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Agency Cost of Debt and Inside Debt: The Role of CEO Overconfidence

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This study extends our understanding of CEO inside debt compensation under an agency problem perspective by considering the impact of a behavioural trait, namely CEO overconfidence. Using a sample of US firms in Standard & Poor's ExecuComp for the period 2006–2019, we find that overconfident CEOs exhibit greater inside debt incentives (i.e. incentives arising from defined-benefit pensions and deferred compensation). This relationship is more pronounced among firms with higher CEO overconfidence-induced agency cost of debt (e.g. financially unconstrained firms) managed by CEOs who are less able to align compensation with their own preferences (e.g. less powerful CEOs). The results are robust to endogeneity, self-selection concerns and alternative explanations. We contribute to the inside compensation literature that deals with agency problems under overconfident CEOs, and optimal contracting and managerial power theories.

Introduction

Under a corporate setting characterized by the separation of ownership and control, agency conflicts arise because of different incentives between principals (i.e. shareholders and debtholders) and agents (i.e. CEOs). Prior literature focuses predominantly on the role of equity-based compensation in alleviating agency conflicts between shareholders and CEOs. Far less researched, especially in the strategic management literature, is the role of defined-benefit pensions and deferred compensation, known as inside debt, on agency conflicts between CEOs, which act on behalf of shareholders, and debtholders in leveraged firms (Sundaram and Yermack, 2007). Once a firm becomes levered, CEOs can increase risk that benefits the value of equity at the debtholder's expense (e.g. through firm investment and financial policies). This happens because debtholders have asymmetric payoffs in relation to firm performance; when firm performance is good, they get fixed payoffs but when the firm goes bankrupt or liquidates their payoffs, they become substantially risky. As a result, debtholders prefer firms to be more conservative. This so-called 'risk-shifting problem' is widely known as the agency cost of debt.

Jensen and Meckling (1976) develop a theoretical framework where inside debt holdings help to alleviate the agency cost of debt. Inside debt holdings are unsecured, unfunded and payable at a future date, and thus like debtholders, CEOs' inside debt holdings are subject to an asymmetric payoff in relation to firm performance; bankruptcy or liquidation of a firm's assets substantially reduces CEOs' inside debt value. Therefore, inside debt encourages CEOs to pursue less risky corporate

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policies and can act as a mechanism that aligns the interests of CEOs with debtholders. Prior literature on inside debt shows that (i) CEOs' holdings are widespread and regularly substantial, (ii) CEOs with more inside debt incentives display lower levels of risk-taking behaviour and (iii) inside debt incentives vary across firm and CEO characteristics, which are likely to relate to agency cost of debt.[1]

A particularly salient shortcoming of this literature is that it assumes that managers are rational. However, this assumption runs counter to a growing body of the psychology, corporate finance and management literatures, demonstrating that both individuals and managers are susceptible to behavioural traits, such as overconfidence (e.g. Chen, Crossland and Luo, 2015; Malmendier and Tate, 2005, 2008, 2015; Schumacher, Keck and Tang, 2020). Motivated by this literature, this study introduces to the inside debt compensation literature that deals with agency problems, a perspective that considers CEO overconfidence.

Intuitively, inside debt incentives for overconfident CEOs should differ relative to rational CEOs; however, the nature of these differences is not obvious. Specifically, overconfident CEOs are known to overestimate their own skills and abilities to improve performance and hence their investment's future cash flows. They also tend to misperceive negative net present value (NPV) projects as being value creating; this, in turn, induces excessive willingness to (over)invest and more risk-taking. In addition, overconfident CEOs perceive the cost of capital required by rational stakeholders (e.g. shareholders/debtholders) as unduly costly (Malmendier and Tate, 2005). This imposes aversion to external financing, and thus overconfident CEOs may forgo investment opportunities if external financing is required. Therefore, the net effect of overconfidence on investing and risk-taking is ambiguous. Overconfidence predicts more risk and overinvesting only if internal financing is sufficient to fund all investment projects. Increasing risk and investing in all investment projects, however, is *always* value destructive for debtholders, but *not necessarily* for shareholders; for instance, shareholders – due to different preferences for risk relative to debtholders – may accept a risky negative NPV project for a large enough gamble (Parrino and Weisbach, 1999). Under this perspective, CEO overconfidence may benefit shareholders at the expense of debtholders. Nevertheless, debtholders may anticipate such actions and thus enforce agency costs, to cover additional costs of structuring, bonding and monitoring debt facilities (Edmans and Liu, 2011), especially when the firm is financially unconstrained. Such costs affect the price of debt, and are thus ultimately borne by shareholders (Jensen and Meckling, 1976). Boards, acting on behalf of shareholders, are expected to respond to this overconfidence-induced agency cost-of-debt problem. One approach to do so is by choosing compensation arrangements that maximize shareholders' value. Under an optimal contracting, boards may reduce the overconfidence-induced agency cost-of-debt problem by rewarding overconfident CEOs with more inside debt incentives, especially when the firm is internally and externally financially unconstrained.

However, this is not an easy task. Prior literature suggests that CEOs have considerable influence on the design of compensation arrangements, especially when they have more bargaining power (e.g. Bebchuk and Fried, 2003; Murphy, 1999). Under a managerial power hypothesis, CEOs may have preferences for a more convex payoff compensation structure (given that overconfident CEOs overestimate investments' future cash flows and perceive their firm as being undervalued by the market), which includes more equity-based compensation and thus relatively less inside debt. Unlike equity-based compensation which benefits from convex payoffs with respect to firm performance, inside debt's value does not benefit from an 'expected' price appreciation. In addition, because the availability of financing facilitates both investing and the overconfident CEO's perception about firm undervaluation, CEOs' aversion to inside debt is expected to be more pronounced when the firm is internally and externally financially unconstrained.

Generally, the optimal contracting and managerial power hypotheses are non-mutually exclusive. Understanding whether and under what circumstances these hypotheses are valid is important, because each of them has different implications on corporate governance policies and more specifically on the contracting relationships between firms and CEOs. In addition, if

[1]For instance, prior studies consider how firm size, firm growth, CEO age, CEO tenure and CEO ownership relate to inside debt incentives (Campbell, Galpin and Johnson, 2016; Sundaram and Yermack, 2007).

both hypotheses coexist empirically, then which hypothesis dominates for the average firm with an overconfident CEO is an open empirical question.[2] We tentatively expect the optimal contracting hypothesis to be stronger (weaker) when the managerial power hypothesis is weaker (stronger).

We test these hypotheses using a sample of US firms over the period between 2006 and 2019. We measure inside debt incentives using the CEO relative incentive ratio (see Cassell *et al.*, 2012; Sundaram and Yermack, 2007). Greater values of inside debt incentives indicate a closer alignment of CEOs' interests with those of debtholders. Following prior literature, we measure CEO overconfidence based on revealed beliefs – captured by CEOs' preferences not to exercise timely deep in-the-money stock options – as would typically be optimal for risk-averse undiversified CEOs (see e.g. Hirshleifer, Low and Teoh, 2012; Malmendier and Tate, 2005). To avoid confounding effects with firm characteristics (see e.g. Graham, Harvey and Puri, 2013), we employ a fixed effect strategy and a propensity score matching (PSM) approach throughout our analysis.

The results show a strong positive relation between CEO overconfidence and inside debt incentives, even after controlling for other known determinants of inside debt. In economic terms, overconfident CEOs have approximately 26% larger CEO relative incentive ratio compared to rational CEOs. This positive relation between CEO overconfidence and inside debt incentives is robust to (i) a battery of checks that account, among others, for omitted variable bias and (ii) alternative explanations for late option exercising behaviour.

Overall, the results suggest that, on average, firms reward overconfident CEOs with more inside debt incentives; therefore, the optimal contracting hypothesis dominates the managerial power hypothesis for the average firm with an overconfident CEO. To further examine the merit of each hypothesis, we use subsamples of firms that exhibit different degrees of financial constraints and CEO power. Consistent with both hypotheses, the results show that the CEO overconfidence effect on inside debt incentives concentrates primarily on financially unconstrained firms managed by CEOs with low power.

Our study offers important contributions to the literature. First, it contributes to the inside debt compensation literature by considering how one of the most prominent behavioural biases, namely overconfidence (e.g. Moore and Healy, 2008), creates agency conflicts between CEOs and debtholders in leveraged firms, which in turn shape inside debt compensation. Overconfidence affects how managers interpret information (Chen, Crossland and Luo, 2015; Schumacher, Keck and Tang, 2020), form expectations and consequently their strategic decision-making (Hribar and Yang, 2016). For instance, in the presence of sufficient financing, Malmendier and Tate (2005) show that overconfident CEOs exhibit a tendency to (over)invest and take more risks. Likewise, Malmendier and Tate (2008) show that overconfident CEOs are more likely to conduct mergers and overpay for target companies. Our theoretical perspective links this tendency to an overconfidence-induced agency cost-of-debt problem, which is distinct from the traditional agency cost-of-debt problem.

Second, our study contributes to the behavioural theory that links psychological traits, such as CEO overconfidence, with strategic decision-making in organizations. Particularly, prior literature associates CEO overconfidence with investments (Hayward and Hambrick, 1997; Malmendier and Tate, 2008), entrepreneurship and innovation (Galasso and Simcoe, 2011; Hirshleifer, Low and Teoh, 2012), payout policies (Deshmukh, Goel and Howe, 2013), value of cash (Aktas, Louca and Petmezas, 2019), stakeholder commitments (Phua, Tham and Wei, 2018) and corporate social responsibility (Tang, Mack and Chen, 2018). Such evidence has important implications for contracting practices, but little is known about the incentives offered by the boards to overconfident CEOs. Provided that CEO overconfidence is an empirically detectable attribute (Goel and Thakor, 2008), we show that firms fine-tune compensation to match CEOs' behavioural traits; that is, firms reward overconfident CEOs with more inside debt incentives, especially when the firm is financially unconstrained and the CEO exhibits low power. These results support the view that firms provide incentives to overconfident CEOs to be more conservative, thus reducing overconfidence-induced agency cost of debt.

[2]Note that inside debt is a plausible mechanism to reduce overconfidence-induced agency costs, and we do not claim that inside debt is the only or the optimal mechanism to do so.

Background and hypotheses

In the presence of separation of ownership and control, agency conflicts arise within a firm because of different incentives between principals (i.e. shareholders and debtholders) and agents (i.e. CEOs) (Berle and Means, 1932; Jensen and Meckling, 1976). Conflicts arise between CEOs and shareholders because (i) CEOs tend to be more risk averse than shareholders would prefer – CEOs' wealth generally exhibits higher idiosyncratic risk than that of shareholders (Beatty and Zajac, 1994; Holmström, 1979) and (ii) CEOs bear the cost of efforts to generate returns for shareholders but retain only a portion of these returns as a reward for their efforts. Consequently, CEOs may not always act in the best interests of shareholders (Dalton *et al.*, 2007); rather, they may take actions aiming to increase perquisite consumption. To alleviate such problems, a large body of literature has investigated how compensation mechanisms alleviate the costs associated with these agency conflicts. Broadly, under the classical agency theory's predictions, equity-based compensation (i.e. stock and stock options) encourages CEOs to behave like shareholders, leading to lower risk aversion and greater effort, resulting in lower perquisite consumption (Fama, 1980).[3]

A different but also important conflict arises between CEOs and debtholders which, surprisingly, has received much less attention in the strategic management literature. CEOs may increase firm risk in ways that benefit shareholders at the expense of debtholders (Jensen and Meckling, 1976). Greater risk, however, may increase the probability of bankruptcy or liquidation; that is because debtholders exhibit an asymmetric payoff function with respect to firm performance (i.e. when firm performance is good, the payoffs of debtholders are fixed, but when firm performance is poor, debtholders' payoffs face substiantial risk), they prefer firms to take less risks and be managed more conservatively. Shareholders, instead, due to their diversified investment portfolios, prefer more risk (Eisenhardt, 1989); in fact, they may even accept a risky negative-NPV project for a large enough gamble because of different preferences for risk (Parrino and Weisbach, 1999). Due to this 'risk-shifting' problem, debtholders may enforce the agency cost of debt; because such costs are ultimately borne by shareholders, it appears intuitive that shareholders will employ mechanisms to alleviate the agency cost of debt. One such mechanism is to pay CEOs considering firm asset value rather than firm equity value alone (Edmans and Liu, 2011). Along this vein, Jensen and Meckling (1976) proclaim that inside debt incentives promote CEOs to manage the firm more conservatively because the value of CEOs' holdings on inside debt is sensitive to poor firm performance. More broadly, this unique feature of inside debt improves the incentive alignment of CEOs and debtholders.

Absent from this literature has been a systematic framework on how behavioural traits affect the agency cost of debt. Specifically, previous research neglects the role of overconfidence as a contingency that may influence the agency cost of debt. That is, an implicit assumption in the literature has been that executives are rational. This assumption, however, runs counter to the well-established applied psychology, finance and management literature suggesting that individuals, especially CEOs, are prone to overconfidence (e.g. Chen, Crossland and Luo, 2015; Malmendier and Tate, 2005, 2008, 2015; Schumacher, Keck and Tang, 2020). Overconfidence has implications for how CEOs view risk outcomes, and thus it seems logical to consider CEO overconfidence in the inside debt compensation literature that deals with agency problems.

CEO overconfidence

Overconfidence is perhaps the most significant of the cognitive biases (Kahneman, 2011); it is defined as the tendency of individuals, when evaluating their relative skills, to overstate their acumen relative to the average (Hill, Kern and White, 2014; Larwood and Whittaker, 1977). According to Grinblatt and Keloharju (2009), this definition has two main components. First, the 'better-than-average effect', which is also the focus of this study. Evidence shows that individuals believe their skills and capabilities, ranging from intelligence, driving ability and the probability of career success, are better than the average individual's ones (e.g.

[3]Other views in the literature include the behavioural agency model (Wiseman and Gomez-Mejia, 1998), which assumes that the accumulated current wealth from equity-based compensation previously awarded to CEOs creates risk-bearing, leading to lower risk-taking. This relationship becomes stronger after considering the prospective wealth from equity-based compensation (Martin, Gomez-Mejia and Wiseman, 2013).

Harrison and Shaffer, 1994; Svenson, 1981; Taylor and Brown, 1994). One can consider this as an irrational upward change in the perceived average. Second, the 'miscalibration effect', where individuals perceive that the confidence interval about uncertain future states of the world is tighter than it indeed is (Bazerman and Neale, 1986). Overconfidence also affects individuals' attribution of causality to past events. Most individuals, when they succeed at a task, are more likely to attribute the success to their actions; but, when they fail, they attribute the failure to bad luck (Miller and Ross, 1975).

Overconfidence is particularly prevalent among CEOs and can vary substantially from one CEO to the next (Klayman *et al.*, 1999). Thus, given that the CEO is the most central decision-maker with considerable power over decisions and strategies (Finkelstein, Hambrick and Cannella, 2009), CEO overconfidence can shape a firm's corporate policies. Not surprisingly, prior literature linked CEO overconfidence and the closely related constructs of narcissism and hubris to firm outcomes, including investments (Chen, Crossland and Luo, 2015; Hayward and Hambrick, 1997; Malmendier and Tate, 2005, 2008), entrepreneurship and innovation (Galasso and Simcoe, 2011; Hirshleifer, Low and Teoh, 2012), financing (Malmendier, Tate and Yan, 2011), payout policies (Deshmukh, Goel and Howe, 2013), value of cash (Aktas, Louca and Petmezas, 2019), stakeholder commitments (Phua, Tham and Wei, 2018) and corporate social responsibility (Tang, Mack and Chen, 2018). Generally, these findings are attributed to three major factors which trigger overconfidence and are pertinent in the context of corporate decision-making: the illusion of control, commitment to achieve superior outcomes and abstract reference points which make the comparison of performance across CEOs more difficult. In particular, CEOs have the illusion that they can control the outcome of their actions, and thus underestimate the probability of a failure (March and Shapira, 1987); they are also typically committed to firm performance given their high exposure to their firm's idiosyncratic risk (e.g. personal wealth and human capital); finally, the comparison of firm performance relative to other firms is complicated and difficult due to various contingent factors (e.g. Flickinger *et al.*, 2016; Louca, Petrou and Procopiou, 2020; Wiersema and Zhang, 2011; Wowak, Hambrick and Henderson, 2011).

Before discussing our theoretical perspective in more detail, it is worth clarifying the relation between overconfidence and other related but distinct constructs such as narcissism (Chatterjee and Hambrick, 2007) and hubris (Hayward and Hambrick, 1997). Like overconfidence, narcissism is accompanied by an overestimation of an individual's own ability but, in addition, it also requires continuous affirmation, applause and adulation by others (Chatterjee and Hambrick, 2007). Thus, narcissism is a much broader construct compared to overconfidence. Closer to overconfidence is the construct of hubris (Hayward and Hambrick, 1997). In fact, the difference between hubris and overconfidence is very subtle. Hubris entails extreme confidence, perhaps as a result of social influence after a recent success, but it also includes the idea of exaggerated pride, which often results in retribution; that is, hubris will ultimately be detrimental for individuals. In contrast, overconfidence does not entail such a negative outcome and prior work points toward the benefits of overconfidence (Hirshleifer, Low and Teoh, 2012; Leary, 2007). As in Chen, Crossland and Luo (2015) and Schumacher, Keck and Tang (2020), in this study we build our theoretical arguments around the term 'overconfidence' because we do not require the concept of retribution.

CEO overconfidence and agency cost of debt

We draw on the theoretical model of Malmendier and Tate (2005) to demonstrate the effect of CEO overconfidence on agency cost of debt. We utilize this model because it illustrates how overconfidence affects risk-taking and leads to overinvestment, both of which are crucial determinants of agency cost of debt. Their model assumes an efficient capital market with two CEOs: an overconfident CEO and a rational one. Both CEOs aim to maximize shareholders' wealth. The only friction in the model comes from overconfident CEOs who overestimate their ability to create value. Accordingly, they overestimate hand-picked investments' future cash flows and, given that their firm represents a series of prior investments, overconfident CEOs also perceive their firm as being undervalued by the market. These manifestations of overconfidence create a trade-off when considering investments and risk-taking. The overestimation of investments' future cash flows induces excessive willingness to invest and more

risk-taking. But the perceived undervaluation of their firm generates financing costs; in particular, potential capital suppliers (i.e. shareholders and debtholders) demand a greater reward than an overconfident CEO deems appropriate given future cash flows. Therefore, the CEO may reject investment opportunities because she perceives financing provided by rational suppliers as unduly costly. Overall, the net effect of overconfidence on investments and risk-taking is ambiguous.

However, overconfidence unambiguously predicts more risk and overinvestment when internal financing is sufficient. Increasing risk (e.g. by selecting investment and financing policies which increase total risk or by altering the portion of idiosyncratic relative to systematic risks; Florackis *et al.*, 2020) and overinvesting (i.e. investing in negative-NPV projects), however, are always value-destructive for debtholders, but not necessarily for shareholders. Parrino and Weisbach (1999) show that shareholders may accept a risky negative-NPV project for a large enough gamble because of different preferences for risk. This situation represents a kind of 'risk-shifting problem' and leads to overconfidence-induced agency cost of debt; as a result, debtholders may face additional costs of structuring, bonding and monitoring debt facilities (Edmans and Liu, 2011). Because debtholders may anticipate the expected costs of such opportunistic actions, they may incorporate them into the price of debt, especially when the overconfidence-induced agency cost of debt is heightened (i.e. when internal financing is sufficient).

CEO overconfidence and inside debt

Among prior literature, the dominant view on executive compensation arrangements perceives them as a partial remedy to the agency problem. Under this approach, known as optimal contracting, boards acting on behalf of shareholders are assumed to choose compensation arrangements that maximize shareholders' value. In this vein, compensation arrangements are driven by economic rationale and reflect firm and industry-level characteristics; most importantly for our setting, they also reflect individual traits (Diamond, 1998; Hirshleifer and Suh, 1992).

As discussed above, although the net effect of overconfidence on investments and risk-taking is ambiguous, overconfidence unambiguously predicts more risk-taking and overinvestment in the presence of sufficient financing. This, in turn, creates overconfidence-induced agency cost of debt, which empirically most likely concentrates among internally and externally financially unconstrained firms. The board of directors which acts on behalf of shareholders is expected to respond to this overconfidence-induced agency cost of debt. One approach to doing so is to provide the CEOs with appropriate incentives (Pepper and Gore, 2015) by reducing their tendency to take risks and overinvest. Jensen and Meckling (1976) argue that inside debt incentives promote CEOs to manage the firm more conservatively. Consistent with this view, prior literature finds that CEO inside debt holdings are negatively related to the volatility of stock returns, research and development expenditures and financial leverage, and positively related to the extent of diversification and asset liquidity (Cassell *et al.*, 2012). This leads us to the following hypotheses:

H1: Under the optimal contracting theory, there is a positive relation between CEO overconfidence and inside debt incentives.

H2: Under the optimal contracting theory, the positive relationship between CEO overconfidence and inside debt incentives is more pronounced among the subsample of internally and externally financially unconstrained firms.

A different approach to study the compensation arrangements and inside debt is by perceiving them as part of the agency problem. Under this approach, known as managerial power theory, prior literature recognizes that compensation arrangements reflect managerial rent-seeking rather than provisions for efficient incentive contracts. Management, particularly the CEOs who are the most central decision-makers within the firm (Finkelstein, Hambrick and Cannella, 2009), can use their power to exercise political and social influence over the board, and thus pervasively impact on all the facets of the pay-setting process (Bebchuk and Fried, 2003; Murphy, 1999). CEOs' power may stem from various sources, including the CEO's formal position (e.g. as reflected in compensation arrangements relative to other executives), their links with the directors of the board (e.g. professional or personal connections) and the tendencies of the directors or even psychological biases to favour the CEO (e.g. the norms of reciprocity and in-group bias). In general, CEOs are risk-averse

and thus rent-seeking CEOs will prefer compensation that is less contingent upon future performance. Thus, under the managerial power theory, more powerful CEOs relative to the board of directors will receive more inside debt. Consistent with this vein, Cen (2011) finds that inside debt is higher when the CEO serves as the chair of the board and when the CEO serves the firm for a longer time.

Overconfidence, however, may alter CEOs' preferences for inside debt. Specifically, overconfident CEOs overestimate investments' future cash flows and perceive their firm as being undervalued by the market. These manifestations induce aversion to inside debt for powerful CEOs because – unlike other components of executive compensation such as stocks and options – inside debt does not benefit from an expected price appreciation. This leads us to the following hypothesis:

H3: Under the managerial power theory, the positive relationship between CEO overconfidence and inside debt incentives is more pronounced among the subsample of less powerful CEOs.

Both the optimal contracting and managerial power hypotheses are non-mutually exclusive and may independently affect inside debt incentives. Thus, we expect the optimal contracting hypothesis to be stronger (weaker) when the managerial power hypothesis is weaker (stronger). This leads us to the following hypothesis:

H4: Among the subsample of internally and externally financially unconstrained firms, the positive relation between CEO overconfidence and inside debt incentives is more (less) pronounced when the CEO is less (more) powerful.

Research design

Sample

To construct the sample, we use ExecuComp to obtain inside debt and CEO-related data, Standard and Poor's Compustat Industrial Annual to obtain accounting data and the Center for Research in Security Prices (CRSP) to obtain stock returns. The initial sample consists of the intersection of firms included in the above-mentioned databases and covers the period 2006–2019. The sample period is driven by the availability of inside debt data, as the year 2006 was the first year that firms were required by the SEC to disclose and describe their top executives' deferred compensation plans, pension benefits and other post-employment payments. From this sample, we eliminate firm-year observations for which net assets are negative, or the market value of equity is negative, or dividends are negative.[4] Finally, following Wei and Yermack (2011), Cassell *et al.* (2012) and Phan (2014), we restrict the sample to firms with positive CEO inside debt holdings. The final sample consists of 1581 firms with 12,288 firm-year observations.

Measures of CEO inside debt

Following the theoretical arguments of Jensen and Meckling (1976) and Edmans and Liu (2011), and the empirical applications of Sundaram and Yermack (2007), Wei and Yermack (2011), Cassell *et al.* (2012), Phan (2014) and Campbell, Galpin and Johnson (2016), we measure CEO inside debt incentive as the *CEO to firm debt-to-equity incentive ratio*. In fact, we precisely follow the definition of Cassell *et al.* (2012) to define *firm debt-to-equity incentive ratio*. The natural log of the relative incentive ratio developed by Cassell *et al.* (2012) is represented in the following model:

$$\textit{CEO relative incentive ratio} = (\Delta \textit{CEO IDH}/\Delta \textit{CEO EH}) / (\Delta \textit{FD}/\Delta \textit{FE}) \quad (1)$$

where ΔCEO IDH is set equal to CEO IDH (the present value of accumulated pension benefits and deferred compensation), ΔCEO EH is equal to the number of shares held by the CEO plus the number of options held by the CEO times the option delta (the option delta is calculated for each option tranche using the Black–Scholes option valuation formula), ΔFD is set equal to total debt (dlc + dltt) and ΔFE is constructed using an approach similar to that used for ΔCEO EH except that there is not complete data on all of the outstanding option tranches issued by the firm [inputs to the valuation formula are the total number of employee stock options outstanding (optosey), the average exercise price of outstanding options (optprcby) and an assumed remaining life of 4 years for all options].

[4]Excluding firms in the financial service industries (SIC codes 6000–6999) and in the utility sector (SIC codes 4900–4999) does not alter our main results.

The reason we focus on the changes rather than the levels of CEO relative debt-to-equity ratio is because the duration and payoff function of a firm's debt and equity securities may be different from those of CEOs' respective securities. As a result, the same investment or financial policy decision that benefits debtholders at the expense of shareholders (or vice versa) will have different value implications for firms and CEOs, even if they have similar debt-to-equity ratio. This problem is particularly pronounced among firms with complex capital structures. Therefore, we use the *CEO relative incentive ratio* as the main inside debt measurement.[5] Wei and Yermack (2011), Cassell *et al.* (2012) and Campbell, Galpin and Johnson (2016) suggest that the CEO relative incentive ratio is skewed to the right. Hence, like the prior literature, to account for this bias we use natural log transformations of inside debt incentives when estimating the regression analysis.

For robustness, we also employ an alternative inside debt level measure: the *CEO to firm debt-to-equity ratio* defined as the CEO debt-to-equity ratio scaled by the firm's debt-to-equity ratio. Using this measure, we obtain similar results.

Measures of CEO overconfidence

Prior literature supports the idea that overconfidence may have both a time-invariant (i.e. stable cognitive disposition) and a time-varying (i.e. state-based) component. The time-invariant component is relatively stable and changes only slowly in response to prior negative feedback or external influences (e.g. Grossman and Owens, 2012; Schumacher, Keck and Tang, 2020). Prior evidence consistent with this conceptualization includes Lee, Hwang and Chen (2017), who show that overconfidence characterizes company founders long after their firm went public, and Hayward *et al.* (2010), who find that repeated failure does not deter overconfident entrepreneurs from continuing to look for new businesses. In contrast, the time-varying component assumes that overconfidence may also be affected by short-run influences. For instance, Ahmed and Duellman (2013) assume that overconfidence can vary over time and suggest operationalizing overconfidence accordingly. As in Chen, Crossland and Luo (2015), we examine both possibilities in our empirical analyses.

First, we measure CEO overconfidence using a CEO stock options-based proxy (see e.g. Malmendier and Tate, 2005, 2008).[6] This measure is based on CEOs' revealed beliefs, captured by their preferences not to exercise deep in-the-money options immediately after the options vest, as this would typically be optimal for risk-averse undiversified executives. Following prior literature (see e.g. Campbell *et al.*, 2011; Hirshleifer, Low and Teoh, 2012), we estimate Holder 67. We do so by using year-on-year aggregate data on CEO vested option holdings and calculate a continuous confidence measure as follows:

$$Confidence = \frac{\text{Average value per vested option}}{\text{Average strike price}} \quad (2)$$

where the average value per vested option is the value of vested unexercised options scaled by the number of vested unexercised options and the average strike price is the stock price at the end of the fiscal year minus the average value per vested option. We then identify overconfident CEOs as those that fail to exercise vested options that are at least 67% in-the-money at least twice (starting from the first time) during their tenure. Accordingly, this measure captures a 'stable' overconfidence effect because it targets CEOs who 'habitually' exercise options late.[7] The advantage of this measure is that it allows us to include more firm-year observations from the ExecuComp database. The disadvantage is that the measure is less precise because it uses aggregate data on CEOs' option holdings. Nevertheless, Campbell *et al.* (2011) find that this measure of overconfidence generates

[5]The Appendix provides more information about the measures.

[6]Prior literature uses various measures to operationalize overconfidence. Broadly, the measures are categorized as follows: (i) behavioural measures which are based on revealed beliefs – captured by CEOs' preference not to exercise timely deep in-the-money stock options or by net purchases on the firm's own stock (Malmendier and Tate, 2005); (ii) media-based measures (Hirshleifer, Low and Teoh 2012; Malmendier and Tate, 2008); (iii) formative measures based on prior success proxies (Billett and Qian, 2008; Doukas and Petmezas, 2007; Hayward and Hambrick, 1997); and (iv) survey-based measures (Graham, Harvey and Puri, 2013).

[7]For robustness reasons, we re-run our analyses after requiring CEOs to continuously hold deep-in-the-money options four or five times. Untabulated results remain qualitatively similar to those reported in the study.

similar investment distortion results as in Malmendier and Tate (2005).[8]

We also follow Humphery-Jenner *et al.* (2016) and divide the sample into CEOs with high and low confidence levels. Specifically, Holder 100, which captures high confidence levels, equals one if CEOs fail to exercise vested options that are at least 100% in-the-money at least twice (starting from the first time) during their tenure, and zero otherwise. Likewise, Holder 67_100, which captures low confidence levels, equals one if CEOs fail to exercise vested options that are between 67% and 100% in-the-money at least twice (starting from the first time) during their tenure, and zero otherwise. Untabulated results show that the effect on inside debt is more pronounced for CEOs with high confidence levels.

Second, in our robustness analysis, we also use CEO awards as an exogenous shock to examine the relationship between CEO overconfidence and inside debt. The expectation is that an award is likely to amplify overconfidence behaviour by CEOs, which in turn makes the use of inside debt to restrain overconfidence more essential. Accordingly, this measure captures 'short-run' state-level influences on the level of overconfidence. As in Malmendier and Tate (2009) and Kubick and Lockhart (2017), we collect information about award-winning CEOs from major media outlets such as the *Times*, *Forbes*, *BusinessWeek*, *Morningstar.com*, *Industry Week*, *Chief Executive* and *Ernst & Young*. We identify 105 CEOs with awards.

Methods

Our primary interest is to evaluate how CEO overconfidence affects inside debt incentives. To do so, we estimate the following ordinary least squares (OLS) regression model:

$$\begin{aligned} \textit{Inside debt}_{i,t} &= \alpha + \beta_1 * \textit{Overconfident (Holder 67)}_{i,t-1} \\ &\quad + \beta_2 * \textit{CEO characteristics}_{i,t-1} \\ &\quad + \beta_3 * \textit{Firm characteristics}_{i,t-1} \\ &\quad + \gamma * \textit{Firm dummies} \\ &\quad + \delta * \textit{Year dummies} + \varepsilon_{i,t-1} \end{aligned} \tag{3}$$

where i indexes CEOs and t indexes years. The variable 'Overconfident (Holder 67)' is the main variable of interest. A positive (negative) and significant β_1 coefficient indicates that overconfident CEOs are compensated with more (less) inside debt incentives relative to rational CEOs. CEO characteristics and firm characteristics are vectors of time-varying CEO and firm control variables, respectively.

Following Sundaram and Yermack (2007) and Liu, Mauer and Zhang (2014), we control for the following CEO and firm characteristics: CEO ownership, CEO tenure, CEO age, CEO vega, CEO delta, size, leverage, firm age, stock return, stock return volatility, free cash flows, research and development expenses, tax status, liquidity and Tobin's Q.[9] All independent variables are lagged by 1 year and the continuous variables are winsorized at the 1% level.

Finally, to also control for potential confounding effects with unobserved firm characteristics (e.g. due to an endogenous matching of CEOs to firms; Graham, Harvey and Puri, 2013), we use in our main models a firm fixed effects estimation strategy. This approach eliminates any time-invariant effects on inside debt incentives. We also include year fixed effects to control for economy-wide shocks and differences in the employment period. Finally, following Petersen (2009) and Abadie *et al.* (2017), we estimate heteroscedasticity-robust standard errors clustered at the firm level to control for residuals that may be correlated over time. Our statistical tests are one-tailed.

Summary statistics

Panel A of Table 1 provides yearly statistics on the number and proportion of overconfident and

[8]We use two additional time-varying measures of CEO overconfidence which are based on stock options. First, motivated by Humphery-Jenner *et al.* (2016), we employ log(1 + Estimated value of in-the-money unexercised exercisable options). Second, as in Banerjee *et al.* (2018), we use the variable 'Overconfident', which is an indicator that equals one if 'CEO confidence' belongs in the top quartile of all CEOs in that year. 'CEO confidence' is defined based on the average value per option scaled by the average strike price. In unreported analysis we confirm our baseline results as overconfident CEOs are positively associated with inside debt and the effect is confined to unconstrained firms with low-power CEOs.

[9]The Appendi provides detailed definitions of all variables.

Table 1. Sample distribution by year, Fama–French 12 industry codes and correlation matrix

Panel A

Year	All sample	Overconfident (Holder 67) CEOs		Rational CEOs	
		Number	%	Number	%
2005	797	455	57.2	342	42.8
2006	945	548	58.01	397	41.99
2007	1,048	545	52.04	503	47.96
2008	974	486	49.9	488	50.1
2009	960	463	48.1	497	51.9
2010	958	481	50	477	50
2011	917	439	47.57	478	52.43
2012	906	448	49.23	458	50.77
2013	916	484	52.87	432	47.13
2014	886	466	52.52	420	47.48
2015	833	421	50.36	412	49.64
2016	726	344	47.48	382	52.52
2017	721	342	47.02	379	52.98
2018	701	314	44.93	387	55.07
Total	12,288	6,236	50.75	6,052	49.25

Panel B

Industries	All sample	Overconfident (Holder 67) CEOs		Rational CEOs	
		Number	%	Number	%
Consumer Non-Durables	756	352	46.56	404	53.44
Consumer Durables	377	160	42.44	217	57.56
Manufacturing	1,707	903	52.90	804	47.10
Energy Oil and Gas	714	427	59.80	287	40.20
Chemicals and Allied Products	569	246	43.23	323	56.77
Business Equipment	1,127	620	55.01	507	44.99
Telephone and Television Transmission	278	137	49.28	141	50.72
Utilities	853	214	25.09	639	74.91
Wholesale, Retail and Some Services	1,254	776	61.88	478	38.12
Healthcare, Medical Equipment and Drugs	711	412	57.95	299	42.05
Money Finance	2,552	1,152	45.14	1,400	54.86
Other	1,390	837	60.22	553	39.78
Total	12,288	6,236	50.75	6,052	49.25

Table 1. (Continued)

Panel C

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 CEO relative incentive ratio	1																
2 Holder 67	0.062	1															
3 CEO ownership	–0.008	0.108	1														
4 CEO tenure (years)	0.042	0.263	0.395	1													
5 CEO age (years)	0.024	0.141	0.154	0.426	1												
6 CEO vega ($thousands)	0.027	0.134	–0.039	0.019	0.056	1											
7 CEO delta ($thousands)	–0.002	0.209	0.523	0.271	0.147	0.366	1										
8 Total assets ($millions)	–0.039	–0.005	–0.087	–0.048	0.051	0.268	0.144	1									
9 Financial leverage	–0.174	–0.065	–0.025	–0.036	–0.032	–0.014	–0.037	–0.040	1								
10 Firm age (years)	–0.031	–0.069	–0.112	–0.096	0.075	0.149	0.001	0.121	0.013	1							
11 Stock return	0.029	0.014	–0.018	–0.015	–0.009	–0.007	0.041	–0.020	–0.033	–0.017	1						
12 Stock volatility	0.010	–0.045	0.074	–0.018	–0.076	–0.166	–0.139	–0.137	0.074	–0.187	0.006	1					
13 Free cash flows	0.003	0.003	–0.009	0.019	0.010	0.038	–0.001	0.101	–0.083	–0.081	0.039	0.050	1				
14 Research and development	0.070	0.042	–0.052	–0.066	–0.051	0.126	–0.002	–0.116	0.064	0.043	0.042	–0.032	–0.011	1			
15 Tax status	0.025	0.086	0.030	0.001	–0.013	0.030	0.035	–0.116	0.058	–0.117	0.010	0.067	0.009	0.203	1		
16 Liquidity	–0.019	–0.017	0.069	0.022	0.004	–0.045	–0.017	0.044	0.044	–0.042	–0.032	0.152	–0.413	–0.050	–0.011	1	
17 Market to book	0.027	0.067	–0.015	–0.011	–0.026	0.052	0.056	–0.029	–0.021	0.015	0.071	–0.090	–0.014	0.093	0.052	−0.048	1

Note: Panel A presents the yearly breakdown of the number and proportion of overconfident (Holder 67) and rational CEO firm-year observations. Panel B presents the number and proportion of overconfident (Holder 67) and rational CEO observations by Fama–French 12 industries classification. The Fama–French 12 industries are: 1, Consumer Non-Durables; 2, Consumer Durables; 3, Manufacturing; 4, Energy Oil and Gas; 5, Chemicals and Allied Products; 6, Business Equipment; 7, Telephone and Television Transmission; 8, Utilities; 9, Wholesale, Retail and Some Services; 10, Healthcare, Medical Equipment and Drugs; 11, Money Finance; and 12, Other. The sample of CEOs is from ExecuComp over the period between 2005 and 2018 for firms with available accounting and stock data in Compustat and CRSP (i.e. 1 year lag relative to the dependent variables which cover the period between 2006 and 2019). In addition, we exclude firm-year observations for which net assets are negative, the market value of equity is negative, or dividends are negative. Panel C presents the pairwise correlations of our variables. The definition of 'Overconfident (Holder 67)' is provided in the Appendix.

rational CEOs in our sample. On average, the option-based overconfidence measure identifies a proportion of 50.75% of overconfident CEOs-years, which is lower than the 61.08% reported by Hirshleifer, Low and Teoh (2012). Importantly, by looking at the 2-year period prior to the financial crisis, which started in July 2007 (Duchin, Ozbas and Sensoy, 2010), the measure identifies a proportion of 57.61% of overconfident CEOs-years whereas after that period it identifies a proportion of only 49.33% CEOs-years. This pattern of identification is possible to relate to the financial crisis because excessively optimistic CEOs may be more likely to experience a forced turnover (Campbell *et al.*, 2011). Panel B of Table 1 partitions the sample by Fama–French 12 industries classification. Overconfident CEOs-years exist in all the industries but are more prevalent in research and development-oriented industries such as Healthcare, Medical Equipment and Drugs. Panel C of Table 1 presents pairwise correlations of our variables. As expected, CEO overconfidence and most of the control variables correlate with inside debt incentives.

Table 2 provides descriptive statistics. The summary statistics for the overall sample are largely comparable with prior literature (e.g. Liu, Mauer and Zhang, 2014). Firms with overconfident CEOs have greater inside debt incentives than firms with rational CEOs; the average CEO relative incentive ratio is 3.040. Interestingly, the median CEO relative incentive ratio is only 0.165, indicating right skewness, even after winsorization. These statistics are comparable with Cassell *et al.* (2012), Phan (2014) and Campbell, Galpin and Johnson (2016) and the explanation of equity bias for the median firm; in addition, this finding is consistent with Edmans and Liu's (2011) prediction that most firms are equity biased. Accordingly, to account for this bias, we use natural log transformations of inside debt incentives when estimating the regression analysis.

Looking into CEO characteristics, firms with overconfident CEOs have larger ownership, longer tenure, are older and receive, on average, more risk-taking incentives (i.e. vega) and incentive compensation associated with stock performance (i.e. delta). Higher risk-taking incentives are consistent with the exploitation hypothesis in Humphery-Jenner *et al.* (2016). Regarding firm characteristics, overconfident CEOs work for firms with lower leverage, lower stock return volatility and higher research and development expenses and market-to-book ratios. The latter is consistent with Hirshleifer, Low and Teoh (2012), who find that overconfident CEOs invest more in innovation and exploit innovative growth opportunities. Additionally, firms with overconfident CEOs are younger and exhibit higher net operating loss carry-forward than firms with rational CEOs.

Because univariate comparisons do not consider any confounding effects, they can be misleading. Consequently, to identify the effect of overconfident CEOs on inside debt incentives, net of CEO and firm-specific characteristics, we need to control for them through multivariate regression analysis, as presented next.

Empirical analysis

Before we begin with the main analysis, it is important to note that if firms with overconfident CEOs are different relative to firms with rational CEOs, then the control variables in the regression which capture linear relations may be inadequate. To alleviate concerns over potential non-linear effects of the control variables on inside debt, we create two data samples that are comparable across the control variables but differ only on whether the CEO is overconfident or rational. To construct these subsamples, we use a PSM approach to match firms with overconfident CEOs on board with firms that exhibit similar characteristics but have a rational CEO on board. Specifically, the method consists of a probit regression to estimate propensity scores, $p(Y = 1/X = x)$, based on the probability of receiving a binary treatment, Y, conditional on all the control variables, X. In our setting, we consider having an overconfident CEO as treatment and we estimate the probability of having an overconfident CEO using all control variables. Then, for each firm-year with an overconfident CEO we use the propensity score to find a comparable firm-year with a rational CEO based on the nearest-neighbour method with replacement. To ensure the adequacy of the matching estimation method, we require that the absolute difference in propensity scores among pairs does not exceed 0.0001. Using this approach, we find 2916 pairs of matched firm-years.

We then perform a diagnostic test to investigate how successful our PSM approach is in removing potential biases related to observable firm

Table 2. Summary statistics

Panel A	Mean				Median			
	All sample	Overconfident (Holder 67)	Rational	Difference	All sample	Overconfident (Holder 67)	Rational	Difference
	(1)	(2)	(3)	(2) − (3)	(4)	(5)	(6)	(5) − (6)
Inside debt variables								
CEO relative incentive ratio	3.040	4.153	1.877	2.276***	0.165	0.292	0.092	0.201***
CEO characteristics								
CEO ownership	0.009	0.012	0.007	0.005***	0.003	0.003	0.002	0.001***
CEO tenure (years)	6.761	8.346	5.105	3.273***	5.000	7.000	4.000	3.000***
CEO age (years)	56.377	57.212	55.504	1.729***	56.000	57.000	56.000	2.000***
CEO vega ($thousands)	149.536	179.996	117.711	62.32***	57.885	82.103	38.890	42.742***
CEO delta ($thousands)	611.428	893.969	316.230	578.500***	209.429	360.750	114.699	246.402***
Firm characteristics								
Total assets ($millions)	20,959.152	20,601.538	21,332.786	−582.800	4,784.126	4,876.800	4,716.667	185.609
Financial leverage	0.268	0.257	0.279	−0.024***	0.246	0.234	0.258	−0.024***
Firm age (years)	33.916	32.517	35.378	−2.512**	30.000	28.000	33.000	−4.000***
Stock return	0.088	0.094	0.082	0.012	0.059	0.073	0.044	0.028***
Stock volatility	0.018	0.018	0.019	−0.001***	0.015	0.015	0.015	−0.001*
Free cash flows	0.054	0.054	0.054	0.001	0.054	0.053	0.055	−0.002
Research and development	0.487	0.508	0.465	0.042***	0.000	1.000	0.000	1.000***
Tax status	0.624	0.665	0.581	0.083***	1.000	1.000	1.000	0.000***
Liquidity	0.040	0.037	0.043	−0.007	0.000	0.000	0.000	0.000*
Market to book	2.664	3.021	2.291	0.732***	2.030	2.341	1.759	0.582***

Note: Panel A presents summary statistics on inside debt over the period 2006–2019, and CEO and firm characteristics over the period 2005–2018 for a sample that consists of 12,288 firm-year observations. Summary statistics are presented for all the sample and then by whether firms are managed by overconfident (Holder 67) or rational CEOs. Panel B presents the correlation of all variables used in the analysis. All variable definitions are provided in the Appendix. We require that firms have accounting and stock data in Compustat and CRSP. All dollar values are adjusted in 2016 dollars using the consumer price index. T-tests (Wilcoxon–Mann–Whitney tests) are conducted to test for differences between means (medians) for firms with overconfident (Holder 67) versus rational CEOs.

*, ** and *** depict the level of significance at 10%, 5% and 1%, respectively.

characteristics. In particular, Panel A of Table 3 reports parameter estimates from the probit model used to estimate propensity scores for firms in the treatment and control groups. Model (1) reports pre-matching probit estimates while model (2) presents post-matching probit estimates. Only two out of the 15 independent variables are statistically significant at conventional levels, while the pseudo-R^2 drops substantially from 17.2% to 0.9%. This diagnostic test shows that the PSM process appears to successfully remove potential observable sample selection biases.

Optimal contracting hypothesis: The role of CEO overconfidence

In Panel B of Table 3 we present the results for the impact of overconfident CEOs on inside debt using the pairs of matched firm-years. The dependent variable is the CEO relative incentive ratio. Models (1) and (2) present the results after including the control variables, while models (3) and (4) present the results after adding the variable of interest, that is, CEO overconfidence. In addition, models (1) and (3) use firm and year fixed effects whereas models (2) and (4) include industry and year fixed effects. Consistent with H1, the results show a positive relation between CEO overconfidence and inside debt incentives, which is significant at conventional levels. In economic terms, model (3) suggests that overconfident CEOs are associated with 26.24% higher inside debt incentives relative to rational CEOs.[10] Turning to the control variables, the results are largely in line with prior literature (see e.g. Cadman and Vincent, 2015; Campbell, Galpin and Johnson, 2016; Liu, Mauer and Zhang, 2014; Sundaram and Yermack, 2007; Wei and Yermack, 2011). CEO age, CEO vega and stock return (CEO ownership, firm size, financial leverage, firm age and stock volatility) are positively (negatively) related to the CEO relative incentive ratio.[11]

Optimal contracting hypothesis: CEO overconfidence and financial constraints

Following prior literature, we use several measures to classify firms as (i) internally and (ii) internally and externally financially constrained. First, we use dividend policy to determine whether firms are internally financially unconstrained. When firms have abundant financial resources, they are more likely to pay dividends. In this respect, Fazzari *et al.* (1988) argue that unconstrained firms are relatively more likely to have higher dividend payments, while constrained firms are relatively less likely to pay dividends. Therefore, following Denis and Sibilkov (2010), we classify firms as internally financially constrained if they do not pay dividends in year t, and internally financially unconstrained otherwise.

Second, we use the commonly used size–age index of Hadlock and Pierce (2010) to classify firms based on their external financial constraint status. Hadlock and Pierce (2010) use quantitative factors to predict a firm's financial constraint status, as captured through detailed qualitative information from the financial filings. Their results reveal that size and age are very important in predicting a firm's financial constraint status. Based on the size–age equation of Hadlock and Pierce (2010), a firm is classified as externally financially constrained when the size–age index is above the sample median in year t (these are generally smaller and younger firms) and externally financially unconstrained otherwise.[12]

[10]Since the coefficient on 'Holder 67' is 0.233 and the estimated constant is –8.605, we obtain $e^{(0.233-8.605)}/e^{-8.605} - 1 = 26.24\%$.

[11]Ding *et al.* (2022) address the research question of whether family involvement moderates the effects of inside debt on the cost of bank loans. In unreported analysis, we check the effect of family firms on our results by using data from Anderson, Duru, Reeb (2009) and Anderson, Reeb and Zhao (2012). We then divide the sample into family firms versus non-family firms and perform the same analysis as that in the baseline tests of Table 3. We find that overconfident CEOs have a positive relationship with inside debt across both family and non-family firms. We also find that the difference in the coefficients of the two groups is statistically insignificant when we perform a Chow test. We thus conclude that family firms do not affect the relationship between CEO overconfidence and inside debt.

[12]We have also used two alternative measures of financial constraints: (1) credit ratings and (2) the Hoberg and Maksimovic (2015) textual-based measures of financial constraints. For credit ratings, we classify firms with no debt outstanding and firms with investment-grade ratings as financially unconstrained; all other firms are classified as financially constrained. The Hoberg and Maksimovic (2015) text-based measures of financial constraints are based on firm disclosures in the capitalization and liquidity discussion of firm 10-Ks. The measures include four different constraint variables: (a) a general measure of the extent to which firms are constrained; (b) a measure that is specific to constrained firms attempting to access the

Table 3. Overconfident CEOs and inside debt

Panel A: Pre-match propensity score regressions and post-match diagnostic regressions		
Dummy = 1 if in Treatment Group, 0 if in Control Group		
	Pre-match (1)	Post-match (2)
CEO ownership	–0.184***	–0.0778
	(0.000)	(0.117)
CEO tenure	0.347***	0.0529*
	(0.000)	(0.056)
CEO age	0.598***	–0.0195
	(0.000)	(0.917)
CEO vega	–0.0248***	–0.000819
	(0.002)	(0.946)
CEO delta	0.309***	0.0605***
	(0.000)	(0.004)
Firm size	–0.0718***	–0.0275
	(0.000)	(0.139)
Financial leverage	–0.263***	0.0819
	(0.001)	(0.494)
Firm age	–0.0715***	–0.0176
	(0.001)	(0.590)
Stock return	–0.107***	–0.0188
	(0.001)	(0.720)
Stock volatility	2.874*	–0.996
	(0.085)	(0.699)
Free cash flows	0.0171	0.109
	(0.888)	(0.554)
Research and development	–0.0869**	–0.0527
	(0.020)	(0.324)
Tax status	0.0510*	–0.00569
	(0.091)	(0.898)
Liquidity	–0.00235	0.0254
	(0.975)	(0.821)
Market to book	0.00886***	0.00215
	(0.000)	(0.534)
Intercept	Yes	Yes
Firm fixed effect	No	No
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
Observations	12,142	4,927
Pseudo R-squared	0.172	0.009

Panel B				
	(1)	(2)	(3)	(4)
Overconfident (Holder 67)			0.233*	0.333***
			(0.052)	(0.002)
CEO ownership	–0.650***	–0.963***	–0.654***	–0.953***
	(0.000)	(0.000)	(0.000)	(0.000)
CEO tenure	0.150	0.204***	0.151	0.197***
	(0.118)	(0.005)	(0.117)	(0.006)
CEO age	3.640***	2.710***	3.490***	2.712***
	(0.000)	(0.000)	(0.000)	(0.000)
CEO vega	0.249***	0.222***	0.249***	0.222***
	(0.000)	(0.000)	(0.000)	(0.000)
CEO delta	–0.0158	0.124**	–0.0217	0.116**
	(0.840)	(0.016)	(0.782)	(0.025)
Firm size	–0.383**	–0.460***	–0.399**	–0.456***
	(0.023)	(0.000)	(0.018)	(0.000)
Financial leverage	–2.640***	–5.061***	–2.635***	–5.071***
	(0.000)	(0.000)	(0.000)	(0.000)

Table 3. (Continued)

Panel B				
	(1)	(2)	(3)	(4)
Firm age	–1.039**	0.0881	–1.061**	0.0905
	(0.034)	(0.364)	(0.031)	(0.348)
Stock return	0.664***	0.657***	0.669***	0.660***
	(0.000)	(0.000)	(0.000)	(0.000)
Stock volatility	–17.30**	–53.93***	–17.28**	–53.81***
	(0.015)	(0.000)	(0.014)	(0.000)
Free cash flows	0.0825	0.369	0.0781	0.355
	(0.847)	(0.446)	(0.854)	(0.461)
Research and development	0.325	0.374**	0.318	0.381***
	(0.389)	(0.011)	(0.398)	(0.010)
Tax status	–0.0665	–0.316***	–0.0666	–0.315***
	(0.608)	(0.007)	(0.609)	(0.007)
Liquidity	–0.224	–0.625**	–0.233	–0.628**
	(0.379)	(0.030)	(0.359)	(0.028)
Market to book	0.00517	0.0195**	0.00531	0.0192**
	(0.354)	(0.023)	(0.348)	(0.022)
Intercept	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	No	Yes	No
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	No	Yes	No	Yes
Observations	4,647	4,927	4,647	4,927
Adjusted R-squared	0.567	0.304	0.567	0.307

Note: Panel A presents parameter estimates from the probit model used to estimate propensity scores for CEOs in the treatment and control groups. The dependent variable is one if the CEO-year belongs to the treatment group, and zero otherwise. The treatment group includes all firms with overconfident CEOs. We match firms using one-to-one nearest-neighbour propensity score matching (PSM) with replacement. The covariate matrix used for the matching is based on the following characteristics: CEO ownership, CEO tenure, CEO age, CEO vega, CEO delta, firm size, financial leverage, firm age, stock return, stock volatility, free cash flows, research and development, tax status, liquidity and market to book. Year fixed effects and industry fixed effects (based on Fama–French 48 industries classification dummies) are included in both columns in Panel A. Panel B presents the effect of overconfident CEOs on inside debt for the matched sample. The independent variables are lagged by 1 year. Models (1) and (3) use firm and year fixed effects; models (2) and (4) include industry and year fixed effects. All variable definitions are provided in the Appendix. The p-values reported in parentheses below the coefficients are based on standard errors that are adjusted for heteroscedasticity and clustered at firm level.
*, ** and *** depict the level of significance at 10%, 5% and 1%, respectively.

Finally, we also combine dividend policy and the size–age index to classify firms as both internally and externally financially unconstrained (i.e. firms that *both* pay dividends and their size–age index is below the sample median in year t). Theoretically, this is the most relevant measure of financial constraint status because the overconfidence-induced agency cost-of-debt problem should become more intense when the firm is both internally and externally financially unconstrained.

Table 4 reports the PSM second-stage results of the main analysis by financial constraint status, in the spirit of model (3) in Panel B of Table 3. Consistent with H2, the results show a positive relation between overconfident CEOs and inside debt incentives among financially unconstrained firms ($p < 0.05$), regardless of whether the firm is internally or internally and externally financially unconstrained. In contrast, there is no significant relation between overconfident CEOs and inside debt incentives, either among internally or among internally and externally financially constrained firms.

In summary, these results confirm the optimal contracting hypothesis, and are consistent with the view that shareholders use inside debt incentives as a compensation mechanism to alleviate debtholder concerns.

equity market; (c) a measure that is specific to constrained firms attempting to access the debt market; and (d) an analogous measure specific to private placements of equity. The results remain qualitatively similar when we use any of the alternative measures of financial constraints.

Table 4. Overconfident CEOs and inside debt by financial constraint status

Financial constraint status				
	Internal		Internal + external	
	Constrained (1)	Unconstrained (2)	Constrained (3)	Unconstrained (4)
Overconfident (Holder 67)	0.183	0.319**	−0.0156	0.329**
	(0.435)	(0.022)	(0.959)	(0.012)
Intercept	Yes	Yes	Yes	Yes
Control variables of Table 3	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	1,230	3,313	875	3,694
Adjusted R-squared	0.767	0.642	0.775	0.652

Note: This table presents the PSM second-stage results for the relation between overconfident CEOs and inside debt by firm financial constraint status. We use two measures for a firm's financial constraint status: internal and internal + external. The firm is classified as internally financially constrained when it does not pay dividends in that year; the firm is classified as externally financially constrained when its size–age index is above the sample median in that year; the firm is classified as internally + externally financially constrained if it is financially constrained with both the dividends and size–age classifications. All variable definitions are provided in the Appendix. In the regressions we include the same control variables as those used in Table 3. All independent variables are lagged by 1 year. All models include firm and year fixed effects whose coefficients are suppressed. The p-values reported in parentheses below the coefficients are based on standard errors that are adjusted for heteroscedasticity and clustered at the firm level.
** depicts the level of significance at 5%.

Managerial power hypothesis: CEO overconfidence and CEO power

We measure CEOs' bargaining power using *CEO pay slice*. Bebchuk, Cremers and Peyer (2011) find that CEO pay slice is a useful tool to capture the relative importance of the CEO relative to other executives and to evaluate the CEO's ability to extract rents. It is defined as the fraction of the average compensation of the firm's top-five non-CEO executive team captured by the CEO.[13] We then create an indicator variable for whether the CEO's pay slice measure is above the median of all firms in that year to proxy for high CEO power.

Table 5 reports the PSM second-stage results of the main analysis by CEO power status. The results show a positive relation between overconfident CEOs and inside debt incentives only for firms with low-power CEOs. This result is consistent with the managerial power hypothesis (i.e. the effect concentrates only on firms with low CEO power as in such firms shareholders are more likely to impose optimal contracting), thus H3 is supported by the data.

Optimal contracting hypothesis versus managerial power hypothesis: The combined effect

Here we consider the optimal contracting and managerial power hypotheses simultaneously. Given that we have already shown that the impact of overconfident CEOs on inside debt is confined to financially unconstrained firms only, we investigate the role of CEO power for unconstrained firms. To do so, we use combinations of firms sorted *independently* by the level of financial constraints and CEO power status and focus on two subsamples: (i) financially unconstrained firms managed by CEOs with high power and (ii) financially unconstrained firms managed by CEOs with low power.[14] If both hypotheses

[13]Our results are qualitatively similar when measuring CEO pay slice as the fraction of the aggregate compensation of the firm's top-five non-CEO executive team that goes to the CEO. Additionally, our results remain similar when we use Top 25% to measure CEO bargaining power. Top 25% is an indicator that equals one if the CEO's total compensation is at the top 25% of the sample firms for that year, and zero otherwise (Humphery-Jenner *et al.*, 2016).

[14]Because internally and externally financially unconstrained is the most relevant measure of financial constraint status, the results of Table 6 are based on this measurement.

Table 5. Overconfident CEOs and inside debt by CEO power status

Dependent variable: log(CEO relative incentive ratio)		
	High power (1)	Low power (2)
Overconfident (Holder 67)	–0.0217	0.681***
	(0.890)	(0.001)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,906	1,804
Adjusted R-squared	0.746	0.812

Note: This table presents the PSM second-stage results for the relation between overconfident CEOs and inside debt by CEO power status. High CEO power is an indicator that equals one if the CEO's pay slice (as measured by the CEO's total compensation scaled by the average of the total compensation of the top-five highest remunerated non-CEO executives) is above the median of the sample firms for that year, and zero otherwise. All variable definitions are provided in the Appendix. In the regressions we include the same control variables as those used in Table 3. All independent variables are lagged by 1 year. All models include firm and year fixed effects whose coefficients are suppressed. The p-values reported in parentheses below the coefficients are based on standard errors that are adjusted for heteroscedasticity and clustered at firm level.
*** depicts the level of significance at 1%.

operate simultaneously, we would expect the relation between CEO overconfidence and inside debt incentives to prevail among financially unconstrained firms managed by CEOs with low power. These are firms which are likely to exhibit high CEO overconfidence-induced agency costs, implying that boards (which represent and act on behalf of shareholders) may increase inside debt incentives relatively easier because the CEOs have low power.

Table 6 reports the results of this analysis. Consistent with H4, we find that the positive relation between CEO overconfidence and inside debt incentives concentrates among financially unconstrained firms managed by CEOs with low power. These results are consistent with our theoretical perspective which predicts that in this subsample, the CEO overconfidence-induced agency cost-of-debt problem should be more pronounced.

Overall, the results indicate that both optimal contracting and managerial power hypotheses are in place and affect the relation between CEO overconfidence and inside debt incentives.

Table 6. Overconfident CEOs and inside debt by financial constraints and CEO power

Dependent variable: log(CEO relative incentive ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Overconfident (Holder 67)	0.144	0.717***
	(0.373)	(0.003)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,550	1,418
Adjusted R-squared	0.733	0.824

Note: This table presents the PSM second-stage results of OLS regressions for the relation between overconfident CEOs and inside debt by the combined effect of firm financial constraints and CEO power status. The firm is classified as internally + externally financially constrained if it is financially constrained with both the dividends and size–age classifications; otherwise, the firm is classified as unconstrained. High CEO power is an indicator that equals one if the CEO's pay slice (as measured by the CEO's total compensation scaled by the average of the total compensation of the top-five highest remunerated non-CEO executives) is above the median of the sample firms for that year, and zero otherwise. All variable definitions are provided in the Appendix. In the regressions we include the same control variables as those used in Table 3. All independent variables are lagged by 1 year. All models include firm and year fixed effects whose coefficients are suppressed. The p-values reported in parentheses below the coefficients are based on standard errors that are adjusted for heteroscedasticity and clustered at firm level.
*** depicts the level of significance at 1%.

Robustness tests

In this section, we perform additional analyses to evaluate the robustness of the results.

Alternative operationalization of CEO overconfidence

Theoretically, overconfidence may have both a time-invariant (i.e. stable cognitive disposition) and a time-varying (i.e. state-based) component. Our main analysis is based on a measure that classifies CEOs as overconfident, relying on a 'habitual' late option exercise behaviour; this measure likely captures a time-invariant overconfidence effect. We also explore for a potential time-varying overconfidence effect. Specifically, we focus on CEO awards which likely amplify overconfidence. If so, the CEO overconfidence-induced agency

cost-of-debt problem should be heightened, which would make the use of inside debt more essential. Because CEO awards are largely exogenous, this approach alleviates, to a great extent, endogeneity concerns, and is thus more suitable at identifying the overconfidence effect on inside debt. A disadvantage, however, is that the number of CEO awards is relatively small, which affects the power of the test.

As in Kubick and Lockhart (2017), we perform a diff-in-diff test based on CEO awards by interacting the 'post-award' variable with Overconfident CEOs. 'Post award' is a binary variable which takes the value one if the CEO receives an award *for all the years* after the award, and zero otherwise. Such diff-in-diff research design allows us to examine the impact of overconfident CEOs on inside debt by comparing the impact of overconfident CEOs on inside debt (i) before and after the award and (ii) relative to non-overconfident CEOs. We present the results in Table 7, Panel A. Regardless of the small number of awards, which makes this test empirically challenging, we find that overconfident CEOs who receive an award are more likely to receive more inside debt incentives.

In unreported analysis, we also perform a test on the parallel trends by using 4-year lag and lead variables. If reverse causality drives our results, we should observe an increasing trend in the inside debt of overconfident CEOs (who later got an award) before the CEO award. Such evidence would cast doubt on the validity of our empirical approach, as it would imply a violation of the parallel trends' assumption that the trends in the inside debt of treatment firms where CEOs get an award and control firms where CEOs do not get an award are parallel before the CEO award.

The key variables of interest are CEO award^{-4}, CEO award^{-3}, CEO award^{-2}, CEO award^{-1}, which equal one if the current year is respectively 4, 3, 2 and 1 years before a CEO award; CEO award^{0} is equal to one for the current year of the CEO award; CEO award^{+1}, CEO award^{+2}, CEO award^{+3} and CEO award^{+4} equal one if the current year is respectively 1, 2, 3 and 4 years after a CEO award, and zero otherwise.

We find that the coefficients on CEO award^{-4}, CEO award^{-3}, CEO award^{-2}, CEO award^{-1} and CEO award^{0} are all statistically insignificant. The only positive significant coefficient is CEO award^{+4}. Overall, these results show that CEOs who get an award experience an increase in their inside debt relative to that of the control group only after the CEO gets the award, *but not before*. Hence, reverse causality – or a violation of the parallel trends assumption – is less likely to explain our key result that an increase in CEO overconfidence leads firms to increase CEOs' inside debt. Additionally, it appears that CEO overconfidence takes time to be amplified due to an award, and this is the reason why inside debt seems necessary only 4 years after the award.[15]

Unobserved omitted variable bias

We also evaluate the robustness of our results to unobserved omitted variables bias using the coefficient stability approach of Oster (2019). A common method in the literature to assuage unobserved omitted variable bias concerns is to explore the sensitivity of the treatment effect to the addition of observable control variables. However, coefficient movements alone are not a sufficient statistic to determine omitted variable bias. To be an effective tool for diagnosis, we must observe how much of the variance in the outcome is explained by the inclusion of the control variable, or in other words, by how much the R^2 moves when that particular control is added. In this respect, Altonji, Elder and Taber (2005) propose a method which assumes that, if one could observe the full set of observable and unobservable characteristics, the outcome variance could be fully explained and the regression would have an R^2 of 1. Building on their method, Oster (2019) proposes a new approach for evaluating robustness to omitted variable bias based on the assumption that the relationship between

[15]To further mitigate concerns that our findings may be driven by omitted time-varying covariates, in unreported analysis we conduct a placebo test. Specifically, we randomly assign CEO award years to our sample CEOs during the sample period, which we consider as pseudo-CEO-award years, and run our baseline regressions. As in Bae *et al.* (2021), we repeat this process 1000 times generating a simulated distribution of the coefficients and t-statistics, under the null hypothesis that there is no CEO award effect on inside debt. If the increase in inside debt simply occurs as a result of unknown time-varying variables and is unrelated to CEO award effect, then we should expect to observe an increase in inside debt even in the placebo test. We find no change in inside debt from the placebo test. Therefore, our findings on inside debt increases following the CEO award are unlikely to be driven by omitted time-varying variables.

Table 7. Robustness tests

Panel A: CEO awards

	Basic (1)	Internal Unconstrained (2)	Internal + external Unconstrained (3)	Internal Low power (4)	Internal + external Low power (5)
Overconfident (Holder 67)	0.200	0.359	0.401	0.579	0.618
	(0.588)	(0.412)	(0.340)	(0.351)	(0.386)
Post award	–5.071***	–4.910***	–5.272***	–1.946***	–2.195***
	(0.000)	(0.000)	(0.000)	(0.006)	(0.003)
Overconfident (Holder 67) × Post award	7.883***	7.487***	7.592***	3.459*	2.864
	(0.000)	(0.000)	(0.000)	(0.085)	(0.137)
Intercept	Yes	Yes	Yes	Yes	Yes
Control variables of Table 3	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	2,755	1,950	2,192	990	779
Adjusted R-squared	0.713	0.667	0.685	0.807	0.795

Panel B: Oster's test – full sample

Treatment variable	Baseline effect [R^2] (1)	Controlled effect [R^2] (2)	Identified set (3)	Controlled confidence interval (4)	δ for $\beta = 0$ given R_{max} (5)	Reject null (6)
Overconfidence (Holder 67)	0.044*** [0.000]	0.225*** [0.725]	1.136, 0.225	0.064–0.387	11.546	Yes

Panel C: Oster's test – unconstrained firms

Treatment variable	Baseline effect [R^2] (1)	Controlled effect [R^2] (2)	Identified set (3)	Controlled confidence interval (4)	δ for $\beta = 0$ Given R_{max} (5)	Reject null (6)
Overconfidence (Holder 67)	–0.010*** [0.000]	0.261*** [0.722]	1.357, 0.261	0.087 to 0.436	2.900	Yes

Note: Panel A reports the second-stage PSM results considering firms in which CEOs received awards. In Panel A, model (1) focuses on the internally financially unconstrained group; model (2) focuses on the internally and externally financially unconstrained group; model (3) focuses on the low CEO power group under the internally financially unconstrained condition; model (4) focuses on the low CEO power group under the internally and externally financially unconstrained condition. Panels B and C present the robustness test for the treatment effect of overconfidence on inside debt following the coefficient stability approach of Oster (2019). Panel B presents the results for the full sample and Panel C for financially unconstrained firms. The baseline effect in column (1) includes only overconfidence, while the controlled effect in column (2) includes all controls from Table 3. The identified set in column (3) is bounded below by the estimated beta and above by the controlled beta, calculated based on R_{max} and $\delta = 1$. Column (4) gives the confidence interval for overconfidence. Column (5) shows the value of $\beta = 0$ given the value of R_{max} reported in column (2).

* and *** depict the level of significance at 10% and 1%, respectively.

the treatment and unobservable characteristics can be informed by the relationship between the treatment and observables. This is because unobserved omitted variables bias is proportional to coefficient movements if those movements are scaled by the change in R^2 when the observables are included. Based on these assumptions, one can estimate the effect of the omitted variables on the 'overconfident' coefficient and identify bounds of the bias-adjusted 'overconfident' coefficient.

We report the results for this analysis in Panels B and C of Table 7 for the full sample and for the sample with unconstrained firms, respectively. As recommended by Oster (2019), we assume that the omitted and the controlled variables have equal effect on treatment coefficient outcomes ($\delta = 1$), and that the addition of omitted variables can lead to a maximum R^2 (R_{max}) of 1.3 times the estimated R^2 in the controlled regression. The results show that potential omitted variables do not significantly affect our primary estimates, as the bias-adjusted 'overconfident' coefficient meets both robustness criteria of Oster (2019).

First, while the bias-adjusted overconfident coefficient (Panel B = 1.136 and Panel C = 1.357) is larger than our controlled coefficient in each panel (Panel B = 0.225 and Panel C = 0.261), the identified set displayed in column (3) does not include zero. Second, we observe that the changes in the adjusted coefficient generally fall within the 95% confidence interval of the estimated coefficients in the controlled regression as shown in column (4). Furthermore, our bound estimates for delta in column (5) show that unobservable variables would need to have a much higher effect than our observed variables on the outcome in order to bias our results. For instance, in Panel B, an unobservable would need to have over 11.546 times the effect of our observables on the outcome in order to bias the results. Assuming we have a good set of control variables, the likelihood of unobservable characteristics confounding our results is very unlikely.[16]

[16]Regardless of the extensive use by previous studies of Oster's (2019) method to address unobserved omitted variable bias, we acknowledge the criticism by De Luca, Magnus and Peracchi (2019) and perform another test for omitted variables bias as in Larcker and Rusticus (2010), Fu *et al.* (2012) and Karampatsas, Petmezas and Travlos (2014). That test is based on the impact threshold for a confounding variable (ITCV) approach. Our results (not reported for brevity) show that our estimates are unlikely to be affected by unobservable characteristics.

Non-random CEO–firm matching

Firm characteristics that correlate with inside debt incentives might also be correlated with characteristics that lead firms to appoint overconfident CEOs. Specifically, if such a firm attitude in rewarding CEOs is a time-invariant characteristic, then the inclusion of firm fixed effects alleviates such concern. It could, however, be that the firm attitude in rewarding CEOs is a time-varying characteristic and firms hire overconfident CEOs when they are about to reward more inside debt incentives. To deal with such reverse causality bias stemming from non-random CEO–firm matching due to latent time-varying firm characteristics, we follow the approach of Hirshleifer, Low and Teoh (2012) and Aktas, Louca and Petmezas (2019) and analyse subsamples where matching (i.e. self-selection) should be less severe. More precisely, given that firm characteristics vary over time, whereas overconfidence is arguably a persistent characteristic by nature (Malmendier and Tate, 2005), matching should be stronger for recently appointed CEOs. Thus, we re-examine the relation between CEO overconfidence and inside debt incentives using subsamples of CEOs with a certain level of tenure. We focus on the firm-year observations where CEO tenure is longer than 2 years.

Panel A of Table 8 reports the results. We find that the effect of CEO overconfidence on inside debt incentives remains positive and statistically significant ($p < 0.05$) among financially unconstrained firms managed by CEOs with low power. Particularly the fact that the coefficients of the main variable of interest keep similar economic magnitude to Table 3 mitigates the possibility that the positive effect of CEO overconfidence on inside debt incentives stems from endogenous selection of CEOs. These results reaffirm the robustness of our previous findings: (i) both optimal contracting and managerial power hypotheses are in place and affect the relation between CEO overconfidence and inside debt incentives and (ii) endogeneity stemming from non-random CEO–firm matching does not seem to be an issue.

Alternative explanations for late option exercising behaviour

In this section we investigate whether the results relate to CEO characteristics that correlate with

Table 8. Further robustness checks

Panel A: Non-random CEO–firm matching		
Dependent variable: log(CEO relative incentive ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Overconfident (Holder 67)	−0.0344	0.720**
	(–0.867)	(–0.022)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,163	965
Adjusted R-squared	0.719	0.616
Panel B: Removing volatility and vega		
Dependent variable: log(CEO relative incentive ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Overconfident (Holder 67)	0.128	0.715***
	(–0.451)	(–0.002)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,550	1,418
Adjusted R-squared	0.6	0.724
Panel C: Controlling for managerial ability		
Dependent variable: log(CEO relative incentive ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Overconfident (Holder 67)	0.172	0.731***
	(–0.316)	(–0.003)
Managerial ability	0.895	3.093**
	(–0.398)	(–0.012)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,376	1,087
Adjusted R-squared	0.583	0.775
Panel D: Alternative inside debt measurement		
Dependent variable: log(CEO to firm debt/equity ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Overconfident (Holder 67)	0.195	0.310**
	(−0.137)	(−0.033)

Table 8. (Continued)

Panel D: Alternative inside debt measurement		
Dependent variable: log(CEO to firm debt/equity ratio)		
	Unconstrained	
	High power (1)	Low power (2)
Intercept	Yes	Yes
Control variables of Table 3	Yes	Yes
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1,550	1,418
Adjusted R-squared	0.751	0.767

Note: This table presents the PSM second-stage robustness results for the analysis on non-random CEO–firm matching where we require CEO tenure to be greater than 2 years (in Panel A). In Panel B, we have excluded stock return volatility and vega. In Panel C, we have controlled for CEO managerial ability using the measure developed by Demerjian, Lev and McVay (2012). Panel D presents the results for the alternative inside debt measurement (i.e. log[CEO to firm debt/equity ratio]). All variable definitions are provided in the Appendix. In the regressions we include the same control variables as those used in Table 3. All independent variables are lagged by 1 year. All models include firm and year fixed effects whose coefficients are suppressed. The p-values reported in parentheses below the coefficients are based on standard errors that are adjusted for heteroscedasticity and clustered at the firm level.

** and *** depict the level of significance at 5% and 1%, respectively.

both late option exercising behaviour and inside debt incentives. Such characteristics include, for instance, risk tolerance and CEO ability. Specifically, more risk-tolerant CEOs may choose to delay the exercise of their options. In addition, they may implement riskier investment policies, which may benefit shareholders at the expense of debtholders. This implies that the relation between late option exercisers and inside debt incentives may capture, besides overconfidence, risk tolerance. Our main analysis includes firm risk (i.e. stock return volatility) and CEO risk-taking incentives (i.e. vega) which proxy for risk-taking, alleviating, at least partially, such concerns. Nevertheless, to further understand whether risk tolerance affects our results, we re-run the main analysis after excluding stock return volatility and vega. If our measure of overconfidence captures risk tolerance, we should observe a larger and more significant coefficient estimate. As shown in Panel B of Table 8, the results do not change materially,

attesting that risk tolerance is unlikely to drive the main results.[17]

Furthermore, more able CEOs may refrain from exercising options because they anticipate their firm to perform better in the future. If CEO ability relates to executive compensation and inside debt, then the results could simply reflect ability, instead of overconfidence. To preclude the possibility that the option-based measure of overconfidence captures ability, we include an additional control variable: the managerial ability index of Demerjian, Lev and McVay (2012), which captures managers' efficiency in generating revenues.[18] Panel C of Table 8 shows that the results remain qualitatively similar.

Alternative measure of inside debt

The main analysis was based on the CEO relative incentive ratio as a measure of inside debt. CEO to firm debt-to-equity ratio is also a common measure to capture CEO inside debt incentive (Cassell *et al.*, 2012; Phan, 2014). Therefore, we re-estimate the results using CEO to firm debt-to-equity ratio and report them in Panel D of Table 8. We find that the positive relation between overconfident CEOs and inside debt incentives is still concentrated on the financially unconstrainted firms that are managed by low-power CEOs.

Conclusions

This study fills a gap in the inside debt literature which assumes that CEOs are rational and considers two non-mutually exclusive hypotheses to study the relation between CEO overconfidence and inside debt incentives. The *optimal contracting hypothesis* is based on the notion that CEO overconfidence can become a source of the agency cost-of-debt problem, borne by shareholders; thus, shareholders may attempt to reduce the agency cost of debt by rewarding overconfident CEOs with more inside debt incentives. But this is not an easy task. According to the *managerial power hypothesis*, CEOs with high bargaining power have considerable influence on the design of compensation arrangements (e.g. Bebchuk and Fried, 2003). Overconfident CEOs perceive their firm as being undervalued, thus they may have preferences for relatively less inside debt incentives; that is because, unlike other components of compensation (e.g. stocks and options), inside debt's value does not increase when undervaluation ceases to exist. Therefore, under the managerial power hypothesis, the relation between CEO overconfidence and inside debt incentives should be negative.

We find that, on average, firms provide overconfident CEOs with more inside debt incentives; the results are more pronounced when firms are financially unconstrained and CEOs have low power. These findings are consistent with both the optimal contracting and managerial power hypotheses. Collectively, the results suggest that firms fine-tune inside debt to restrain CEO overconfidence, aiming to alleviate CEO overconfidence-induced agency cost of debt.

More broadly, the findings indicate that behavioural traits have important implications for corporate governance policies which attempt to align the interests among managers, shareholders and debtholders. More specifically, they have implications for the contracting relationships between firms and managers. This is an important area for future research because prior studies focus primarily on the 'dark side' (rather than the 'bright side') effects of CEO overconfidence on corporate policies. Our results offer insights on how sophisticated principals (the shareholders through the election of the board) can (partly) alleviate some of the 'dark side' effects of CEO overconfidence. Importantly, our results shed light on an unresolved puzzle: why do we consistently observe overconfident CEOs over time? By considering ex-post rewards to overconfident CEOs, our findings suggest that boards are likely to employ inside debt incentives as a mechanism to (partly) alleviate the negative effects of CEO overconfidence.

[17] In unreported analysis we have re-run the regressions after removing from the analysis CEO delta and CEO ownership which have a correlation of 20.9% and 10.8%, respectively, with CEO overconfidence obtaining similar results.

[18] This index is the regression residual from the estimation of firm efficiency. In particular, we divide total firm efficiency into firm efficiency and managerial ability by regressing total firm efficiency on six firm characteristics that affect firm efficiency: firm size, firm market share, cash availability, lifecycle, operational complexity and foreign operations. After removing the impact of firm-specific characteristics, the residual of total firm efficiency is the managerial ability.

References

Abadie, A., S. Athey, G. W. Imbens and J. Wooldridge (2017). 'When should you adjust standard errors for clustering?', NBER Working Paper w24003.

Ahmed, A. S. and S. Duellman (2013). 'Managerial overconfidence and accounting conservatism', *Journal of Accounting Research*, **51**, pp. 1–30.

Aktas, N., C. Louca and D. Petmezas (2019). 'CEO overconfidence and the value of corporate cash holdings', *Journal of Corporate Finance*, **54**, pp. 85–106.

Altonji, J. G., T. E. Elder and C. R. Taber (2005). 'An evaluation of instrumental variable strategies for estimating the effects of Catholic schooling', *Journal of Human Resources*, **40**, pp. 791–821.

Anderson, R., A. Duru and D. Reeb (2009). 'Founders, heirs, and corporate opacity in the United States', *Journal of Financial Economics*, **92**, pp. 205–222.

Anderson, R., D. Reeb and W. Zhao (2012). 'Family-controlled firms and informed trading: evidence from short sales', *Journal of Finance*, **67**, pp. 351–385.

Bae, K. H., S. El Ghoul, O. Guedhami and X. Zheng (2021). 'Board reforms and dividend policy: international evidence', *Journal of Financial and Quantitative Analysis*, **56**, pp. 1296–1320.

Banerjee, S., M. Humphery-Jenner, V. Nanda and M. Tham (2018). 'Executive overconfidence and securities class actions', *Journal of Financial and Quantitative Analysis*, **53**, pp. 2685–2719.

Bazerman, M. H. and M. A. Neale (1986). 'Heuristics in negotiation: limitations to effective dispute resolution'. In H. R. Arkes and K. R. Hammond (eds), *Judgment and Decision Making: An Interdisciplinary Reader*, pp. 311–321. Cambridge: Cambridge University Press.

Beatty, R. P. and E. J. Zajac (1994). 'Managerial incentives, monitoring, and risk bearing: a study of executive compensation, ownership, and board structure in initial public offerings', *Administrative Science Quarterly*, **39**, pp. 313–335.

Bebchuk, L. A., K. M. Cremers and U. C. Peyer (2011). 'The CEO pay slice', *Journal of Financial Economics*, **102**, pp. 199–221.

Bebchuk, L. A. and J. M. Fried (2003). 'Executive compensation as an agency problem', *Journal of Economic Perspectives*, **17**, pp. 71–92.

Berle, A. and G. Means (1932). *The Modern Corporation and Private Property*. New York: Commerce Clearing House.

Billett, M. T. and Y. Qian (2008). 'Are overconfident CEOs born or made? Evidence of self-attribution bias from frequent acquirers', *Management Science*, **54**, pp. 1037–1051.

Black, F. and M. Scholes (1973). 'The valuation of options and corporate liabilities', *Journal of Political Economy*, **81**, pp. 637–654.

Cadman, B. and L. Vincent (2015). 'The role of defined benefit pension plans in executive compensation', *European Accounting Review*, **24**, pp. 779–800.

Campbell, C. T., M. Gallmeyer, S. Johnson, J. Rutherford and B. W. Stanley (2011). 'CEO optimism and forced turnover', *Journal of Financial Economics*, **101**, pp. 695–712.

Campbell, T. C., N. Galpin and S. A. Johnson (2016). 'Optimal inside debt compensation and the value of equity and debt', *Journal of Financial Economics*, **119**, pp. 336–352.

Cassell, C. A., S. X. Huang, J. Manuel Sanchez and M. D. Stuart (2012). 'Seeking safety: the relation between CEO inside debt holdings and the riskiness of firm investment and financial policies', *Journal of Financial Economics*, **103**, pp. 588–610.

Cen, W. (2011). 'Essays on CEO inside debt', Thesis.

Chatterjee, A. and D. C. Hambrick (2007). 'It's all about me: Narcissistic chief executive officers and their effects on company strategy and performance', *Administrative Science Quarterly*, **52**, pp. 351–386.

Chen, G., C. Crossland and S. Luo (2015). 'Making the same mistake all over again: CEO overconfidence and corporate resistance to corrective feedback', *Strategic Management Journal*, **36**, pp. 1513–1535.

Dalton, D. R., M. A. Hitt, S. T. Certo and C. M. Dalton (2007). 'Chapter 1: the fundamental agency problem and its mitigation', *The Academy of Management Annals*, **1**, pp. 1–64.

De Luca, G., J. R. Magnus and F. Peracchi (2019). 'Comments on "Unobservable selection and coefficient stability: theory and evidence" and "Poorly measured confounders are more useful on the left than on the right', *Journal of Business and Economics Statistics*, **37**, pp. 217–222.

Demerjian, P., B. Lev and S. McVay (2012). 'Quantifying managerial ability: a new measure and validity tests', *Management Science*, **58**, pp. 1229–1248.

Denis, D. J. and V. Sibilkov (2010). 'Financial constraints, investment, and the value of cash holdings', *Review of Financial Studies*, **23**, pp. 247–269.

Deshmukh, S., A. M. Goel and K. M. Howe (2013). 'CEO overconfidence and dividend policy', *Journal of Financial Intermediation*, **22**, pp. 440–463.

Diamond, P. A. (1998). 'Optimal income taxation: an example with a U-shaped pattern of optimal marginal tax rates', *American Economic Review*, **88**, pp. 83–95.

Ding, R., M. Liu, Y. Wang and Z. Wu (2022). 'Can family involvement be a substitute for executive inside debt in lowering the cost of bank loans? A behavioral agency perspective', *Review of Corporate Finance*, **2**, forthcoming.

Doukas, J. A. and D. Petmezas (2007). 'Acquisitions, overconfident managers and self-attribution bias', *European Financial Management*, **13**, pp. 531–577.

Duchin, R., O. Ozbas and B. A. Sensoy (2010). 'Costly external finance, corporate investment, and the subprime mortgage credit crisis', *Journal of Financial Economics*, **97**, pp. 418–435.

Edmans, A. and Q. Liu (2011). 'Inside debt', *Review of Finance*, **15**, pp. 75–102.

Eisenhardt, K. M. (1989). 'Agency theory: an assessment and review', *The Academy of Management Review*, **14**, pp. 57–74.

Fama, E. F. (1980). 'Agency problems and the theory of the firm', *The Journal of Political Economy*, **88**, pp. 288–307.

Fazzari, S. M., R. G. Hubbard, B. C. Petersen, A. S. Blinder and J. M. Poterba (1988). 'Financing constraints and corporate investment', *Brookings Papers on Economic Activity*, **1**, pp. 141–206.

Finkelstein, S., D. C. Hambrick and A. A. Cannella (2009). *Strategic Leadership: Theory and Research on Executives, Top Management Teams, and Boards*. Oxford: Oxford University Press.

Flickinger, M., M. Wrage, A. Tuschke and R. Bresser (2016). 'How CEOs protect themselves against dismissal: a social status perspective', *Strategic Management Journal*, **37**, pp. 1107–1117.

Florackis, C., A. Kanas, A. Kostakis and S. Sainani (2020). 'Idiosyncratic risk, risk-taking incentives and the relation between managerial ownership and firm value', *European Journal of Operational Research*, **283**, pp. 748–766.

Fu, R., A. Kraft and H. Zhang (2012). 'Financial reporting frequency, information asymmetry, and the cost of equity', *Journal of Accounting and Economics*, **54**, pp. 132–149.

Galasso, A. and T. S. Simcoe (2011). 'CEO overconfidence and innovation', *Management Science*, **57**, pp. 1469–1484.

Goel, A. M. and A. V. Thakor (2008). 'Overconfidence, CEO selection, and corporate governance', *Journal of Finance*, **63**, pp. 2737–2784.

Graham, J. R., C. R. Harvey and M. Puri (2013). 'Managerial attitudes and corporate actions', *Journal of Financial Economics*, **109**, pp. 103–121.

Grinblatt, M. and M. Keloharju (2009). 'Sensation seeking, overconfidence, and trading activity', *The Journal of Finance*, **64**, pp. 549–578.

Grossman, Z. and D. Owens (2012). 'An unlucky feeling: overconfidence and noisy feedback', *Journal of Economic Behavior & Organization*, **84**, pp. 510–524.

Hadlock, C. J. and J. R. Pierce (2010). 'New evidence on measuring financial constraints: moving beyond the KZ Index', *Review of Financial Studies*, **23**, pp. 1909–1940.

Harrison, D. A. and M. A. Shaffer (1994). 'Comparative examinations of self-reports and perceived absenteeism norms: wading through Lake Wobegon', *Journal of Applied Psychology*, **79**, p. 240.

Hayward, M. L., W. R. Forster, S. D. Sarasvathy and and B. L. Fredrickson (2010). 'Beyond hubris: how highly confident entrepreneurs rebound to venture again', *Journal of Business Venturing*, **25**, pp. 569–578.

Hayward, M. L. and D. C. Hambrick (1997). 'Explaining the premiums paid for large acquisitions: evidence of CEO hubris', *Administrative Science Quarterly*, **42**, pp. 103–127.

Hill, A. D., D. A. Kern and M. A. White (2014). 'Are we overconfident in executive overconfidence research? An examination of the convergent and content validity of extant unobtrusive measures', *Journal of Business Research*, **67**, pp. 1414–1420.

Hirshleifer, D., A. Low and S. H. Teoh (2012). 'Are overconfident CEOs better innovators?', *Journal of Finance*, **67**, pp. 1457–1498.

Hirshleifer, D. and Y. Suh (1992). 'Risk, managerial effort, and project choice', *Journal of Financial Intermediation*, **2**, pp. 308–345.

Hoberg, G. and V. Maksimovic (2015). 'Redefining financial constraints: a text-based analysis', *The Review of Financial Studies*, **28**, pp. 1312–1352.

Holmström, B. (1979). 'Moral hazard and observability', *The Bell Journal of Economics*, **10**, pp. 74–91.

Hribar, P. and H. Yang (2016). 'CEO overconfidence and management forecasting', *Contemporary Accounting Research*, **33**, pp. 204–227.

Humphery-Jenner, M., L. L. Lisic, V. Nanda and S. D. Silveri (2016). 'Executive overconfidence and compensation structure', *Journal of Financial Economics*, **119**, pp. 533–558.

Jensen, M. C. and W. H. Meckling (1976). 'Theory of the firm: managerial behavior, agency costs and ownership structure', *Journal of Financial Economics*, **3**, pp. 305–360.

Kahneman, D. (2011). *Thinking, Fast and Slow*. New York: Macmillan.

Karampatsas, N., D. Petmezas and N. G. Travlos (2014). 'Credit ratings and the choice of payment method in mergers and acquisitions', *Journal of Corporate Finance*, **25**, pp. 474–493.

Klayman, J., J. B. Soll, C. González-Vallejo and S. Barlas (1999). 'Overconfidence: it depends on how, what, and whom you ask', *Organizational Behavior and Human Decision Processes*, **79**, pp. 216–247.

Kubick, T. R. and G. B. Lockhart (2017). 'Overconfidence, CEO awards, and corporate tax aggressiveness', *Journal of Business Finance & Accounting*, **44**, pp. 728–754.

Larcker, D. F. and T. O. Rusticus (2010). 'On the use of instrumental variables in accounting research', *Journal of Accounting and Economics*, **49**, pp. 186–205.

Larwood, L. and W. Whittaker (1977). 'Managerial myopia: self-serving biases in organizational planning', *Journal of Applied Psychology*, **62**, pp. 194–198.

Leary, M. R. (2007). 'Motivational and emotional aspects of the self', *Annual Review of Psychology*, **58**, pp. 317–344.

Lee, J. M., B. H. Hwang and H. Chen (2017). 'Are founder CEOs more overconfident than professional CEOs? Evidence from S&P 1500 companies', *Strategic Management Journal*, **38**, pp. 751–769.

Liu, Y., D. C. Mauer and Y. Zhang (2014). 'Firm cash holdings and CEO inside debt', *Journal of Banking and Finance*, **42**, pp. 83–100.

Louca, C., A. P. Petrou and A. Procopiou (2020). 'When does the board blame the CEO for poor firm performance? Extreme resource reallocation and the board's industry and CEO experience', *British Journal of Management*, **31**, pp. 505–524.

Malmendier, U. and G. Tate (2005). 'CEO overconfidence and corporate investment', *Journal of Finance*, **60**, pp. 2661–2700.

Malmendier, U. and G. Tate (2008). 'Who makes acquisitions? CEO overconfidence and the market's reaction', *Journal of Financial Economics*, **89**, pp. 20–43.

Malmendier, U. and G. Tate (2009). 'Superstar CEOs', *Quarterly Journal of Economics*, **124**, pp. 1593–1638.

Malmendier, U. and G. Tate (2015). 'Behavioral CEOs: the role of managerial overconfidence', *Journal of Economic Perspectives*, **29**, pp. 37–60.

Malmendier, U., G. Tate and J. Yan (2011). 'Overconfidence and early-life experiences: the effect of managerial traits on corporate financial policies', *Journal of Finance*, **66**, pp. 1687–1733.

March, J. G. and Z. Shapira (1987). 'Managerial perspectives on risk and risk taking', *Management Science*, **33**, pp. 1404–1418.

Martin, G. P., L. R. Gomez-Mejia and R. M. Wiseman (2013). 'Executive stock options as mixed gambles: revisiting the behavioual agency model', *Academy of Management Journal*, **56**, pp. 451–472.

Miller, D. T. and M. Ross (1975). 'Self-serving biases in the attribution of causality: fact or fiction?', *Psychological Bulletin*, **82**, pp. 213–225.

Moore, D. A. and P. J. Healy (2008). 'The trouble with overconfidence', *Psychological Review*, **115**, pp. 502–517.

Murphy, K. J. (1999). Executive compensation. In O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, vol. **3**, pp. 2485–2563. Amsterdam: North Holland.

Oster, E. (2019). 'Unobservable selection and coefficient stability: theory and evidence', *Journal of Business and Economics Statistics*, **37**, pp. 187–204.

Parrino, R. and M. S. Weisbach (1999). 'Measuring investment distortions arising from stockholder–bondholder conflicts', *Journal of Financial Economics*, **53**, pp. 3–42.

Pepper, A. and J. Gore (2015). 'Behavioral agency theory: new foundations for theorizing about executive compensation', *Journal of Management*, **41**, pp. 1045–1068.

Petersen, M. A. (2009). 'Estimating standard errors in finance panel data sets: comparing approaches', *Review of Financial Studies*, **22**, pp. 435–480.

Phan, H. (2014). 'Inside debt and mergers and acquisitions', *Journal of Financial and Quantitative Analysis*, **49**, pp. 1365–1401.

Phua, K., T. M. Tham and C. Wei (2018). 'Are overconfident CEOs better leaders? Evidence from stakeholder commitments', *Journal of Financial Economics*, **127**, pp. 519–545.

Schumacher, C. S. K. and W. Tang (2020). 'Biased interpretation of performance feedback: the role of CEO overconfidence', *Strategic Management Journal*, **41**, pp. 1139–1165.

Sundaram, R. and D. Yermack (2007). 'Pay me later: inside debt and its role in managerial compensation', *Journal of Finance*, **62**, pp. 1551–1588.

Svenson, O. (1981). 'Are we all less risky and more skillful than our fellow drivers?', *Acta Psychologica*, **47**, pp. 143–148.

Tang, Y., D. Z. Mack and G. Chen (2018). 'The differential effects of CEO narcissism and hubris on corporate social responsibility', *Strategic Management Journal*, **39**, pp. 1370–1387.

Taylor, S. E. and J. D. Brown (1994). 'Positive illusions and well-being revisited: separating fact from fiction', *Psychological Bulletin*, **116**, pp. 21–27.

Wei, C. and D. Yermack (2011). 'Investor reactions to CEOs' inside debt incentives', *Review of Financial Studies*, **24**, pp. 3813–3840.

Wiersema, M. F. and Y. Zhang (2011). 'CEO dismissal: the role of investment analysts', *Strategic Management Journal*, **32**, pp. 1161–1182.

Wiseman, R. M. and L. R. Gomez-Mejia (1998). 'A behavioral agency model of managerial risk taking', *Academy of Management Review*, **23**, pp. 133–153.

Wowak, A. J., D. C. Hambrick and A. D. Henderson (2011). 'Do CEOs encounter within-tenure settling up? A multiperiod perspective executive pay and dismissal', *Academy of Management Journal*, **54**, pp. 719–739.

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Supporting Information

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