369	1.6305	6.7738	7.8240	8.9681
R&D / Total assets	8,941	0.0241	0.0528	0.0000	0.0000	0.0250
CAPEX / Total assets	8,515	0.0471	0.0528	0.0164	0.0319	0.0587
<b>CEO characteristics</b>						
CEO age	8,889	55.8215	6.6980	51.0000	56.0000	60.0000
CEO tenure (Years)	8,941	6.8082	6.7002	2.0000	5.0000	9.0000
Overconfidence dummy	8,941	0.2693	0.4436	0.0000	0.0000	1.0000
<b>Inside debt ratios &amp; deviations</b>						
CEO relative leverage ( <i>k</i> )	8,941	0.3036	0.6248	0.0000	0.0614	0.3167
CEO relative incentive ( <i>k*</i> )	8,941	9.0581	42.0224	0.0000	0.5279	2.8578
Deviation $DISD_1$ ( $k - k^\wedge$ )	8,246	-0.0091	9.7304	-2.9816	-1.4694	0.0026
Deviation $DISD_2$ ( $k^* - k^*\wedge$ )	8,246	-0.0179	22.2498	-7.6147	-3.8741	-0.4434

Note: This table presents descriptive statistics for the key variables used in the analysis for the sample period 2006–2017. The sample includes 9,736 firm-year observations. All variables are winsorized at the 1st and 99th percentiles.

Table 2 provides a crucial first look at the relationship between our key constructs. It presents univariate tests comparing the mean and median inside debt deviations for firms with overconfident versus non-overconfident CEOs. The results provide a powerful motivating fact for our study. For both deviation measures,  $DISD_1$  and  $DISD_2$ , firms with overconfident CEOs have significantly more negative deviations than firms with non-overconfident CEOs. For example,

the mean  $DISD_2$  for overconfident-CEO firms is -2.51, compared to 0.94 for non-overconfident-CEO firms, a statistically significant difference. This suggests that overconfident CEOs systematically hold less inside debt relative to their firm’s optimal level. This unconditional correlation provides initial evidence that a CEO’s psychological traits are linked to the structure of their compensation, justifying our subsequent investigation into the consequences of this link.

**Table 2.** Univariate analysis of inside debt deviations

Deviations	All firms	Overconfident CEOs	Non-overconfident CEOs	Difference (Overconfident – Non-overconfident)
<b>Panel A: Deviation <math>DISD_2</math> (from <i>k</i>)</b>				
Mean	-0.0179	-2.5091	0.9406	-3.4497***
Median	-3.8741	-4.7184	-3.5407	-1.1777***
<b>Panel B: Deviation <math>DISD_1</math> (from <i>k</i>)</b>				
Mean	-0.0091	-0.9028	0.3347	-1.2375***
Median	-1.4694	-2.1365	-1.2457	-0.8908***

Note: \*\*\* denotes significance at the 1% level.

The psychological mechanism underlying this negative correlation is rooted in the overconfident

CEO’s unique perception of firm value and personal risk. Because overconfident executives

systematically believe their firms are undervalued by the market, they view equity-based compensation as significantly more attractive than the fixed, concave payoffs of inside debt. Furthermore, their inherent tendency to underestimate default risk and the “better-than-average” effect leads them to perceive the risk-mitigation benefits of pensions and deferred compensation as redundant. Driven by an illusion of control, these executives prefer to maximize their exposure to the firm’s upside through equity, thereby avoiding the “safety” of debt-like instruments that a rational, risk-averse manager would utilize to diversify their personal portfolio. This demand-side preference for equity-heavy pay results in the observed systematic negative deviation from optimal inside debt levels.

#### 4.2. The moderating effect of inside debt on corporate risk-taking

We now turn to our primary multivariate tests of *H1* and *H2*. We focus our main analysis on R&D expenditures ( $R\&D / TA$ ), as it is a clean and widely accepted proxy for discretionary, innovative, and risky corporate investment, aligning well with the theoretical predictions about overconfidence and innovation. Tables 3 presents the regression results.

The results in Table 3 provide strong support for our hypotheses. First, looking at the full sample in Panel A, column 1, the coefficient on the overconfidence dummy is positive and significant (0.0035), confirming the baseline finding

in the literature that overconfident CEOs, on average, invest more in R&D. The core findings emerge when we examine the moderating role of inside debt deviations. In the negative deviation subsample (Panel A, column 3), the coefficient on the overconfidence dummy remains positive and highly significant (0.0034). This indicates that when inside debt is below the optimal level, the risk-taking propensity of overconfident CEOs is unleashed, consistent with *H2*. In stark contrast, in the positive deviation subsample (Panel A, column 2), the coefficient on the overconfidence dummy becomes statistically indistinguishable from zero (-0.0001). This provides strong support for *H1*: when inside debt is above the optimal level, it effectively mitigates the tendency of overconfident CEOs to increase risky R&D investment.

Panel B confirms this result using an interaction term in the full sample. The coefficient on *Positive dev \* Overconfidence* is negative and statistically significant (-0.0042), showing that the effect of overconfidence is significantly dampened when deviations are positive. Results for other risk proxies (CAPEX, leverage, cash) are less consistent and are presented in Tables 3 and 4. The ambiguity in these results may be because CAPEX is less discretionary than R&D, while financial policies are subject to a wider array of institutional constraints. The clear and strong results for R&D, however, provide compelling evidence for our primary hypotheses.

Table 3. Inside debt deviations, overconfidence, and investment activity

<b>Panel A: Dependent variable = R&amp;D / TA (Subsample analysis)</b>			
Variables	(1) All obs	(2) Positive DISD <sub>2</sub>	(3) Negative DISD <sub>2</sub>
Overconfidence dummy	0.0035**	-0.0001	0.0034***
DISD <sub>2</sub>	-0.0001*		
DISD <sub>2</sub> * Overconfidence	0.0001		
Observations	5,150	2,241	3,982
Adjusted R <sup>2</sup>	0.2390	0.3198	0.2166
<b>Panel B: Dependent variable = R&amp;D / TA (Interaction model)</b>			
Variables	(1) All obs.		
Positive deviation dummy	0.0001		
Positive dev * Overconfidence	-0.0042*		
Overconfidence dummy	0.0038**		
Observations	6,223		
Adjusted R <sup>2</sup>	0.2549		
<b>Panel C: Dependent variable = CAPEX / TA (Subsample analysis)</b>			
Variables	(1) All obs.	(2) Positive DISD <sub>2</sub>	(3) Negative DISD <sub>2</sub>
Overconfidence dummy	0.0067***	0.0064**	0.0060***
DISD <sub>2</sub>	-0.0001***		
DISD <sub>2</sub> * Overconfidence	0.0000		
Observations	5,147	2,234	3,980
Adjusted R <sup>2</sup>	0.0587	0.0511	0.0596
<b>Panel D: Dependent variable = CAPEX / TA (Interaction model)</b>			
Variables	(1) All obs.		
Positive deviation dummy	-0.0055***		
Positive dev * Overconfidence	0.0022		
Overconfidence dummy	0.0053***		
Observations	6,214		
Adjusted R <sup>2</sup>	0.0552		

Note: This table presents ordinary least squares (OLS) regression estimates of the effect of inside debt deviations (DISD<sub>2</sub>) and CEO overconfidence on R&D expenditures (R&D / TA) and capital expenditures (CAPEX / TA). Panels A and C show results for the full sample and for subsamples split by the sign of the deviation. Panels B and D show results using an interaction term. All models include firm and year fixed effects and a full set of control variables. Standard errors are clustered at the firm level. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables included but not reported for brevity.

Table 4. Inside debt deviations, overconfidence, and financial policies

<b>Panel A: Dependent variable = Leverage (Subsample analysis)</b>			
Variables	(1) All obs.	(2) Positive DISD <sub>2</sub>	(3) Negative DISD <sub>2</sub>
Overconfidence dummy	-0.0268***	-0.0451***	-0.0180***
DISD <sub>2</sub>	-0.0002		
DISD <sub>2</sub> * Overconfidence	0.0016***		
Observations	6,229	2,752	4,821
Adjusted R <sup>2</sup>	0.1465	0.1120	0.2150
<b>Panel B: Dependent variable = Leverage (Interaction model)</b>			
Variables	(1) All obs.		
Positive deviation dummy	0.1020***		
Positive dev * Overconfidence	0.0502***		
Overconfidence dummy	-0.0324***		
Observations	7,573		
Adjusted R <sup>2</sup>	0.1818		
<b>Panel C: Dependent variable = Cash / asset (Subsample analysis)</b>			
Variables	(1) All obs.	(2) Positive DISD <sub>2</sub>	(3) Negative DISD <sub>2</sub>
Overconfidence dummy	-0.0071***	-0.0084***	-0.0082***
DISD <sub>2</sub>	0.0002***		
DISD <sub>2</sub> * Overconfidence	0.0002		
Observations	6,132	2,703	4,757
Adjusted R <sup>2</sup>	0.2641	0.3031	0.2517
<b>Panel D: Dependent variable = Cash / asset (Interaction model)</b>			
Variables	(1) All obs.		
Positive deviation dummy	0.0014		
Positive dev * Overconfidence	0.0033		
Overconfidence dummy	-0.0090***		
Observations	7,460		
Adjusted R <sup>2</sup>	0.2589		

Note: This table presents OLS regression estimates of the effect of inside debt deviations (DISD<sub>2</sub>) and CEO overconfidence on firm leverage and cash holdings. Panels A and C show results for the full sample and for subsamples split by the sign of the deviation. Panels B and D show results using an interaction term. All models include firm and year fixed effects and a full set of control variables. Standard errors are clustered at the firm level. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Control variables included but not reported for brevity.

### 4.3. The moderating effect of inside debt on firm value

Having established that inside debt deviations moderate the risk-taking behavior of overconfident

CEOs, we now test whether this moderation has consequences for firm value (H3). Table 5 presents the results from our Fama-French style valuation regression.

Table 5. Inside debt deviations, overconfidence, and firm value

<b>Panel A: Subsample and interaction analysis</b>			
Variables	(1) All obs.	(2) Positive DISD <sub>2</sub> obs.	(3) Negative DISD <sub>2</sub> obs.
<b>Dependent variable: MV / TA</b>			
Overconfidence dummy	0.2844***	0.4298***	0.2152***
DISD <sub>2</sub>	0.0018***		
DISD <sub>2</sub> * Overconfidence	0.0024***		
Fama-French controls	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	5,331	1,311	4,037
Adjusted R <sup>2</sup>	0.3727	0.2978	0.4209
<b>Panel B: Interaction model</b>			
Variables	(1) All obs.		
<b>Dependent variable: MV / TA</b>			
Positive deviation dummy	0.0691***		
Positive dev * Overconfidence	0.0999*		
Overconfidence dummy	0.2613***		
Fama-French controls	Yes		
Firm fixed effects	Yes		
Year fixed effects	Yes		
Observations	5,348		
Adjusted R <sup>2</sup>	0.3712		

Note: This table presents OLS regression estimates of the effect of inside debt deviations (DISD<sub>2</sub>) and CEO overconfidence on firm value, measured by the market-to-book ratio of assets (MV / TA). The model includes the full set of Fama and French (1998) control variables, as well as firm and year fixed effects. Standard errors are clustered at the firm level. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

The results in Table 5 only partially support H3, but they reveal a nuanced and important relationship. Across all specifications, the overconfidence dummy is positive and

significantly related to firm value, consistent with the “bright side” of overconfidence where CEOs overcome managerial conservatism and pursue valuable growth opportunities. However, H3 predicts

that this effect should differ based on the sign of the inside debt deviation. We do not find that negative deviations are associated with value destruction. Instead, we find that the positive effect of overconfidence on value is significantly stronger when inside debt deviations are positive. In the positive deviation subsample (Panel A, column 2), the coefficient on the overconfidence dummy is 0.4298. In the negative deviation subsample (column 3), the coefficient is only 0.2152. The difference between these coefficients is statistically significant. This suggests that while overconfidence may be beneficial, on average, its value-enhancing potential is most fully realized when it is constrained by a strong, debt-like incentive structure. Reining in the excessive risk-taking of an overconfident CEO appears to be more beneficial to shareholders than allowing their biases to go unchecked by an equity-heavy compensation package.

#### 4.4. Robustness of findings

To ensure the validity of our results, we conduct several robustness tests. First, we re-run all our main analyses using the alternative deviation measure,  $DISD_i$ , based on the relative leverage ratio ( $k$ ). The results are qualitatively identical: positive deviations of  $DISD_i$  mitigate the R&D spending of overconfident CEOs, and this moderation is associated with a stronger positive impact on firm value. Second, we re-estimate our models using control variables lagged by one year ( $t - 1$ ) instead of contemporaneous controls to mitigate concerns about reverse causality. Our main findings remain robust to this alternative specification. The consistency of our results across different measures and specifications increases our confidence in the core findings of the paper ( $DISD_i$  results can be provided upon request).

### 5. DISCUSSION

This study investigates the critical interaction between a powerful managerial bias, CEO overconfidence, and a key governance mechanism, inside debt. By considering these phenomena simultaneously, we provide a more nuanced understanding of how incentive structures can moderate the real effects of behavioral traits.

Our empirical analysis yields three primary findings. First, we establish a direct link between the behavioral trait and the compensation contract: firms with overconfident CEOs are significantly more likely to have inside debt levels that are below the firm-specific optimum. This suggests a potential failure in governance, where compensation committees may not be adequately adjusting incentive packages to account for the CEO's psychological profile.

Second, we demonstrate that these deviations from optimal inside debt have a powerful moderating effect on corporate risk-taking. When an overconfident CEO's compensation includes an above-optimal level of inside debt (a positive deviation), his/her natural tendency to engage in risky R&D investment is completely mitigated. Conversely, when inside debt is below the optimal level (a negative deviation), their risk-taking

propensity is unleashed. This supports the view that inside debt acts as a crucial "brake" on the behavioral biases of overconfident managers. This empirical result finds strong theoretical and empirical support in the work of Lee et al. (2021), who conclude that granting excessive debt-based pay can divert executives from firm-specific but productive activities like R&D. Our finding that this effect is particularly potent in curbing the tendencies of overconfident CEOs provides a crucial nuance, suggesting that this "diversion" from R&D can be value-enhancing when it corrects for a pre-existing behavioral bias toward overinvestment.

Third, we find that this moderation of risk-taking has tangible consequences for firm value. While overconfidence is, on average, positively associated with firm value in our sample, this positive effect is more than twice as strong when the CEO is constrained by an above-optimal level of inside debt. This suggests that the value-enhancing aspects of overconfidence, such as a willingness to innovate and pursue growth, are most effective when tempered by an incentive structure that discourages excessive, potentially value-destroying gambles. This uncovers a critical interaction. While some research cautions that excessive inside debt might stifle productive R&D in a typical firm (Lee et al., 2021), our findings indicate that for an overconfident CEO, this supposedly "excessive" level of inside debt is precisely what is needed to achieve the highest firm value. The "over-braking" that might be suboptimal for a rational manager appears to be the correct amount of braking to bring an overconfident manager, who is prone to overinvestment, back toward an optimal level of risk-taking. This implies that the very definition of an optimal compensation contract is not merely firm-specific but is contingent on the psychological traits of the CEO.

These findings have important implications for both academic theory and corporate practice. For behavioral finance theory, our results underscore the importance of studying the interaction between behavioral biases and institutional context. The impact of a trait like overconfidence is not uniform; it is contingent on the incentives and governance structures in place. Our study reframes inside debt not merely as a tool for aligning interests between managers and debtholders, but as a potential cognitive de-biasing mechanism that makes the downside of risk-taking more salient to a manager who might otherwise discount it.

For corporate governance and compensation design, the implications are direct and actionable. The "one-size-fits-all" approach to executive compensation, or even a "one-size-fits-firm" approach, appears suboptimal. Our results suggest that compensation committees should consider the psychological profile of their CEO when structuring incentive packages. For a CEO perceived as highly overconfident, a contract with a stronger debt-like component, which is, effectively, a planned positive deviation from the standard optimum, may be necessary to protect shareholder value from excessive risk-taking. This supports a move toward more tailored, "CEO-specific" incentive contracts

that account for the behavioral realities of leadership.

Our vision for this research departs from the traditional governance literature by reframing inside debt not merely as a tool for aligning interests, but as a cognitive corrective for specific behavioral biases. While seminal studies such as Wei and Yermack (2011) and Cassell et al. (2012) establish that inside debt generally reduces firm risk, they treat the executive as a rational agent responding to economic incentives. In contrast, we demonstrate that the effectiveness of inside debt is contingent upon the psychological profile of the CEO. Specifically, we show that what the literature might characterize as “excessive” inside debt — a positive deviation from the firm-specific optimum — is precisely what is required to achieve optimal value when the firm is led by an overconfident CEO.

Furthermore, our focus on deviations from the target inside debt ratio allows us to identify a critical governance gap: firms with overconfident CEOs are the most likely to have negative deviations, effectively removing the “brake” exactly when it is most needed. This suggests that for an overconfident leader, the very definition of an “optimal” contract must be adjusted upward to account for their innate tendency toward overinvestment and risk underestimation. By highlighting this interaction, our study contributes a more nuanced, trait-contingent perspective to the behavioral corporate finance and executive compensation literatures.

## 6. CONCLUSION

This study provides a comprehensive investigation into the relationship between CEO overconfidence and CEO inside debt levels, moving beyond prior research that has typically considered these factors in isolation. We examine how CEO overconfidence affects firm risk-taking activities and firm value, particularly in the context of deviations from optimal inside debt levels. Our findings reveal that these deviations play a crucial role in moderating the impact of CEO overconfidence.

Our results demonstrate that positive deviations of inside debt, i.e., when a CEO holds more debt-like compensation than the firm-specific optimum, mitigate the risk-taking behaviors of firms with overconfident CEOs. Using various methodologies to estimate inside debt levels and firm risk, we find a consistent pattern. Specifically, when using R&D expenditures as a proxy for investment risk, we find that a positive deviation is negatively related to firm risk-taking behaviors when the CEO is identified as overconfident. This suggests that debt-like incentives effectively curb the natural tendency of overconfident CEOs to engage in excessively risky projects, a finding consistent with

the idiosyncratic risk-mitigation mechanisms identified by Lee et al. (2021).

Conversely, our findings indicate that CEO overconfidence consistently leads to increased capital expenditures, regardless of deviations in inside debt. When examining the impact on financial policy risk, we find that CEO overconfidence is negatively related to firm leverage, suggesting that overconfident CEOs tend to decrease firm leverage under both positive and negative inside debt deviations. However, the magnitude of this decrease is smaller when the inside debt deviation is negative. Regarding firm cash levels, our results show that overconfident CEOs tend to reduce cash holdings, but this effect is less pronounced when their inside debt is above the target level, although these findings are not always statistically significant.

Furthermore, we examine the moderating effects of CEO inside debt on firm value. We confirm a positive relationship between deviations from the target inside debt level and firm value. Our results also show that CEO overconfidence has a positive effect on firm value, and this positive effect is more significant for positive deviations of inside debt than for negative deviations.

In conclusion, this study contributes to the literature by demonstrating that the corporate consequences of CEO overconfidence are not inevitable but are, instead, shaped and moderated by the design of executive compensation. The findings suggest that different signs of CEO inside debt deviation have distinct influences on firm value and risk, highlighting the need for a more integrated approach to corporate governance that considers both managerial psychology and incentive alignment.

While this study offers significant insights, it is subject to several limitations that suggest avenues for future inquiry. First, our primary measure of overconfidence is an indirect proxy based on option exercise behavior, which may partially reflect managerial ability or specific tax considerations. Future work could employ direct textual analysis or psychological assessments to more precisely isolate the overconfidence trait. Second, while we focus on the CEO, the psychological profiles and compensation of the broader top management team likely influence corporate outcomes, representing a valuable area for collective-bias research. Third, our analysis is situated within the U.S. institutional context; exploring these dynamics in emerging economies or under different legal frameworks would provide evidence of the generalizability of our “cognitive brake” hypothesis. Finally, investigating how the interaction between managerial bias and incentives evolves across varying economic cycles remains a critical next step for understanding the long-term stability of corporate governance systems.

## REFERENCES

- Aktas, N., Louca, C., & Petmezas, D. (2019). CEO overconfidence and the value of corporate cash holdings. *Journal of Corporate Finance*, 54, 85–106. <https://doi.org/10.1016/j.jcorpfin.2018.11.006>
- Barberis, N., & Thaler, R. (2003). A survey of behavioral finance. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), *Handbook of the economics of finance* (Vol. 1, pp. 1053–1128). Elsevier. [https://doi.org/10.1016/S1574-0102\(03\)01027-6](https://doi.org/10.1016/S1574-0102(03)01027-6)
- Ben-David, I., Graham, J. R., & Harvey, C. R. (2013). Managerial miscalibration. *The Quarterly Journal of Economics*, 128(4), 1547–1584. <https://doi.org/10.1093/qje/qjt023>

- Black, F., & Scholes, M. (1973). The pricing of options and corporate liabilities. *Journal of Political Economy*, 81(3), 637-654. <https://doi.org/10.1086/260062>
- Campbell, T. C., Galpin, N., & Johnson, S. A. (2016). Optimal inside debt compensation and the value of equity and debt. *Journal of Financial Economics*, 119(2), 336-352. <https://doi.org/10.1016/j.jfineco.2015.09.003>
- Cassell, C. A., Huang, S. X., Sanchez, J. M., & Stuart, M. D. (2012). Seeking safety: The relation between CEO inside debt holdings and the riskiness of firm investment and financial policies. *Journal of Financial Economics*, 103(3), 588-610. <https://doi.org/10.1016/j.jfineco.2011.10.008>
- Core, J., & Guay, W. (2002). Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. *Journal of Accounting Research*, 40(3), 613-630. <https://doi.org/10.1111/1475-679X.00064>
- Daniel, K., Hirshleifer, D., & Subrahmanyam, A. (1998). Investor psychology and security market under- and overreactions. *The Journal of Finance*, 53(6), 1839-1885. <https://doi.org/10.1111/0022-1082.00077>
- Deshmukh, S., Goel, A. M., & Howe, K. M. (2013). CEO overconfidence and dividend policy. *Journal of Financial Intermediation*, 22(3), 440-463. <https://doi.org/10.1016/j.jfi.2013.02.003>
- Edmans, A., & Liu, Q. (2011). Inside debt. *Review of Finance*, 15(1), 75-102. <https://doi.org/10.1093/rof/rfq008>
- Fama, E. F., & French, K. R. (1998). Taxes, financing decisions, and firm value. *The Journal of Finance*, 53(3), 819-843. <https://doi.org/10.1111/0022-1082.00036>
- Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, 81(3), 607-636. <https://doi.org/10.1086/260061>
- Frank, M. Z., & Goyal, V. K. (2007). *Trade-off and pecking order theories of debt*. <https://doi.org/10.2139/ssrn.670543>
- Galasso, A., & Simcoe, T. S. (2011). CEO overconfidence and innovation. *Management Science*, 57(8), 1469-1484. <https://doi.org/10.1287/mnsc.1110.1374>
- Gervais, S., Heaton, J. B., & Odean, T. (2011). Overconfidence, compensation contracts, and capital budgeting. *The Journal of Finance*, 66(5), 1735-1777. <https://doi.org/10.1111/j.1540-6261.2011.01686.x>
- Goel, A. M., & Thakor, A. V. (2008). Overconfidence, CEO selection, and corporate governance. *The Journal of Finance*, 63(6), 2737-2784. <https://doi.org/10.1111/j.1540-6261.2008.01412.x>
- Hall, B. J., & Murphy, K. J. (2002). Stock options for undiversified executives. *Journal of Accounting and Economics*, 33(1), 3-42. [https://doi.org/10.1016/S0165-4101\(01\)00050-7](https://doi.org/10.1016/S0165-4101(01)00050-7)
- Hambrick, D. C., & Mason, P. A. (1984). Upper echelons: The organization as a reflection of its top managers. *The Academy of Management Review*, 9(2), 193-206. <https://doi.org/10.2307/258434>
- Heaton, J. B. (2002). Managerial optimism and corporate finance. *Financial Management*, 31, 33-45. <https://www.bartlit-beck.com/assets/htmldocuments/managerial%20optimism.pdf>
- Hiller, N. J., & Hambrick, D. C. (2005). Conceptualizing executive hubris: The role of (hyper-) core self-evaluations in strategic decision-making. *Strategic Management Journal*, 26(4), 297-319. <https://doi.org/10.1002/smj.455>
- Hirshleifer, D., Low, A., & Teoh, S. H. (2012). Are overconfident CEOs better innovators? *The Journal of Finance*, 67(4), 1457-1498. <https://doi.org/10.1111/j.1540-6261.2012.01753.x>
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
- Kaplan, S. N., Sorensen, M., & Zakolyukina, A. A. (2020). *What is CEO overconfidence? Evidence from executive assessments* (NBER Working Paper No. 27853). National Bureau of Economic Research (NBER). <https://doi.org/10.3386/w27853>
- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121-1134. <https://doi.org/10.1037/0022-3514.77.6.1121>
- Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology*, 32(2), 311-328. <https://doi.org/10.1037/0022-3514.32.2.311>
- Larwood, L., & Whittaker, W. (1977). Managerial myopia: Self-serving biases in organizational planning. *Journal of Applied Psychology*, 62(2), 194-198. <https://doi.org/10.1037/0021-9010.62.2.194>
- Lee, C.-F., Hu, C., & Foley, M. (2021). Differential risk effect of inside debt, CEO compensation diversification, and firm investment. *Review of Quantitative Finance and Accounting*, 56, 505-543. <https://doi.org/10.1007/s11156-020-00901-0>
- Li, J., & Tang, Y. (2010). CEO hubris and firm risk taking in China: The moderating role of managerial discretion. *Academy of Management Journal*, 53(1), 45-68. <https://doi.org/10.5465/amj.2010.48036912>
- Liu, Y., Mauer, D. C., & Zhang, Y. (2014). Firm cash holdings and CEO inside debt. *Journal of Banking & Finance*, 42, 83-100. <https://doi.org/10.1016/j.jbankfin.2014.01.031>
- Malmendier, U., & Tate, G. (2005). CEO overconfidence and corporate investment. *The Journal of Finance*, 60(6), 2661-2700. <https://doi.org/10.1111/j.1540-6261.2005.00813.x>
- Malmendier, U., & Tate, G. (2008). Who makes acquisitions? CEO overconfidence and the market's reaction. *Journal of Financial Economics*, 89(1), 20-43. <https://doi.org/10.1016/j.jfineco.2007.07.002>
- Malmendier, U., & Tate, G. (2015). Behavioral CEOs: The role of managerial overconfidence. *Journal of Economic Perspectives*, 29(4), 37-60. <https://doi.org/10.1257/jep.29.4.37>
- Malmendier, U., Tate, G., & Yan, J. (2011). Overconfidence and early-life experiences: The effect of managerial traits on corporate financial policies. *The Journal of Finance*, 66(5), 1687-1733. <https://doi.org/10.1111/j.1540-6261.2011.01685.x>
- March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management Science*, 33(11), 1404-1418. <https://doi.org/10.1287/mnsc.33.11.1404>
- Merton, R. C. (1973). Theory of rational option pricing. *The Bell Journal of Economics and Management Science*, 4(1), 141-183. <https://doi.org/10.2307/3003143>
- Miller, D. T., & Ross, M. (1975). Self-serving biases in the attribution of causality: Fact or fiction? *Psychological Bulletin*, 82(2), 213-225. <https://doi.org/10.1037/h0076486>
- Moore, D. A., & Healy, P. J. (2008). The trouble with overconfidence. *Psychological Review*, 115(2), 502-517. <https://doi.org/10.1037/0033-295X.115.2.502>
- Moore, P. G. (1977). The manager's struggles with uncertainty. *Journal of the Royal Statistical Society: Series A (General)*, 140(2), 129-165. <https://doi.org/10.2307/2344872>

- Odean, T. (1998). Volume, volatility, price, and profit when all traders are above average. *The Journal of Finance*, 53(6), 1887-1934. <https://doi.org/10.1111/0022-1082.00078>
- Pallier, G., Wilkinson, R., Danthiir, D., Kleitman, S., Knezevic, G., Stankov, R., & Roberts, R. D. (2002). The role of individual differences in the accuracy of confidence judgments. *Journal of General Psychology*, 129(3), 257-299. <https://doi.org/10.1080/00221300209602099>
- Phan, H. V. (2014). Inside debt and mergers and acquisitions. *Journal of Financial and Quantitative Analysis*, 49(5-6), 1365-1401. <https://doi.org/10.1017/S0022109014000593>
- Roll, R. (1986). The hubris hypothesis of corporate takeovers. *Journal of Business*, 59(2), 197-216. <https://doi.org/10.1086/296325>
- Stotz, O., & von Nitzsch, R. (2005). The perception of control and the level of overconfidence: Evidence from analyst earnings estimates and price targets. *Journal of Behavioral Finance*, 6(3), 121-128. [https://doi.org/10.1207/s15427579jpfm0603\\_2](https://doi.org/10.1207/s15427579jpfm0603_2)
- Sundaram, R. K., & Yermack, D. L. (2007). Pay me later: Inside debt and its role in managerial compensation. *The Journal of Finance*, 62(4), 1551-1588. <https://doi.org/10.1111/j.1540-6261.2007.01251.x>
- Tang, H.-W., & Chang, C.-C. (2024). CEO overconfidence, risk-taking, and firm value: Influence of incentive compensation and financial constraints. *The North American Journal of Economics and Finance*, 69, Article 102034. <https://doi.org/10.1016/j.najef.2023.102034>
- Tang, Y., Li, J., & Yang, H. (2015). What I see, what I do: How executive hubris affects firm innovation. *Journal of Management*, 41(6), 1698-1723. <https://doi.org/10.1177/0149206312441211>
- Wang, C., Xie, F., & Xin, X. (2017). *CEO inside debt and accounting conservatism*. <https://doi.org/10.2139/ssrn.1703478>
- Wei, C., & Yermack, D. (2011). Investor reactions to CEOs' inside debt incentives. *The Review of Financial Studies*, 24(11), 3813-3840. <https://doi.org/10.1093/rfs/hhr028>
- Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology*, 39(5), 806-820. <https://doi.org/10.1037/0022-3514.39.5.806>

## APPENDIX A. VARIABLE DEFINITIONS

- *Ch\_at*: Cash scale by book value of total assets.
- *Size*: Natural log of book value of assets.
- *Divdummy*: Dividend dummy set to 1 if the company pays a dividend, otherwise zero.
- *Cashflow*: Calculated as: EBITDA-interest-taxes-common dividends, and then scaled by total assets.
- *Nwcap*: Net working capital is net working capital minus cash and marketable securities, and then scaled by total assets.
- *Capx\_TA*: Capital expenditures scaled by total assets.
- *Leverage*: Market debt ratio calculated by book value of liability / market value of assets.
- *MB*: Market-to-book ratio of assets: (book liabilities + market value of equity) / total assets.
- *Rddummy*: R&D dummy set to one if the firm did not report R&D expenses.
- *Rd\_ta*: R&D expense scale by total assets.
- *Lnta*: Log of asset size, measured in 1983 dollars.
- *Dep-at*: Depreciation (Compustat item 14) as a proportion of total assets.
- *Overceo*: Overconfident CEO dummy set to one if the CEO consider as overconfident.
- *Delaware*: Delaware dummy set to one is the firm incorporated in Delaware, otherwise zero.
- *After95*: After 95 dummy set to one for firm years after 1995, and zero otherwise.
- *BCL*: Business Combination Law dummy set to one if the firm is incorporated in a state and in a year that business combination law has passed.
- *Sales growth rate*: The ratio of total sales (*revt*) in year *t* to total sales in year *t* - 1.
- *Firm equity*: Market value of firm equity.
- *Firm debt*: Current debt and long-term debt of firms.
- *CEO age*: The age of the CEO at fiscal year *t*.
- *CEO tenure*: CEO tenure is the number of years that the current CEO has served in that capacity, as reported in the ExecuComp database.
- *CEO equity*: Sum of the value of stock and stock options.
- *CEO debt*: Sum of the present value of accumulated pension benefits and deferred compensation as reported in ExecuComp.
- *CEO debt to equity ratio*: CEO debt divided by CEO equity.
- *CEO relative leverage ratio (k)*: CEO's debt-to-equity ratio divided by the firm's debt-to-equity ratio.
- *CEO relative incentive ratio (k\*)*: The ratio of the marginal change in the value of CEO inside debt holdings to the marginal change in CEO inside equity holdings given the change in firm value, all scaled by the firm's respective ratio.
- *DISD<sub>1</sub>*: Actual *k* ratio minus the optimal *k* ratio.
- *DISD<sub>2</sub>*: Actual *k\** ratio minus the optimal *k\** ratio.

**APPENDIX B. ESTIMATING OPTION VALUE**

Estimates of a stock option’s value or sensitivity to stock price or stock-return volatility are calculated based on the Black and Scholes (1973) formula for valuing European call options but modified to account for dividend payouts following Merton (1973).

$$Option\ value = \left[ Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma T \frac{1}{2}\right) \right] \tag{A.1}$$

where,

$$Z = \frac{\left[ \ln\left(\frac{S}{X}\right) + T\left(r - d + \frac{\sigma^2}{2}\right) \right]}{\sigma T \frac{1}{2}} \tag{A.2}$$

- $N$  = cumulative probability function for the normal distribution;
- $Z$  = probability-weighted distance the stock price is “in-the-money”, adjusted for the risk-free rate and volatility;
- $S$  = underlying stock price;
- $X$  = option exercise price;
- $T$  = time to maturity of the option (in years);
- $d$  = natural log of expected dividend yield over the life of the option;
- $r$  = natural log of risk-free interest rate;
- $\sigma$  = expected stock return volatility over the life of the option.

We follow Core and Guay (2002) and Frank and Goyal (2007) to estimate the value of unexercised options held by executives (i.e., options granted in previous years whose value is not reported). The inputs are obtained as follows:

1. *Exercise price for unexercised options:* To estimate the average exercise price for unexercised exercisable options, we follow a two-step process. First, we compute the ratio of the realizable value of in-the-money exercisable options and the number of unexercised exercisable options. Second, we subtract this ratio from the fiscal year-end stock price. The resulting number is an estimate of the average exercise price for unexercised exercisable options held by executives. Similarly, an estimate of the average exercise price of unexercised unexercisable options can be obtained by subtracting the ratio of in-the-money unexercisable options to the number of unexercised unexercisable options from the fiscal year-end stock price.

2. *Option maturity for unexercised exercisable options:* The maturity of unexercised exercisable options is assumed to be four years less than the average maturity of the new grants. In case no grants are made this year, the maturity is set at six years. The maturity of unexercisable options is set at 1 less than the average maturity of the new grants. In case no grants are made this year, the maturity is set at nine years.

3. *Stock price, risk-free rate, dividend yield, and volatility:* These inputs are obtained from Compustat, Center for Research in Security Prices, and ExecuComp databases.

**APPENDIX C. FAMA AND FRENCH (1998) FIRM VALUE VARIABLES**

We estimate regressions using the method of Fama and MacBeth (1973). Each regression includes cross-sections.  $X_t$  is the level of variable  $X$  in year  $t$ , divided by the amount of assets in year  $t$ .  $dX_t$  is the change in the level of  $X$  from year  $t - 1$  to year  $t$ , divided by total assets in year  $t$  ( $\frac{X_t - X_{t-1}}{A_t}$ ).  $A$  is the book value of assets.

$dX_{t+1}$  is the change in the level of  $X$  from year  $t + 1$  divided by assets in year  $t$  ( $\frac{X_{t+1} - X_t}{A_t}$ ).  $V$  is the market value of the equity plus the value of debt.  $E$  is earnings defined as earnings before extraordinary items, plus interest plus deferred tax credits plus investment tax credits.  $NA$  is net assets, which is defined as total assets minus total liabilities.  $RD$  is research and development (R&D) expense. When R&D is missing, it is set to zero.  $I$  is interest expense.  $D$  is common dividends.  $L$  is liquid assets, defined as cash and cash equivalents.