TWO ESSAYS ON CEO OVERCONFIDENCE IN RELATION TO SPEED OF ADJUSTMENT OF FIRM FINANCIAL POLICY AND CEO INSIDE DEBT

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ABSTRACT

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This dissertation is a thorough examination of CEO overconfidence, and consists of two essays.

The first essay focuses on the relationship between CEO overconfidence and the adjustment speed of firm financial policy. No research has examined the relationship between CEO overconfidence and firm financial policies adjustment speed. Previous studies focus solely on the adjustment speed of leverage, we are motivated to examine the adjustment of firm leverage and the adjustment of cash holdings together because there is evidence that firm leverage and firm liquidity are related. We find that CEO overconfidence places an important role in adjusting firm leverage and cash. Specifically, overconfident CEOs speed up (slow down) the adjustment of firm leverage when it is above (below) target leverage. In addition, overconfident CEOs speed up (slow down) the adjustment of firm cash holding when it is below (above) the estimated target. Consistent with the prediction of Acharya et al. (2007), our analysis suggests that cash and reduced leverage serve different purposes in the eyes of overconfident CEOs. Specifically, we find evidence that overconfident CEOs of financially constrained firms that have high (low) hedging needs hoard cash (reduce debt).

Although extensive research has been carried out to find the optimal inside debt ratio, no study has examined the association between deviations from the optimal inside debt ratio and the firm's risk taking behavior. The second essay is to fill out the gap, try to find out what is the effect of Inside debt deviation on risk-taking activities of firms with overconfident CEOs. The second essay is the first paper to examine the effects of deviations of inside debt and CEO overconfidence on firm value. Our results show that positive deviations of inside debt mitigate the risk taking behaviors of firms with overconfident CEOs. We find that CEO overconfidence is negatively related to firm leverage. This result indicates that overconfident CEOs will decrease firm leverage under both positive and negative deviations in inside debt. However, we do find that the amount of the decrease is smaller when the inside debt deviation is negative. we find that overconfident CEOs tend to lower firm cash levels. We also find that if a CEO's inside debt is above the target level, the

amount of the decrease is smaller. However, the results are nonsignificant. We confirm the positive relation between deviations from the target inside debt level and firm value. Our results also show that CEO overconfidence has a positive effect on firm value. This positive effect is more significant for positive deviations of inside debt than for negative deviations.

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DEDICATION

This dissertation is dedicated to my wife, Zoe Chen, to my mom, to my uncle, and to my lovely American family members: Edwina and Martin Morgan, Kurnia Foe and The Global Student Friends Organization, for without their love and support, I never would have become who I am and where I am today.

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CHAPTER 1

ESSAY 1: CEO OVERCONFIDENCE AND ADJUSTMENT SPEEDS OF CASH AND LEVERAGE: EVIDENCE ON CASH IS NOT NEGATIVE DEBT

1. Introduction

A growing body of research suggests that a considerable percentage of top corporate executives exhibit symptoms of overconfidence in their decisions (Baker, Ruback, and Wurgler, 2012; Ben-David, Graham, and Harvey, 2013). Some studies find evidence implying that CEO overconfidence is undesirable for the firm because overconfident managers are associated with corporate investment distortions (Malmendier and Tate, 2005), value-destroying mergers (Malmendier and Tate, 2008), or excess entry in a market (Camerer and Lovallo, 1999). Other studies report findings suggesting that CEO overconfidence is beneficial to the firm because overconfident CEOs are associated with higher levels of firm innovation (Hirshleifer, Low and Teoh, 2012) and greater effectiveness in leading the firm in facing external shocks (Galasso and Simcoe, 2010).

Prior studies have largely focused on the effect of CEO overconfidence on firm investment activity and few have examined the relation between CEO overconfidence and corporate financial policies (Hackbarth, 2008; Malmendier, Tate, and Yan, 2011). Understanding corporate financial policies is a major challenge for financial economists. Despite distinct approaches such as agency cost or market imperfections have contributed to explaining a significant portion of the observed variation in the debt-equity choice of the firm, there is evidence that conventional theories cannot fully explain firm-specific persistence in corporate financial policy (Lemmon, Roberts, and Zender, 2008). Some researchers suggest that the behavioral bias of managers may be related to

the remaining variation in the firm's financial decision making (Malmendier et al., 2011; Ben-David et al., 2013).

A recent strand of research on corporate financial policy examines the speed of adjustment (SOA) of the firm's capital structure (Hovakimian et al., 2001; Flannery and Rangan, 2006; Oztekin and Flannery, 2012; Devos et al., 2017). It has been generally argued that capital structure decisions are dynamic and firms make periodic adjustments to achieve optimal leverage. Results of existing studies largely point to the adjustment process as a rational decision determined by careful evaluations of costs and benefits. Given the growing evidence of the association between CEO overconfidence and corporate financial decision making (Hackbarth, 2008; Malmendier et al., 2011), we expand the current research to examine the relation between CEO overconfidence and the adjustment speed of firm leverage. Unlike prior studies that focus solely on the adjustment speed of firm leverage, we also examine the relation between CEO overconfidence and the adjustment speed of the firm's cash holdings. We are motivated to examine the adjustment of firm leverage and the adjustment of cash holdings together because there is evidence that firm leverage and firm liquidity are related (Opler et al., 1999, Bates et al., 2009). Examining the SOA of leverage without also examining the SOA of cash is thus incomplete. In addition, a number of researchers argue that cash and (negative) debt are substitutable (Kim et al., 1998; Baskin, 1987; John, 1993). This line of research further stresses the importance to examine the SOA of leverage and the SOA of cash together as the two may be related.

We find a number of important results in this study. First, our results show highly overconfident CEOs speed up (slow down) the adjustment speed of cash if the firm's cash holding is below (above) the optimal balance. Second, highly overconfident CEOs speed up (slow down) the adjustment speed of firm leverage if the firm's leverage is above (below) target leverage. Third,

the results suggest that low overconfidence CEOs are conservative relative to highly overconfident CEOs in adjusting firm leverage and firm cash holding. Fourth, we find evidence suggesting that the tendency of highly overconfident CEOs to hoard cash and reduce debt is not a manifestation of the cash is equal to negative debt phenomenon. Based on the prediction of prior studies (Acharya et al., 2007), our results imply that overconfident CEOs treat cash and negative debt differently as if the two serve different purposes in investment activity in the face of uncertainty. Specifically, we find that overconfident CEOs of financially constrained firms that have high (low) hedging needs tend to hoard cash (reduce debt). While our results support earlier hypotheses (Malmendier et al., 2011) that overconfident CEOs prefer internal funds over external financing and the CEOs exhibit debt conservatism, our results may also be explainable by overconfident CEOs' resentment of the monitoring imposed by shareholders or debtholders. That is, several aspects of the personality traits of overconfident CEOs, instead of merely the tendency to overestimate their ability and underestimate risk, may be affecting the firm's financial policy.

Our study contributes to the strand of literature on the adjustment speed of leverage by showing the importance of investigating the adjustment speed of cash simultaneously. Our results imply that the adjustment of leverage and the adjustment of cash are related, given the fact that prior studies have considerable evidence that leverage is one of the determinants of firm cash holdings. Our investigation adds to the literature by showing that CEO overconfidence is associated with the adjustment speeds of cash and leverage. Our study is also related to the literature on cash and debt(negative) substitutability. We provide evidence supporting the view of Acharya et al. (2007) that cash is not negative debt. Despite our results are consistent with the opinion of Malmendier et al. (2011) that overconfident CEOs prefer internal funds over external financing and the CEOs also exhibit debt conservatism, our results further suggest that adjustments

of firm leverage and cash are also related to the personality traits of overconfident CEOs that their debt decisions may also reflect their strong dislike of monitoring imposed by lenders.

The remainder of the paper is structured as follows. We review the related literature and present our empirical hypotheses in section 2. Section 3 describes key variable construction and the sample Section 4 presents the analysis and discusses the results. Section 5 summarizes and concludes the paper.

2.1. Related literature

2.1.1. CEO overconfidence

One commonly observed finding in the psychology literature is that people tend to be overconfident (e.g., Kidd, 1970; Moore, 1977). Financial economists find that CEOs are no exception to this rule (Malmendier and Tate, 2005 & 2008; Ben-David et al., 2013). In addition, it has been argued that overconfident managers are more likely to become CEOs (Goel and Thakor, 2008). Researchers have largely concluded that overconfident CEOs tend to overestimate their ability (Braumeister, 1998; Gervais et al. 2009, and Goel and Thakor 2008) and underestimate the riskiness of future cash flows (Hackbarth, 2008).

The behavioral literature has evidence that overconfident persons enjoy control (Stotz and Nitzsch, 2005). Overconfident individuals tend to have enormous pride and there is a substantial literature highlighting the egos of business executives (Hiller and Hamrick, 2005; Roll, 1986). In addition, it has been found that overconfident individuals are prone to have a self-importance bias and they tend to disregard the opinion of others (Miller and Ross, 1975). Collectively, the above suggests that overconfident CEOs are strong-willed individuals who dislike being interfered.

A survey of CFO Outlook conducted by Graham and Harvey (2001) provides evidence of a direct role for managerial overconfidence in financing decisions. According to the survey, prior to the end of the technology bubble of 2000, 70% of senior executives considered their company stock undervalued and 67% said that misvaluation was an important factor in the decision to alter firm leverage. However, conflicting empirical results on the relation between CEO overconfidence and firm financial policy have been reported in prior studies. Malmendier et al. (2011) examine the effects of CEO overconfidence on corporate financial policies. The authors find that overconfident CEOs issue less equity in financing decisions and prefer internal financing because they perceive the cost of external funds excessively expensive. Malmendier et al. argue that overconfident CEOs can lead to debt levels that are too low relative to available tax benefits. In addition, they find that overconfident CEOs have a marginally significant association with higher leverage only when the firm has a financing deficit.[1] Consistent with Malmendier et al. (2011), Atkas et al. (2019) find that firms with overconfident CEOs avoid external financing as it is perceived to be relatively more expensive, and rely more on internal funds to finance their investment opportunities. In contrast, Ben-David et al. (2013) find that overconfident managers use more debt because they overestimate the firm's ability to meet its debt obligations, and are less likely to pay dividends and more likely to buy back shares. The authors also report that overconfident managers tend to prefer long-term debt over short-term instruments. However, Huang et al. (2016) find that overconfident CEOs tend to adopt a shorter debt maturity structure by using a higher proportion of short-term debt and that this behavior of overconfident CEOs is not deterred by the high liquidity risk associated with such a financing strategy.

[1] The amount raised through debt or equity issues to cover expenditures (Malmendier et al. (2011), page 1697).

2.1.2. Speed of adjustment of firm leverage

Traditional trade-off theory suggests that there exists an optimal capital structure that maximizes firm value and therefore, firms adjust their debt levels to their optimal levels when deviations occur. Survey evidence supports this notion as 81% of firm CFOs claim to have a target range for debt-equity ratio (Graham and Harvey, 2001). The earlier work seeking to determine the speed of adjustment of firm leverage generally assumes a smooth optimal adjustment mechanism over the adjustment period. Later studies argue that there are several costs (security issuance cost and/or opportunity cost) and/or firm characteristics that may affect the speed at which firms move towards their target leverage, making the capital structure adjustment dynamic in nature (Korajczyk and Levy 2003; Shivadasani and Stefanescu 2010; Faulkender et al., 2012). It has been suggested that firms can only partially adjust toward their target leverage due to firm-specific characteristics such as firm size, liquidity, cash flow, distance between observed and target leverage, profitability, tangibility, and growth opportunities (Faulkender et al., 2008; Mukherjee and Mahakud, 2010). Recent studies suggest that macroeconomic factors (Cook and Tang, 2010; Drobetz et al., 2015; Antzoulatos et al., 2016) and country-level institutional factors (Elsas and Florysiak 2011; Öztekin and Flannery 2012; An, Li, and Yu 2015; Öztekin 2015) are also related to the speed of adjustment of firm leverage. It is generally argued that a firm will adjust its leverage ratio only if the benefits outweigh the adjustment costs, and the adjustment speed is lower when adjustment costs are higher.

Speed of adjustment estimations for leverage differ significantly across prior studies despite researchers commonly concur that leverage exhibits mean reversion. For example, Fama & French (2002) report SOA between 7% and 15% for dividend payers versus non-dividend payers. Flannery & Rangan (2006) estimate an SOA of 35.5% per year, with a half-life of 1.6

years. It has been argued that the different estimation results are likely related to the different methodologies employed. For example, Flannery & Rangan (2006) use fixed effects models while Lemmon, Roberts, & Zender (2008) use the GMM regression technique.

Expanding the literature on the relation between CEO overconfidence and firm financial policy, we argue that the adjustment speed of firm leverage is associated with CEO overconfidence. Given the conflicting empirical evidence in the literature that overconfident CEOs use more debt (Ben-David et al., 2013) and exhibit debt conservatism (Malmendier et al., 2011; Atkas et al., 2019), we develop a pair of competing hypotheses. The first hypothesis is developed based on the argument of Ben-David et al. (2013) whereas the second hypothesis is based on the argument of Malmendier et al. (2011).

Hypothesis 1: CEO overconfidence is positively (negatively) associated with the adjustment speed of firm leverage if the firm's debt ratio is below (above) the estimated target.

Hypothesis 2: CEO overconfidence is positively (negatively) associated with the adjustment speed of firm leverage if the firm's debt ratio is above (below) the estimated target.

2.2 Firm cash holdings and speed of adjustment

The median cash ratio of firms in the US increased from 5.5% in 1980 to 13.3% in 2006 (Bates et al., 2009). In the beginning of 2013, the S&P 500 firms held a total of $1.2 trillion in cash, more than the GDP of Mexico and South Korea added together. Researchers have documented significant evidence that large corporate cash stockpiles are associated with heightened agency problems (Jensen, 1986; Dittmar et al., 2007; Harford et al., 2008). Cash stockpiles could draw unwanted attention from activist shareholders. For example, investor Carl

Icahn accumulated $1.5 billion of the shares of Apple Inc. in 2013 and pressed the firm to buy back more shares.

Firms hold cash for transaction cost motives (Kim, Mauer & Sherman, 1998) and precautionary motives (Opler et al., 1999), among other reasons. Strong liquidity enables firms to have strategic advantages in the face of product market competition (Fresard, 2011). He and Wintoki (2016) find that firms with strong cash positions are associated with higher levels of research and development. Holding cash is not costless. Opler et al. (1999) point out that firms incur opportunity costs in holding cash. Excess cash holdings can lead to declines in firm value as agency problems escalate (Jensen, 1986; Dittmar and Mahrt-Smith, 2007; Harford et al., 2008). Thus, an optimal cash level exists when the costs and benefits of holding cash are balanced. Cash holding models have included firm leverage as one of the factors that are associated with the optimal level of cash holdings (Opler et al., 1999; Bates, Kahle, & Stulz, 2009), suggesting that corporate liquidity policy is related to firm leverage. It is thus reasonable that adjustments of firm leverage are related to adjustments of firm cash holding. Examining the SOA of leverage without considering the SOA of cash is therefore incomplete.

The literature on the relation between CEO overconfidence and firm cash holdings is relatively scant and indirect. Malmendier and Tate (2008) find that overconfident CEOs prefer cash and debt financing for acquisition activity. Malmendier et al. (2011) suggest that overconfident CEOs prefer internal funds to external financing as they consider external funds expensive. Ferris et al. (2013) provide evidence that overconfident CEOs use more cash to finance acquisitions than non-overconfident CEOs. Direct evidence of an association between managerial confidence and firm cash holdings is reported by Huang-Meier et al. (2016). Their results show find that optimistic managers are reluctant to use external funds and the managers hoard cash for

growth opportunities and save more cash in adverse conditions. Recently, Atkins et al. (2019) investigate the relation between CEO overconfidence and the value of cash. They find that cash holding is more valuable for firms with overconfident CEOs as the CEOs may underinvest given their tendency to view external financing as unduly costly. Collectively, the above studies suggest a positive relation between firm cash holdings and CEO overconfidence. As a result, we develop the following hypotheses

Hypothesis 3: CEO overconfidence is positively (negatively) associated with the adjustment speed of cash holding if the firm's cash level is below (above) the estimated target.

3. Key variables

3.1 Measuring CEO overconfidence

The extant literature identifies overconfident CEOs as those who deliberately over-expose their personal wealth to the idiosyncratic risk of their firms (Lambert, Larcker, and Verrecchia, 1991; Hall and Murphy, 2002). We follow Malmendier and Tate (2005, 2008) and define a CEO as overconfident once he postpones exercising vested options that are at least 67% in the money. The 67% threshold is based on a calculation of Hall and Murphy (2002) that suggests that a failure to exercise an option that is 67% in the money implies a constant relative risk-aversion of three. Given that there is no detailed information on CEO options holdings and the exercise price of each granted option, we follow prior studies (Campbell et al., 2009; Hirshleifer et al., 2012) in calculating an average moneyness of the CEO's option portfolio for each year. First, for each CEO-year, the average realizable value per option is calculated by dividing the total realizable value of the options by the number of options held by the CEO. The strike price is calculated as the fiscal year end stock price minus the average realizable value. The average moneyness of the options is

equal to the stock price divided by the estimated strike price minus 1. In these computations, only the vested options are included. CEO overconfidence is represented by a (0,1) dummy variable that has a value of one if the CEO is identified as overconfident, and is zero otherwise. Similar to Hirshleifer et al. (2012), the overconfidence measure of a CEO remains unchanged over the sample period because the personality trait is considered persistent. Malmendier, Tate, and Yan (2011) show that this measure of overconfidence works well after controlling for past stock return performance. In addition, Campbell et al. (2011) show that this measure of overconfidence generates results similar to those in Malmendier and Tate (2005).

3.2 Measuring SOA of firm leverage

We follow prior studies and begin by estimating the target capital structure of a firm (Flannery and Rangan, 2006; Byoun, 2008; Faulkender et al., 2012, Devos et al., 2017). Specifically, target leverage is estimated using the following equation.

$$Lev^*_{i,t+1}=\beta X_{i,t}+\varepsilon_{i,t} \qquad (1)$$

where Lev* is the estimated target leverage ratio of the firm, X is a vector of firm and industry characteristics that are included in the regressions to estimate the target. The firm characteristics include profitability (EBIT/TA), growth opportunities (MB), nondebt tax shield (Dep/TA), firm size (LnTA), asset tangibility (FA/TA), research and development expenditures (R&D/TA), and industry median leverage. Variable definitions are given in Appendix A.

In the next step, the following equation (equation (2)) is used to estimate the speed at which a firm makes partial adjustments towards its target within each period.

$$Lev_{i,t+1}-Lev_{i,t} = \lambda\,(Lev^*_{i,t+1}-Lev_{i,t})+\varepsilon_{i,t+1} \qquad (2)$$

where Lev_{t+1} represents a firm's market leverage ratio (Flannery et al. 2006) at time *t+1*, Lev_t represents the firm's market leverage ratio at time *t*, (Lev*$_{t+1}$−Lev_t) represents the deviation from target leverage, and λ is the average annual leverage adjustment speed to the target. In our empirical analysis, we examine leverage deviations, *LevDev*, and CEO overconfidence, *ConfidenceDummy* (i.e., a dummy variable that equals one if the CEO is overconfident and zero otherwise), as an interaction variable.

In a frictionless environment where information asymmetries, transaction costs, and other adjustment costs and/or benefits are absent, firms would always maintain their target leverage by making rapid adjustments to the debt ratio. In other words, in a perfect environment, the difference between the current and the previous period's observed capital structure should be the same as the difference between target capital structure and the pervious period's capital structure. Thus, Lev_{t+1}−Lev_t should be equal to Lev*$_{t+1}$−Lev_t. However, in the presence of adjustment costs and/or benefits, Lev is not necessarily the same as Lev*. Firms may not fully adjust their capital structure to the target capital structure. Deviations from the target leverage may be adjusted partially.

3.3 Measuring SOA of cash holdings

Similar to the estimation of leverage adjustment speed, we start by estimating the firm's target cash holding.

$$Cash^*_{i,t+1}=\alpha Y_{i,t}+\varepsilon_{i,t} \qquad (3)$$

where Cash* is the estimated target cash ratio, Y is a vector of firm and industry characteristics that are included in the regressions to estimate the target. We follow the existing literature (Opler et al., 1999; Bates et al., 2009) in choosing the Independent variables. Specifically, the Independent

variables include firm size, the Tobin's Q, industry cash flow volatility, cash flow, net working capital, capital expenditures, leverage ratio, R&D expenditures, a dividend dummy, acquisition, and firm age.

Then we follow the methodology of prior studies in estimating the adjustment speed of cash (Flannery and Rangan, 2006; Byoun, 2008; Faulkender et al., 2012; Devos et al., 2017).

$$Cash_{i,t+1} - Cash_{i,t} = \theta\,(Cash^*_{i,t+1} - Cash_{i,t}) + \varepsilon_{i,t+1} \qquad (4)$$

The estimation procedure entails estimating the target cash ratio in a first stage regression and then regressing the subsequent change in the cash ratio during a year against the deviation in the current cash ratio from the target ratio at the beginning of the year. In the model, $Cash_{t+1}$ represents a firm's cash ratio at time $t+1$, $Cash_t$ represents the firm's cash ratio at time t, $(Cash^*_{t+1} - Cash_t)$ measures the deviation from target cash, and θ is the average annual cash adjustment speed to the target cash.

3.4 Data and sample selection

To construct our sample, we use two datasets that are available from Wharton Research Data Services. We retrieve firm financial variables from Compustat, and we use Execucomp to obtain CEO-related information. The initial sample consists of the intersection of firms that are included in both databases. The sample period is between 1993 and 2017. We exclude ADRs, utility firms (SIC 4900-4999), and financial firms (SIC 6000-6999). We also delete observations with missing data on key variables (for example, cash/total assets). We winsorize all the key variables at the first and 99th percentiles. The final sample in this study consists of 2,731 firms, 5,570 CEOs, and a total observations of 29,580. Our sample size is comparable to prior studies on

CEO overconfidence. For example, Aktas et al. (2019) report a sample size of 12,105 firm-year observations between 1993-2013 in a study that examines the relation between CEO overconfidence and the value of firm cash holdings. Variable definitions are given in Appendix A.

4. Results

4.1 Sample descriptive statistics

Table 1 presents descriptive statistics of the sample. Included are the mean, median, standard deviation, and 25th and 75th percentiles. Average cash ratios of firms in the sample are consistent with those reported in the literature. The mean (median) cash/total assets ratio is 0.1017 (0.0680). The mean (median) cash/net assets is 0.1507 (0.0732), and the mean (median) cash/sales ratio is 0.2639 (0.0665). Regarding the measures of investment activity, the mean (median) capital expenditures (CAPEX_TA) is 0.0584 (0.0419), R&D/TA has a mean (median) of 0.0503 (0.0268). Book leverage has a mean of 0.2099 and a median of 0.0.1827.The firms in the sample are relatively large, with a mean (median) log(total assets) of 7.1430 (7.0207). Tobin's Q has a mean of 2.0303 and a median of 1.6056. Cash flow, measured as EBITDA/TA, has a mean (median) of 0.0823 (0.0864).

[Insert Table 1 about here]

4.2. Main results

4.2.1 SOA of leverage

To examine the relation between CEO overconfidence and the adjustment speed of leverage, we follow the methodology of prior studies (Byoun, 2008; Faullkender et al., 2012; Devos et al. , 2017) by adding an overconfidence dummy variable to the model. The advantage of

this procedure is that it is suitable for estimating interactive effects in adjustment speeds, which is what Byoun (2008) does in his model. The modified model has the following specification:

$$Lev_{i,t+1} - Lev_{i,t} = \propto_0 + \beta_1 LevDev + \beta_2 \text{Confidence}Dummy_{i,t} + \beta_3 LevDev \times \text{Confidence}Dummy_{i,t} + \varepsilon_{it} \quad (5)$$

LevDev is deviation from target leverage ($\text{Lev}^*_{t+1} - Lev_t$). The model examines partial adjustments of firm leverage towards its target within each period. We expect β_3 to be significantly different from zero if CEO overconfidence is associated with the adjustment speed (SOA) of leverage.

Table 2 reports regression results using equation (5). In Table 2, the result of model (1) shows that without considering the effect of CEO confidence, SOA of leverage is 21.35% per year. That is, firms close 21.35% of the gap between current and target leverage within one year. In other words, firms on average take 4.68 years to close deviations from target leverage. With the effect of CEO confidence taken into consideration, the result of model (2) shows that SOA of leverage is increased to 22.75% per year. The coefficient on LevDev*ConfidenceDummy is significant at the one percent level. The source of the increase in SOA of leverage, however, is associated with CEOs who are highly overconfident. As can be seen by comparing the results of models (3), (4), and (5), the SOA of leverage of firms with highly overconfident CEOs is 25.35% whereas the SOA of leverage of firms with low overconfidence CEOs is 21.20%. That is, highly overconfident CEOs significantly speed up the adjustment speed of leverage whereas low overconfidence CEOs marginally slow down the adjustment speed of leverage. The results imply that it takes an average of 3.94 (4.72) years for a high- (low-) overconfidence CEO to adjust the firm's leverage to its target. Economically, highly overconfident CEOs speed up SOA of leverage by 20.4% whereas low overconfidence CEOs slow down SOA of leverage by 0.35%. In

untabulated results (available from the authors), we observe consistent but slightly stronger findings when book leverage is used as the dependent variable.

The results in Table 2 are obtained following the methodology of prior studies that estimate target leverage and SOA of leverage in a two-step process. To confirm the robustness of our findings, we follow the approach of Jiang and Lie (2016) and Orlova and Rao (2018) which estimates target leverage and SOA of leverage simultaneously in one single step. The methodology of Jiang and Lie (2016) and Orlova and Rao (2018) is explained in Appendix B.

[Insert Table 2 about here]

Table 3 reports results of SOA of leverage estimated using the methodology of Jiang and Lie (2016) and Orlova and Rao (2018). Without considering the effect of CEO confidence, SOA of leverage is 24.33% in Model (1). With CEO confidence taken into consideration, Model (2) shows that SOA of leverage is increase moderately to 25.25%. Comparing the results of Models (3), (4), and (5), it can be seen that SOA of leverage is increased (reduced) to 28.91% (22.71%) when firms have high- (low-) overconfidence CEOs. The results are similar and consistent with the findings reported in Table 2.

[Insert Table 3 about here]

4.2.2 SOA of cash

Following the literature of adjustment speed of leverage (Flannery & Rangan, 2006; Byoun, 2008; Faulkender et al., 2012; Devos et al., 2017), an examination of the relation between CEO confidence and cash adjustment speed is relatively straightforward and a partial adjustment model has the following specification:

$$\text{Cash}_{i,t+1}-\text{Cash}_{i,t}=\propto_0+\gamma_1\text{Cash}Dev+\gamma_2\text{Confidence}Dummy_{i,t}+\gamma_3\text{Cash}Dev\times C\text{onfidenceD}ummy_{i,t}+\varepsilon_{it} \quad (6)$$

The adjustment process of cash is similar to the adjustment of leverage. Assuming that a target level of cash exists (Opler et al., 1999; Bates et al., 2009) and the objective of the firm is to maximize firm value, managers would want to maintain such an optimal cash level if doing so is costless. Firms with too much cash are likely to suffer significant agency problems. For example, excess cash enables entrenched managers to pursue unprofitable projects or even personal interests at the expense of the shareholders. On the contrary, a firm will be financially distressed if its inadequate cash holding disrupts the firm's daily operations and requires the firm to seek external funds when unexpected contingencies arise. In both cases, the manager will choose to rebalance cash, which implies an active cash adjustment (i.e. $\gamma_1>0$). However, in an imperfect capital market where adjustment costs are positive, firms may not fully adjust their cash holdings to the optimal level. Deviations from the target cash level may be adjusted partially as long as adjusting back to the target will bring about sufficiently large benefits that exceed the associated adjustment cost. In equation (6), we expect γ_3 to be significantly different from zero if the association between CEO confidence and SOA of cash is significant.

Table 4 reports regression results using equation (6). Without considering the effect of CEO confidence, the result of Model (1) shows that SOA of cash is 32.87%. That is, firms in the sample close 32.87% of the gap between target and actual cash within one year. In other words, an average firm takes 3.07 years to adjust deviations to the firm's optimal cash level. With the effect of CEO confidence taken into consideration, the result of Model (2) shows that SOA of cash is increased to 38.62%. That is, the time of cash adjustment is reduced from 3.07 years to 2.59 years. A comparison of the results of Models (3), (4), and (5) reveals that the decrease in the time

of cash adjustment is primarily driven by CEOs who are highly overconfident. When firms have highly overconfident CEOs, SOA of cash is 45.06%. When firms have low overconfidence CEOs, SOA of cash is 34.75%. That is, highly overconfident CEOs speed up SOA (reduce the adjustment time) of cash significantly whereas low overconfidence CEOs speed up SOA (reduce the adjustment time) of cash only marginally.

[Insert Table 4 about here]

In Table 5, we report results of cash adjustment speed using the methodology of Jiang and Lie (2016) and Orlova and Rao (2018). The result in Table 5 are similar and consistent with the results in Table 4. That is, highly overconfident CEOs are associated with a significantly higher cash SOA whereas low overconfidence CEOs are associated with a marginally higher cash SOA.

[Insert Table 5 about here]

4.2.3 Positive and negative deviations from the target

To garner supporting evidence for our hypotheses (H1 and H2), we examine the relation between CEO overconfidence and SOA of leverage (cash) by separating the sample into two, one for those with positive deviations (that is, the actual ratio is above target) and the other for those with negative deviations (the actual ratio is below target).

In Panel A of Table 6, the result shows that when actual leverage is higher than target leverage (i.e., positive deviations), overconfident CEOs increase SOA of leverage from 21.35% (the full sample in Table 2 before CEO confidence is considered) to 33.87%. SOA of leverage is marginally reduced to 20.49% when the actual leverage is below target (i.e., negative deviations). The results imply that overconfident CEOs rapidly speed up (slightly slow down) adjusting

leverage back down (up) to the target when firm leverage is above (below) target leverage. The findings strongly suggest that overconfident CEOs do not want high firm leverage. The finding is consistent with view of Melmendier et al. (2011) that CEO overconfidence is associated with debt conservatism. However, the observation is also consistent with the view that overconfident CEOs are strong-willed individuals who distain being interfered by debtholders (Stotz and Nitzsch, 2005; Hiller and Hamrick, 2005; Miller and Ross, 1975).

In panel B of Table 6, we focus our examination on the effect of highly overconfident CEOs only. The result in Panel B shows that highly overconfident CEOs speed up SOA of leverage from 21.35% (the full sample in Table 2 without considering CEO overconfidence) to 39.19% (27.96%) when the firm's leverage is above (below) target. The increase in SOA of leverage when deviations are positive is 44.6% higher than the increase in SOA of leverage when deviations are negative (coefficients of the interaction variable are 0.11428 and 0.07902, respectively). The finding implies a very strong tendency among highly overconfident CEOs to pare down firm debt.

In Panel C of Table 6, we focus on the influence of low overconfidence CEOs only. The result in Panel C shows that low overconfidence CEOs speed up (slow down) SOA of leverage to 29% (17.85%) when the firm's leverage is above (below) target. That is, low overconfidence CEOs also tend to keep firm leverage at a low level by making moderate adjustments. Given the fact that the CEOs have lower levels of overconfidence, thus it is reasonable to speculate that their tendency to avoid debt may be due to their conservativeness.

Collectively, the results in Table 6 suggest that SOA of firm leverage is associated with the confidence of the CEO. Highly overconfident CEOs want to quickly reduce debt likely because

they resent the monitoring imposed by lenders and/or they consider debt unduly expensive, whereas low overconfidence CEOs want to keep debt at a low level below the target likely because the CEOs are conservative and/or unsure of their ability.

[Insert Table 6 about here]

Next, we examine the association between CEO overconfidence and the adjustment speed of cash when there are positive (negative) deviations from the target. In Panel A of Table 7, the result shows that overconfident CEOs considerably slow down SOA of cash from 32.87% (the full sample in Table 4 before CEO confidence is considered) to 26.52% when the firm has positive cash deviations (that is, above the target cash holding). The change represents lengthening the adjustment period from 3.04 years to 3.77 years. For firms with negative cash deviations, overconfident CEOs increase SOA considerably from 32.87% to 51.46% (that is, shorten the adjustment time from 3.07 years to 1.94 years). The results in Panel A clearly imply overconfident CEOs like to have high cash levels. In short, overconfident CEOs tend to keep cash at an excess level and very rapidly revise the firm's cash holding upward if it is below the estimated target.

In panel B of Table 7, we focus on the relation between SOA of cash and highly overconfident CEOs only. The result in Panel B shows that highly overconfident CEOs slow down (speed up) SOA of cash from 32.87% (the full sample in Table 4 without considering CEO confidence) to 19.04% (61.20%) when the firm's cash level is above (below) target. These observations are consistent with the results reported in Panel A. That is, highly overconfident CEOs tend to hoard cash.

In Panel C of Table 7, we focus on the relation between SOA of cash and low overconfidence CEOs only. The result in Panel C shows that low overconfidence CEOs slow down (speed up) SOA of cash from 32.87% to 27.85% (44.02%) when the firm's cash holding is above

(below) target. The changes in the adjustment speed of cash, however, are considerably smaller when compared with highly overconfident CEOs. Collectively, the results of Table 7 highlight that CEO overconfidence has a large impact on the adjustment speed of cash holdings.

[Insert Table 7 about here]

4.3 Is cash negative debt?

Up to this point, our results on SOAs of leverage and cash suggest that overconfident CEOs hoard cash and reduce leverage. While the findings are consistent with the argument of Malmendier et al. (2012) that overconfident CEOs prefer internal financing over external funds and that overconfident CEOs exhibit debt conservatism because they consider external financing too expensive, our results are also consistent with the view that cash and (negative) debt are substitutable (Kim et al., 1998; Baskin, 1987; John, 1993).

The literature has provided significant evidence that corporate cash holding and firm leverage are related (Opler et al., 1999; Bates et al., 2009), making it difficult to rule out that firms regard cash as negative debt. Kim et al. (1998) document that the optimal investment in liquidity is increasing in the cost of external financing. Baskin (1987) argues that as the firm's debt ratio increases, the cost of funds used to invest in liquidity increases thereby reducing funded liquidity. John (1993) postulates that firms with access to debt markets—as proxied by the debt ratio—can use borrowing as a substitute for maintaining a stock of liquid assets.

Acharya et al. (2007), however, argue that cash is not the same as negative debt. They argue that cash and negative debt perform different functions in the optimization of investment under uncertainty. According to Acharya et al., financially constrained firms prefer hoarding cash (rather than reducing debt) if investment opportunities tend to arrive in low cash flow states (that is, when hedging needs are high). Holding cash transfers resources from high cash flow states to

low cash flow states, permitting financially constrained firms to engage investment opportunities that arise in low cash flow states. In contrast, if hedging needs are low, constrained firms are better off reducing debt (save debt capacity) because it helps transfer resources into future states with high cash flows and allows the constrained firm to borrow more when investment needs arise.

To confirm that our findings regarding the relation between CEO overconfidence and the respective adjustment speed of leverage and cash are not confounded by cash-debt substitutability, we follow the methodology of Acharya et al. (2007) and explore how overconfident CEOs handle cash and leverage when the firm is financially constrained (unconstrained). Specifically, we first examine the cash flow sensitivity of cash and the cash flow sensitivity of debt of firms with overconfident (non-overconfident) CEOs without taking into consideration the hedging needs of the firm. Then we repeat the analysis by dividing the sample into firms with high (low) hedging needs. Following Acharya et al. (2007), the following 3SLS system equations are used:

$$\Delta Debt_{i,t} = a0 + a1CashFlow_{i,t} + a2Q_{i,t} + a3Size_{i,t} + a4\Delta Cash_{i,t} + a5Debt_{i,t} + \text{fixed effects} + \varepsilon_{i.t} \quad (7)$$

$$\Delta Cash_{i,t} = b0 + b1CashFlow_{i,t} + b2Q_{i,t} + b3Size_{i,t} + b4\Delta Debt_{i,t} + b5Casht_{i,t} + \text{fixed effects} + \varepsilon_{i.t} \quad (8)$$

In the model, ΔDebt is the ratio of the net long-term debt issuances to total assets, and ΔCash is the ratio of change in cash and cash equivalent assets to total assets. a1 estimates the cash flow sensitivity of debt and b1 estimates the cash flow sensitivity of cash. The estimation controls for firm and year fixed effects. If overconfident CEOs consider cash not the same as negative debt, we expect cash flow sensitivity of debt (a1) and cash flow sensitivity of cash (b1) to behave according to the arguments of Acharya et al (2007).

In Table 8, without considering the hedging needs of the firm, overconfident and non-overconfident CEOs behave largely similarly in that they both hoard cash and reduce debt (increase debt capacity) to enable constrained firms to engage new investment opportunities. This finding is consistent with the view of Acharya et al. (2007) that firms hoard cash and reduce debt to engage investment opportunities that arise in the future. Overconfident CEOs appear comparable to non-overconfident CEOs in hoarding cash (0.1848*** vs 0.1628***) but are more aggressive in reducing firm leverage than non-overconfident CEOs (-0.2299*** vs -0.0894***). The finding suggests that overconfident CEOs either want to prepare for aggressive future investment plans or that they have a personal bias against firm leverage. For unconstrained firms, non-overconfident CEOs increase cash holdings (0.1124***) while simultaneously reduce leverage (-0.0665***) but overconfident CEOs do not make significant changes to cash or debt. The results on unconstrained firms imply that non-overconfident CEOs are conservative and cautious whereas overconfident CEOs are confident of their ability to engage investment opportunities such that they do not need to prepare for financing (reserve debt capacity) in advance. In sum, the results in Table 8 suggest that CEOs manage liquidity and leverage of the firm to prepare for future investment opportunities.

[Insert Table 8 about here]

In Table 9, we report results using equations (7) and (8) with the firm's hedging needs taken into consideration. Here, if the argument of Acharya et al. (2007) that cash is not negative debt is correct, we would expect to see the results for constrained firms with high hedging needs different from the results for constrained firms with low hedging needs. Specifically, according to Acharya et al., constrained firms should hoard cash (reduce debt) when hedging needs are high (low). For unconstrained firms, they are predicted to reduce debt.

In Panel A of Table 9, we measure hedging needs of a firm by the correlation between the firm's cash flow and industry-median R&D expenditures (Acharya et al., 2007). A high (low) correlation implies low (high) hedging needs. The results in Panel A show that when hedging needs are high, constrained firms with non-overconfident CEOs increase cash holdings whereas constrained firms with overconfident CEOs increase cash holdings and reduce debt. Despite both types of CEOs increase cash as predicted by Acharya et al. (2007), the optimism (or overestimation) of overconfident CEOs regarding future investment needs is reflected by the significantly larger increases in cash holdings relative to non-overconfident CEOs (0.4159 vs 0.2818). Reducing debt while hoarding cash at the same time suggest that overconfident CEOs are very optimistic about investment opportunities in the future that they want to also reserve debt capacity. Thus, while there is some evidence in Panel A supporting the argument of Acharya et al. (2007) that cash is not negative debt, the decision of overconfident CEOs to hoard cash and reduce debt appears to be also affected by the personality traits of the CEOs. That is, the inclination to reduce debt when the firm is constrained may imply that overconfident CEOs resent the monitoring imposed by lenders. When hedging needs are low, overconfident CEOs of constrained firms act as predicted by Acharya et al. (2007) in reducing debt, but non-overconfident CEOs do not reduce debt. Contrary to predictions, both overconfident and non-overconfident CEOs of constrained firms increase cash holdings when hedging needs are low. The cash hoarding by overconfident CEOs may imply their overestimation of investment needs in the future. The cash hoarding by non-overconfident CEOs may be an indication of their cautiousness, echoing the cash hoarding of non-overconfident CEOs when the firm is not financially constrained (reported in Table 8). Thus, the results on firms with low hedging needs also show some evidence supporting that cash is not negative debt, despite they also imply the influence of the personality traits of the CEOs.

In Panel B of Table 9, we measure hedging needs of a firm by the correlation between the firm's cash flow and industry median 3-year-ahead sales growth (Acharya et al., 2007). A high (low) correlation implies low (high) hedging needs. The results of constrained firms with high hedging needs are largely consistent and similar to the results in Panel A. For firms with low hedging needs, only non-overconfident CEOs hoard cash, suggesting the cautiousness of the CEOs may be a factor related to the firm's liquidity decisions. In short, Table 9 provides some evidence supporting that cash is not negative debt among overconfident CEOs, however, the results also imply that the personality traits of CEOs also play a role in the financial decisions of the firm. Taken together with the results on SOAs of leverage and cash, it is reasonable to say that the relation between CEO confidence and SOAs of leverage and cash do not imply a manifestation of the view that cash is negative debt. In addition, the results imply that the decision of overconfident CEOs to adjust SOA slower (faster) when actual cash (leverage) is above target represent choices that are also likely influenced by the personality traits of CEOs.

[Insert Table 9 about here]

4.3.1 SOA and financial constraints

To incorporate the 'cash is not negative debt' argument of Acharya et al. (2007) in our investigation, we focus our attention on financially constrained firms because Acharya et al. predict constrained firms to act differently when facing high and low hedging needs. We divide our sample into subcategories according to CEO confidence, the firm's hedging needs, and whether the deviation from target is positive or negative.

In Panel A of Table 10, we report results on the relation between CEO overconfidence and the adjustment speed of cash of financially constrained firms that have high hedging needs

and negative deviations of cash. Based on the cash is not negative debt argument of Acharya et al. (2007), constrained firms are predicted to increase cash holdings instead of reducing debt if hedging needs are high. Comparing the results of Models (3), (4), and (5), it is observed that high overconfidence CEOs increase SOA of cash from 47.28% (2.12 years) to 65.29% (1.53 years). That is, highly overconfident CEOs of constrained firms that have high hedging needs and negative deviations of cash holdings adjust cash upward rapidly. Low overconfidence CEOs also increase SOA of cash but at a slower pace of 55.72%. The coefficient on CashDev*High overconfidence dummy is 0.2326 whereas the coefficient on CashDev*Low overconfidence dummy is 0.0952. That is, high overconfidence CEOs increase cash accumulations at a speed 2.44 times that of low overconfidence CEOs. The finding implies that high overconfidence CEOs act in a way consistent with the prediction of Acharya et al. (2007).

In Panel B of Table 10, we report results on the relation between CEO overconfidence and the adjustment speed of leverage of financially constrained firms that have high hedging needs and negative deviations of leverage. In this case, constrained firms are predicted not to make significant changes to firm leverage if hedging needs are high. Comparing the results of Models (3), (4), and (5), it is observed that high- (low-) overconfidence CEOs slow down (speed up) adjusting firm leverage if it is below the estimated target. Highly overconfident CEOs slow down SOA of leverage from 29.97% (3.36 year) to 7.19% (13.91 years). The considerable slow down suggests that highly overconfident CEOs are keen on maintaining the firm's leverage below target leverage. This is consistent with the view of Malmendier et al. (2011) that overconfident CEOs are associated with debt conservatism. On the other hand, Panel B shows that low overconfidence CEOs speed up SOA of leverage from 29.97% (3.36 years) to 43.17% (2.32 years). The result implies that low overconfidence CEOs want to increase leverage upward

towards the estimated target. Despite the results on SOA of leverage in Panel B are not consistent with the prediction of Acharya et al. (2007), the findings nevertheless show that reducing debt is frequently chosen by overconfident CEOs even when it is not predicted to happen. The results imply that debt conservatism, in addition to the expensive external financing argument of Malmendier at al. (2011), may be reflecting a behavior inherent in the personality trait of overconfident CEOs. Specifically, overconfident CEOs reduce firm leverage because they dislike the monitoring imposed by lenders.

[Insert Table 10 about here]

Next, we examine constrained firms that have low hedging needs. In Panel A of Table 11, we report results on the relation between CEO overconfidence and the adjustment speed of cash of financially constrained firms that have low hedging needs and negative deviations of cash. In this case, constrained firms are predicted to reduce debt instead of increasing cash holdings. Comparing the results of Models (3), (4), and (5), it is observed that high overconfidence CEOs increase SOA of cash from 49.14% (2.04 years) to 91.43%% (1.09 years). That is, highly overconfident CEOs of constrained firms that have low hedging needs and negative deviations of cash holdings adjust cash upward rapidly. Low overconfidence CEOs, on the other hand, slow down SOA of cash from 49.14% (2.04 years) to 29.77% (3.36 years). The results are inconsistent with the prediction of Acharya et al. (2007) but they imply a very strong tendency among highly overconfident CEOs to accumulate cash. It is consistent with the findings reported earlier in this study and implies that overconfident CEOs overestimate their ability and hoard cash for investment opportunities in the future.

In Panel B of Table 11, we report results on the relation between CEO overconfidence and the adjustment speed of leverage of financially constrained firms that have low hedging

needs and negative deviations of leverage. Constrained firms are predicted to reduce leverage in this case. Comparing the results of Models (3), (4), and (5), it is observed that high overconfidence CEOs slow down SOA of leverage from 44.26% (2.26 years) to 14.21% (7.04 years). The slow down implies highly overconfident CEOs want to keep firm leverage below target leverage. The observation is consistent with the prediction of Acharya et al. (2007). Low overconfidence CEOs, on the other hand, make a marginal increase in SOA of leverage from 44.26% to 45.19%, implying that low overconfidence CEOs want to adjust firm leverage upward.

Collectively, the results in Tables 10 and 11 provide support for the predictions of Acharya et al. (2007) that cash is not same as negative debt, but the results also point to the implication that the firm's financial decisions are also influenced by the personality traits of CEOs,[2] such as their dislike of being interfered.

[Insert Table 11 about here]

To make our investigation complete, we also examine financially unconstrained firms. For brevity sake, we only report the estimates of SOA of cash (leverage) in Table 12. According to Acharya et al. (2007), unconstrained firms are expected to reduce leverage instead of increasing cash holding. In Panel A of Table 12, comparing the results of Model (3), (4), and (5), it can be seen that highly overconfident CEOs of unconstrained firms with high hedging needs speed up significantly (marginally) the adjustment speed of leverage (cash) if firm leverage (cash) has positive deviations. That is, highly overconfident CEOs prefer reducing debt to hoarding cash when the firm is unconstrained. The finding is consistent with the prediction of

[2] Untabulated results based on constrained firms with positive deviations of cash or leverage are weaker and less consistent. They are available upon request.

Acharya et al. (2007). The results on unconstrained firms with low hedging needs, however, are not supportive of the prediction of Acharya et al. In Panel B of Table 12, comparing the results of Model (3), (4), and (5), the results show that highly overconfident CEOs of unconstrained firms with low hedging needs and negative deviations of leverage slow down SOA of leverage to keep firm leverage at a level below target but increase SOA of cash to bring cash level upwards. In sum, the results on unconstrained firms provide some mixed evidence supporting the view that cash is not same as negative debt. Nevertheless, the results also suggest the cash and leverage adjustment decisions of firms that have overconfident CEOs are confounded by other aspects of CEO overconfidence in addition to the tendency to overestimate their ability and the inclination to underestimate risk in the face of uncertainty.

[Insert Table 12]

5. Summary and conclusion

We investigate the relation between CEO overconfidence and the respective adjustment speed of firm leverage and cash. Unlike prior studies that focus on either the adjustment speed of leverage or cash, we argue that an investigation of the two together is important as the literature has significant evidence suggesting that firm leverage and cash holdings are related. Our results show that CEO overconfidence plays an important role in adjusting firm leverage and cash. Specifically, overconfident CEOs speed up (slow down) the adjustment of firm leverage when it is above (below) target leverage. In addition, overconfident CEOs speed up (slow down) the adjustment of firm cash holding when it is below (above) the estimated target. Our results remain robust upon using different methodologies to estimate adjustment speed. Our finding that overconfident CEOs hoard cash and reduce debt is consistent with the view of Malmendier et al. (2007) that overconfident CEOs prefer internal funds to eternal financing and the CEOs exhibit

debt conservatism. Despite our findings are also consistent with earlier studies that cash and negative debt are substitutable, our results do not represent a manifestation of the view that cash is same as negative debt. Consistent with the prediction of Acharya et al. (2007), our analysis suggests that cash and reduced leverage serve different purposes in the eyes of overconfident CEOs. Specifically, we find evidence that overconfident CEOs of financially constrained firms that have high (low) hedging needs hoard cash (reduce debt). That is, cash and negative debt serve different purposes for firm investment activity in the face on uncertainty. Our additional finding that overconfident CEOs reduce debt in unwarranted situations (that is, when financially constrained firms have high hedging needs), however, suggests that other aspects of the personality traits of overconfident CEOs may also play a role in the adjustment of firm leverage and cash. That is, the debt conservatism associated with overconfident CEOs may also reflect their resentment of the monitoring imposed by lenders, a personality trait inherent to strong-willed individuals who dislike being interfered.

Table 1 Descriptive Statistics

variable	N	mean	sd	p25	p50	p75
ch_at	22,972	0.1061	0.1158	0.0234	0.0685	0.1478
ch_nta	22,972	0.1477	0.2487	0.0239	0.0738	0.1739
ch_sale	22,972	0.1626	0.6942	0.0217	0.0675	0.1649
size	23,234	7.1625	1.5591	6.01778	7.0178	8.1989
TobinQ	23,234	1.9778	1.2060	1.2235	1.5958	2.2781
divdummy	23,234	0.5354	0.4988	0	1	1
rated	23,234	0.8678	0.3387	1	1	1
cashflow	21,831	0.0859	0.0958	0.0547	0.0878	0.1253
nwcap	22,409	0.1218	0.1740	0.0078	0.1056	0.2197
capex	23,093	0.0589	0.0570	0.0231	0.0427	0.0729
booklev	17,511	0.2015	0.1844	0.0144	0.1823	0.3205
rddummy	23,234	0.1228	0.3283	0	0	0
LEV	23,232	0.1992	0.2048	0.0239	0.1458	0.2993
MB	23,223	1.6687	1.2047	0.9102	1.3014	1.9928
BDR	23,232	0.2125	0.1795	0.0422	0.2001	0.3231
ebit_ta	21,832	0.0852	0.1130	0.0456	0.0930	0.1413
dep_at	23,233	0.0455	0.0263	0.0278	0.0406	0.0560
lnta	23,234	20.0859	1.5591	18.9413	19.9413	21.1225
rdta	14,561	0.0507	0.0638	0.0044	0.0256	0.0770

Table 2

	Dependent variable				
	$LEV_{t+1} - LEV_t$				
Independent variable	**Model 1**	**Model2**	**Model3**	**Model 4**	**Model 5**
LevDev	**0.2135 (<0.001)**	**0.2059 (<0.001)**	**0.2106 (<0.001)**	**0.2118 (<0.001)**	**0.2127 (<0.001)**
LevDev*Overconfidence dummy		**0.0215 (0.071)**			
Overconfidence Dummy		**0.0089 (<0.001)**			
LevDev*High overconfidence dummy			**0.0429 (0.045)**		
High overconfidence Dummy			**0.0110 (<0.001)**		
LevDev*Medium overconfidence dummy				**0.0168 (0.421)**	
Medium overconfidence dummy				**0.0062 (0.015)**	
LevDev*Low overconfidence dummy					**-0.0007 (0.965)**
Low overconfidence dummy					**0.0046 (0.027)**
Intercept	**0.0042**	**0.0011**	**0.0032**	**0.0035**	**0.0035**

	(<0.001)	**(0.001)**	**(<0.001)**	**(<0.001)**	**(<0.001)**
Speed of Adjustment	**21.35%**	**22.75%**	**25.35%**	**22.86%**	**21.20%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**15,647**	**15,647**	**15,647**	**15,647**	**15,647**
R-squared	**0.1201**	**0.1224**	**0.1215**	**0.1206**	**0.1204**

Table 3

	Dependent variable				
	$LEV_{t+1} - LEV_t$				
Independent variable	**Model 1**	**Model2**	**Model3**	**Model 4**	**Model 5**
LevDev	**0.2433 (<0.001)**	**0.2411 (<0.001)**	**0.2408 (<0.001)**	**0.2425 (<0.001)**	**0.2448 (<0.001)**
LevDev*Overconfidence dummy		**0.0114 (<0.001)**			
			0.0483		

LevDev*High overconfidence dummy			**(<0.001)**		
LevDev*Medium overconfidence dummy				**0.0144 (<0.001)**	
LevDev*Low overconfidence dummy					**-0.0177 (-0.911)**
Intercept	**0.0038 (0.02)**	**0.0036 (<0.001)**	**0.0037 (<0.001)**	**0.0037 (<0.001)**	**0.0038 (<0.001)**
Speed of Adjustment	**24.33%**	**25.25%**	**28.91%**	**25.69%**	**22.71%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**15,644**	**15,644**	**15,644**	**15,644**	**15,644**
R-squared	**0.1319**	**0.132**	**0.1332**	**0.1319**	**0.132**

Table 4

Independent variable	Dependent variable				
	$Cash/Assets_{t+1} – Cash/Assets_t$				
	Model 1	Model2	Model3	Model 4	Model 5
CashDev	0.3287 (<0.001)	0.2993 (<0.001)	0.3129 (<0.001)	0.3255 (<0.001)	0.3258 (<0.001)
CashDev*Overconfidence dummy		0.0869 (<0.001)			
Overconfidence dummy		-0.0079 (<0.001)			
CashDev*High overconfidence dummy			0.1376 (<0.001)		
High overconfidence dummy			-0.0089 (<0.001)		
CashDev*Medium overconfidence dummy				0.0371 (0.03)	
Medium overconfidence dummy				-0.0052 (<0.001)	
CashDev*Low overconfidence dummy					0.0217 (0.138)
Low overconfidence dummy					-0.0047 (<0.001)
Intercept	0.0007 (<0.001)	0.0031 (<0.001)	0.0015 (<0.001)	0.0012 (<0.001)	0.0014 (<0.001)

Speed of Adjustment	**32.87%**	**38.62%**	**45.06%**	**36.26%**	**34.75%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**18,701**	**18,701**	**18,701**	**18,701**	**18,701**
R-squared	**0.192**	**0.1972**	**0.1965**	**0.1926**	**0.1926**

Table 5

Independent variable	**Dependent variable**				
	$Cash/Assets_{t+1} – Cash/Assets_t$				
	Model 1	**Model2**	**Model3**	**Model 4**	**Model 5**
CashDev	**0.3287 (<0.001)**	**0.2999 (<0.001)**	**0.3131 (<0.001)**	**0.3255 (<0.001)**	**0.3259 (<0.001)**
CashDev*Overconfidence dummy		**0.0872 (<0.001)**			
			0.1441		

CashDev*High overconfidence dummy			**(<0.001)**		
CashDev*Medium overconfidence dummy				**0.0353 (-0.035)**	
CashDev*Low overconfidence dummy					**0.0216 (-0.21)**
Intercept	**0.0007 (<0.001)**	**0.0008 (<0.001)**	**0.0009 (<0.001)**	**0.0007 (<0.001)**	**0.0007 (<0.001)**
Speed of Adjustment	**32.87%**	**38.71%**	**45.72%**	**36.08%**	**34.75%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**18,701**	**18,701**	**18,701**	**18,701**	**18,701**
R-squared	**0.192**	**0.195**	**0.1956**	**0.1922**	**0.1921**

Table 6.

Panel A			**Panel B**			**Panel C**		
	Dependent variable			**Dependent variable**			**Dependent variable**	
	$LEV_{t+1} - LEV_t$			**$LEV_{t+1} - LEV_t$**			**$LEV_{t+1} - LEV_t$**	
Independent variable	**Positive deviations**	**Negative deviations**	**Independent variable**	**Positive deviations**	**Negative deviations**	**Independent variable**	**Positive deviations**	**Negative deviations**
LevDev	**0.2652**	**0.1970**	**LevDev**	**0.2777**	**0.2005**	**LevDev**	**0.2873**	**0.2051**
	(<0.001)	**(<0.001)**		**(<0.001)**	**(<0.001)**		**(<0.001)**	**(<0.001)**
LevDev* Overconf. dummy	**0.0734**	**0.0078**	**LevDev*High overconf. dummy**	**0.1143**	**0.0790**	**LevDev*Low overconf. dummy**	**0.0027**	**-0.0266**
	(0.003)	**(0.805)**		**(0.007)**	**(0.184)**		**(0.936)**	**(0.561)**
Overconf. dummy	**0.0026**	**0.0113**	**High overconf. dummy**	**0.0005**	**0.0194**	**Low overconf. dummy**	**0.0046**	**0.0032**
	(0.373)	**(0.01)**		**(0.92)**	**(0.009)**		**(0.223)**	**(0.6)**
Intercept	**-0.0055**	**0.0004**	**Intercept**	**-0.0043**	**0.0028**	**Intercept**	**-0.0051**	**0.0038**
	(<0.001)	**(0.853)**		**(0.003)**	**(0.156)**		**(0.004)**	**(0.067)**
Speed of Adjustment	**33.87%**	**20.49%**	**Speed of Adjustment**	**39.19%**	**27.96%**	**Speed of Adjustment**	**29.00%**	**17.85%**
Year Fixed Effect	**Yes**	**Yes**	**Year Fixed Effect**	**Yes**	**Yes**	**Year Fixed Effect**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Industry Fixed Effect**	**Yes**	**Yes**	**Industry Fixed Effect**	**Yes**	**Yes**

Observations	**9,399**	**6,248**	**Observations**	**9,399**	**6,248**	**Observations**	**9,399**	**6,248**
R-squared	**0.0659**	**0.0653**	**R-squared**	**0.0639**	**0.0647**	**R-squared**	**0.0619**	**0.0638**

Table 7.

Panel A			**Panel B**			**Panel C**		
	Dependent variable			**Dependent variable**			**Dependent variable**	
	$Cash/Assets_{t+1}$ –$Cash/Assets_t$			**$Cash/Assets_{t+1}$ – $Cash/Assets_t$**			**$Cash/Assets_{t+1}$ – $Cash/Assets_t$**	
Independent variable	**Positive deviations**	**Negative deviations**	**Independent variable**	**Positive deviations**	**Negative deviations**	**Independent variable**	**Positive deviations**	**Negative deviations**
CashDev	**0.2235**	**0.3806**	**CashDev**	**0.2388**	**0.4003**	**CashDev**	**0.2282**	**0.4278**
	(<0.001)	**(<0.001)**		**(<0.001)**	**(<0.001)**		**(<0.001)**	**(<0.001)**
CashDev*	**0.0417**	**0.1341**	**CashDevl***	**-0.0484**	**0.2116**	**CashDev***	**0.0503**	**0.0125**
Overconf. dummy	**(0.1)**	**(<0.001)**	**High overconf. dummy**	**(0.268)**	**(<0.001)**	**Low overconf. dummy**	**(0.16)**	**(0.678)**
Overconf. dummy	**-0.0064**	**0.0005**	**High overconf. dummy**	**0.0006**	**0.0067**	**Low overconf. dummy**	**-0.0069**	**-0.0048**
	(0.001)	**(0.871)**		**(0.875)**	**(0.204)**		**(0.008)**	**(0.235)**
Intercept	**0.0057**	**0.0134**	**Intercept**	**0.0038**	**0.0128**	**Intercept**	**0.0048**	**0.0147**
	(<0.001)	**(<0.001)**		**(<0.001)**	**(<0.001)**		**(<0.001)**	**(<0.001)**
Speed of Adjustment	**26.52%**	**51.46%**	**Speed of Adjustment**	**19.04%**	**61.20%**	**Speed of Adjustment**	**27.85%**	**44.02%**

Year Fixed Effect	**Yes**	**Yes**	**Year Fixed Effect**	**Yes**	**Yes**	**Year Fixed Effect**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Industry Fixed Effect**	**Yes**	**Yes**	**Industry Fixed Effect**	**Yes**	**Yes**
Observations	**11,305**	**7,414**	**Observations**	**11,305**	**7,414**	**Observations**	**11,305**	**7,414**
R-squared	**0.037**	**0.199**	**R-squared**	**0.0361**	**0.1986**	**R-squared**	**0.0366**	**0.1918**

Table 8

	Non-overconfident CEOs	Overconfident CEOs
1. Cashflow sensitivity of cash		
Constrained firms	0.1628***	0.1848***
Unconstrained firms	0.1124***	-0.1640
2. Cashflow sensitivity of debt		
Constrained firms	-0.0894***	-0.2299***
Unconstrained firms	-0.0665***	-0.0626

Table 9a. Hedging needs measured by the correlation between cash flow and R&D expenditures

	High hedging needs		Low hedging needs	
	Non-overconfident CEOs	Overconfident CEOs	Non-overconfident CEOs	Overconfident CEOs
1. Cashflow sensitivity of cash				
Constrained firms	0.2818***	0.4159**	0.1299**	0.2371***
Unconstrained firms	0.0367	-0.1292	0.1752**	-0.0514
2. Cashflow sensitivity of debt				
Constrained firms	-0.0164	-0.2659***	-0.0377	-0.2654**
Unconstrained firms	0.2248	0.1449	-0.0406	-0.1656

Table 9b. Hedging needs measured by the correlation between cash flow and sales growth

	High hedging needs		Low hedging needs	
	Non-overconfident CEOs	Overconfident CEOs	Non-overconfident CEOs	Overconfident CEOs
1. Cashflow sensitivity of cash				
Constrained firms	0.1911***	0.3393***	0.1119***	0.04776
Unconstrained firms	0.0960***	-0.0050	0.1221	-0.0624
2. Cashflow sensitivity of debt				
Constrained firms	-0.1221	-0.4263***	-0.0464	-0.0959
Unconstrained firms	-0.0146	-0.0163	-0.1843**	0.0643

Table 10 Panel A. Financially constrained firms with high hedging needs and negative deviations of cash

Independent variable	Dependent variable				
	$Cash/Assets_{t+1} - Cash/Assets_t$				
	Model 1	Model2	Model3	Model 4	Model 5
CashDev	0.4728 (<0.001)	0.4169 (<0.001)	0.42028 (<0.001)	0.4939 (<0.001)	0.4619 (<0.001)
CashDev*Overconfidence dummy		0.1254 (0.199)			
Overconfidence dummy		0.0032 (0.864)			
CashDev*High overconfidence dummy			0.2326 (0.054)		
High overconfidence dummy			0.0187 (0.475)		
CashDev*Medium overconfidence dummy				-0.2541 (0.148)	
Medium overconfidence dummy				-0.0252 (0.449)	
CashDev*Low overconfidence dummy					0.0953 (0.509)
Low overconfidence dummy					-0.0018 (0.943)
Intercept	0.0206 (0.022)	0.0188 (0.097)	0.0164 (0.089)	0.0226 (0.016)	0.0213 (0.03)

Speed of Adjustment	**47.28%**	**54.22%**	**65.29%**	**23.98%**	**55.72%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**356**	**356**	**356**	**356**	**356**
R-squared	**0.2151**	**0.2219**	**0.2262**	**0.2204**	**0.2177**

Table 10

Panel B. Financially constrained firms with high hedging needs and negative deviations of leverage

	Dependent variable				
	$LEV_{t+1} - LEV_t$				
Independent variable	**Model 1**	**Model2**	**Model3**	**Model 4**	**Model 5**
LevDev	**0.2997** **(<0.001)**	**0.3043** **(<0.001)**	**0.3027** **(<0.001)**	**0.3051** **(<0.001)**	**0.2959** **(<0.001)**
LevDev*Overconfidence dummy		**-0.0511** **(0.765)**			
Overconfidence Dummy		**-0.0042** **(0.846)**			
			-0.2308		

LevDev*High overconfidence dummy			**(0.478)**		
High overconfidence Dummy			**-0.0099** **(0.725)**		
LevDev*Medium overconfidence dummy				**-0.4792** **(0.251)**	
Medium overconfidence dummy				**-0.0302** **(0.452)**	
LevDev*Low overconfidence dummy					**0.1358** **(0.551)**
Low overconfidence dummy					**0.0057** **(0.854)**
Intercept	**0.0073** **(0.462)**	**0.0080** **(0.548)**	**0.0071** **(0.523)**	**0.0077** **(0.461)**	**0.0077** **(0.471)**
Speed of Adjustment	**29.97%**	**25.32%**	**7.19%**	**-17.41%**	**43.17%**
Year Fixed Effect **Industry Fixed Effect** **Observations** **R-squared**	**Yes** **Yes** **345** **0.1052**	**Yes** **Yes** **345** **0.1054**	**Yes** **Yes** **345** **0.1066**	**Yes** **Yes** **345** **0.1088**	**Yes** **Yes** **345** **0.1065**

Table 11 Panel A. Financially constrained firms with low hedging needs and negative deviations of cash

Independent variable	Dependent variable				
	$Cash/Assets_{t+1} – Cash/Assets_t$				
	Model 1	Model2	Model3	Model 4	Model 5
CashDev	0.4914 (<0.001)	0.5004 (<0.001)	0.4620 (<0.001)	0.4909 (<0.001)	0.5337 (<0.001)
CashDev*Overconfidence dummy		-0.0286 (0.814)			
Overconfidence dummy		-0.0444 (0.021)			
CashDev*High overconfidence dummy			0.4523 (0.053)		
High overconfidence dummy			0.0271 (0.431)		
CashDev*Medium overconfidence dummy				0.2297 (0.411)	
				-0.0363	

Medium overconfidence dummy				**(0.288)**	
CashDev*Low overconfidence dummy					**-0.2361 (0.099)**
Low overconfidence dummy					**-0.0566 (0.024)**
Intercept	**0.0248 (0.005)**	**0.0374 (<0.001)**	**0.0238 (0.009)**	**0.0279 (0.002)**	**0.0331 (0.001)**
Speed of Adjustment	**49.14%**	**47.18%**	**91.43%**	**72.06%**	**29.77%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**320**	**320**	**320**	**320**	**320**
R-squared	**0.1905**	**0.214**	**0.2037**	**0.2035**	**0.2035**

Table 11 Panel B. Financially constrained firms with low hedging needs and negative deviations of leverage

	Dependent variable				
	$LEV_{t+1} - LEV_t$				
Independent variable	**Model 1**	**Model2**	**Model3**	**Model 4**	**Model 5**
LevDev	**0.4426**	**0.4679**	**0.4534**	**0.4521**	**0.4432**

	(<0.001)	**(<0.001)**	**(<0.001)**	**(<0.001)**	**(<0.001)**
LevDev*Overconfidence dummy		**-0.2094** **(0.277)**			
Overconfidence Dummy		**-0.0346** **(0.209)**			
LevDev*High overconfidence dummy			**-0.3113** **(0.406)**		
High overconfidence Dummy			**-0.0516** **(0.266)**		
LevDev*Medium overconfidence dummy				**-0.3218** **(0.303)**	
Medium overconfidence dummy				**-0.0426** **(0.375)**	
LevDev*Low overconfidence dummy					**0.0087** **(0.977)**
Low overconfidence dummy					**-0.0015** **(0.97)**
Intercept	**0.0329** **(0.004)**	**0.0409** **(0.003)**	**0.0366** **(0.003)**	**0.0349** **(0.003)**	**0.0333** **(0.007)**

Speed of Adjustment	**44.26%**	**25.85%**	**14.21%**	**13.02%**	**45.19%**
Year Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Fixed Effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	**350**	**350**	**350**	**350**	**350**
R-squared	**0.1894**	**0.1932**	**0.1923**	**0.192**	**0.1894**

Table 12. Panel A. Financially unconstrained firms with positive deviations of leverage (cash)

High hedging needs	SOA Leverage	**26.33%**	**51.00%**	**89.76%**	**56.02%**	**38.13%**
	SOA Cash	**36.83%**	**32.97%**	**45.38%**	**39.93%**	**20.58%**
Low hedging needs	SOA Leverage	**26.13%**	**27.29%**	**10.17%**	**35.54%**	**27.99%**
	SOA Cash	**6.17%**	**18.51%**	**-39.68%**	**12.41%**	**45.43%**

Panel B: Financially unconstrained firms with negative deviations of leverage (cash)

High hedging needs	SOA Leverage	**6.51%**	**31.08%**	**80.03%**	**-11.15%**
	SOA Cash	**36.23%**	**54.02%**	**59.37%**	**53.16%**
Low hedging needs	SOA Leverage	**23.57%**	**21.85%**	**-15.74%**	**42.10%**
	SOA Cash	**34.07%**	**30.74%**	**61.29%**	**36.44%**

Appendix 1.A: Variable definitions

Ch_at: Cash scale by book value of total assets.

Ch_nta: cash scale by net total assets.

Ch_sale: cash scale by sales.

Size: natural log of book value of assets.

TobinQ: (book value of assets-book value of equity + market value of equity) scale by total assets.

Divdummy: Dividend dummy set to 1 if the company pays dividend otherwise zero.

Rated: rated dummy set to 1 if the company has public debt otherwise 0.

Cashflow: calculated as: EBITDA-interest-taxes- common dividends, and then scale by total assets.

Nwcap: net working capital is net working capital minus cash and marketable securities and then scale by

total assets.

Capex: capital expenditures scaled by total assets.

Booklev: total debt scale by total assets.

LEV: market debt ratio calculated by book value of debt/market value of asset.

BDR: book debt ratio: long-term debt+ short term debt and then scale by total assets.

MB: market to book ratio of assets: (book liabilities + market value of equity)/total assets.

Rddummy: R&D dummy set to one if firm did not report R&D expenses.

rdta: R&D expense scale by total assets.

Lnta: log of asset size, measured in 1983 dollars.

Dep-at: depreciation (Compustat item [14]) as a proportion of total assets

Overceo: overconfident CEO dummy set to one if CEO consider as overconfident.

Delaware: Delaware dummy set to one is the firm incorporated in Delaware otherwise 0.

After95: after 95 dummy set to one for firm years after 1995, and zero otherwise.

BCL: BCL dummy set to one if firm incorporated in a stat and in a year that business combination law has passed.

Appendix 1.B

Measuring SOA of firm leverage (cash) following the method of Jiang and Lie (2016) and Orlova and Rao (2018)

Jiang and Lie (2016) and Orlova and Rao (2018) use a different approach to estimate SOA in which the target cash (or leverage) and the partial adjustment process are estimated simultaneously. Using SOA of leverage for illustration, the following equation (equation (1)) is used to estimate the speed at which a firm makes partial adjustments towards its target within each period.

$$Lev_{i,t+1} - Lev_{i,t} = \lambda\,(Lev^*_{i,t+1} - Lev_{i,t}) + \varepsilon_{i,t+1} \qquad (1)$$

where Lev_{t+1} represents a firm's book leverage ratio at time $t+1$, Lev_t represents the firm's book leverage ratio at time t, $(Lev^*_{t+1} - Lev_t)$ represents the deviation from target leverage, and λ is the average annual leverage adjustment speed to the target.

$$Lev^*_{i,t+1} = \beta X_{i,t} + \varepsilon_{i,t} \qquad (2)$$

where Lev* is the estimated target leverage ratio of the firm, X is a vector of firm and industry characteristics that are included in the regressions to estimate the target. The firm characteristics include profitability (EBIT/TA), growth opportunities (MB), nondebt tax shield (Dep/TA), firm size (LnTA), asset tangibility (FA/TA), and research and development expenditures (R&D/TA). In addition, industry median leverage is added as another Independent variable following the literature (Flannery and Rangan, 2006) .

Substituting (2) into (1) and rearranging the terms yields:

$$Lev_{i,t+1} = (\lambda\beta)\, X_{i,t} + (1-\lambda)\, Lev_{i,t} + \delta_{i,\,t+1} \qquad (3)$$

$$\widehat{DevLev}_{i,\,t+1} = \widehat{Lev}^*_{i,t+1} - Lev_{i,t} \qquad (4)$$

Substituting equation (4) into equation (1) leads to an OLS regression model:

$$Lev_{i,t+1} - Lev_{i,t} = \lambda_{i,t+1}\,(\widehat{DevLev}_{i,\,t+1}) + \delta_{i,\,t+1} \qquad (5)$$

and

$$\lambda_{i,t+1} = \gamma_0 + \gamma_{i,t+1} Z_{i,t} \quad (6)$$

Substituting (6) into (5) leads to

$$Lev_{i,t+1} - Lev_{i,t} = (\gamma_0 + \gamma_{i,t+1} Z_{i,t})(\widehat{DevLev}_{i,t+1}) + \delta_{i,t+1} \quad (7)$$

where Z represents the variables that we hypothesize to have an impact on the adjustment speed of leverage. Following Oztekin and Flannery (2012), equation (7) is estimated using OLS regression. The model controls for firm and year fixed effects in the regression, and standard errors are clustered at the firm-level to control for potential heteroskedasticity.

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CHAPTER 2

ESSAY 2: CEO overconfidence and inside debt

1. Introduction

A strong relation between agency conflicts and top management incentives has been reported in the literature. Two well-known management incentives include equity-based compensation and debt-based compensation. Two well-recognized agency conflicts within the firm are the conflict between shareholders and the manager and the conflict between debtholders and the manager. The literature on agency conflicts is voluminous. While the early literature has concluded that equity-based compensation aligns the interests of managers and shareholders and thus mitigates the agency conflict between them, recent research finds that inside debt helps align the interests of managers and debtholders and thus alleviates the agency conflict between them. More recently, a growing body of literature is investigating the optimal chief executive officer (CEO) incentive ratio for mitigating the two types of agency conflicts at the same time.

Jensen and Meckling (1976) were among the first to state that inside equity compensation and inside debt compensation used together can alleviate shareholder–bondholder conflicts. They propose a straightforward general rule to solve agency problems, specifically that the firm should grant a manager inside debt and equity incentives so that the manager's ratio is similar to the firm's leverage ratio. In this situation, the manager will consider the interests of both shareholders and debtholders appropriately. If the manager's debt-to-equity ratio is below the firm's, then the manager has incentive to

benefit personally by promoting the interests of shareholders at the expense of debtholders.

Edmans and Liu (2011) develop a more complicated model regarding the optimal compensation contract for managers facing effort and investment choices. The authors point out that the CEO's optimal debt-to-equity ratio (inside debt divided by inside equity) can be greater or less than the firm's because of several factors. These factors include the relative importance of risk shifting, the firm value in solvency, and the firm value in bankruptcy. According to Edmans and Liu, the CEO's optimal inside debt-to-equity ratio is not necessarily equal to one. Freund, Latif, and Phan (2018) confirm this finding and state that the optimal inside debt ratio differs across firms.

Several recent studies have documented a negative relation between management inside debt holdings and firm risk taking behavior (Edmans and Liu, 2011; Phan, 2014; Bennett et al., 2015; Van Bekkum, 2016), because inside debt is an unsecured and unfunded form of firm debt and it aligns a firm's managers to the firm's debtholders. Thus CEOs holding inside debt are exposed to company default risk and have incentives to lower firm risk taking activity. Although extensive research has been carried out to find the optimal inside debt ratio, no study has examined the association between deviations from the optimal inside debt ratio and the firm's risk taking behavior. We intend to fill this void in this study.

We start our investigation by estimating the optimal CEO inside debt-to-equity ratio. By following the work of Campbell et al. (2016), we use firm and CEO characteristics to estimate the optimal CEO inside debt ratio. We then calculate the difference between the

actual and optimal inside debt levels. Next, we investigate the association between deviations from optimal inside debt and the firm's risk taking behavior.

In addition, a growing literature suggests that firm behavior is affected by CEO overconfidence. We expand our investigation to examine the effect of CEO overconfidence and CEO inside debt on firm risk taking behavior.

Our investigation makes several contributions to the literature. First, our study complements and extends the literature that investigates the effects of management incentives on corporate risk taking behavior. Our results show that firms change their risk taking behavior when inside debt deviates from the optimal level. Specifically, we find that the CEO will increase firm risk taking activities when the CEO's inside debt is below the optimal level (negative deviation). This finding is consistent with the results of Jensen and Meckling (1976) and Edmans and Liu (2011), who argue that CEOs with high inside debt display lower levels of risk taking. By using different proxies to measure firm risk taking behavior—namely, capital expenditures, research and development (R&D), and cash levels—we find consistent results, where a negative deviation of inside debt escalates the risk taking behavior of firms with overconfident CEOs. Our results also show that the firm's risk taking activity is moderated when the CEO's inside debt is above the target level. Our results are more pronounced when the CEO is categorized as overconfident.

Second, our study provides an important contribution to an emerging stream of empirical research by examining the association between CEO overconfidence and CEO inside debt. We find that, relative to rational CEOs, overconfident CEOs tend to be associated

with larger deviations from the optimal level of inside debt. Specifically, overconfident CEOs tend to hold less inside debt compared to rational CEOs.

Third, our investigation is the first paper to examine the effects of deviations of inside debt and CEO overconfidence on firm value. We find a positive relation between firm value and deviations from the target level of inside debt. More importantly, we find that overconfident CEOs will increase firm value when their inside debt is above the target level.

The remainder of the paper is organized as follows: Section 2 reviews the literature. Section 3 develops our hypotheses. Section 4 describes the sample, the measurement of the major variables, and the empirical design. Section 5 reports the result of our primary tests and robustness checks, and the final section concludes the paper.

2. Literature review

2.1 CEO inside debt and the optimal level of inside debt

According to Jensen and Meckling (1976), the separation of ownership and control causes managers to deviate from protecting shareholder interests to maximize their personal benefits. This situation leads to the first type of agency conflict: conflicts between managers and shareholders. Jensen and Meckling (1976) suggest firms add stock and stock options to a manager's compensation package to remedy this type of conflict. They argue that equity-based compensation will align the manager's and shareholders' interests. Despite equity- and option-based compensations driving managers to adopt corporate policies that protect shareholder interests, policies that benefit shareholders are frequently disadvantageous to debtholders. This situation thus leads to the second type of

agency conflict: conflicts between managers and debtholders. To remedy the second of agency conflict, Jensen and Meckling (1976) suggest firms add debt-based compensation to align the manager's and debtholders' interests. This mention is the first time that CEO inside debt appears in the corporate finance literature.

In short, to alleviate conflicts among managers, shareholders, and debtholders, Jensen and Meckling (1976) propose that the firm grant the manager inside debt and equity incentives simultaneously so that the manager's debt-to-equity ratio is the same as the firm's. John and John (1993) state that an optimal compensation package should be designed to eliminate both types of agency conflict.

Edmans and Liu (2011) argue that the CEO's optimal compensation ratio is not necessarily equal to the firm's debt-to-equity ratio. Specifically, to measure the incentive compensation package of managers, they introduce a ratio called the *CEO relative leverage* ratio, where the CEO's relative leverage is equal to his or her debt-to-equity ratio divided by the firm's debt-to-equity ratio. The authors predict that the optimal CEO relative leverage ratio varies with firm characteristics. Thus, this ratio is not always equal to one, as Jensen and Meckling propose. Consistent with the view of Edmans of Liu (2011), Freund, Latif, and Phan (2018) find similar results and argue that the optimal inside debt ratio differs across firms.

One of the potential limitations of the CEO relative leverage ratio, however, is that it is based on levels rather than changes in the value of debt and equity. As Wei and Yermack (2011) state,

> In a simple capital structure with only plain vanilla debt and equity, this distinction should be unimportant. However, managers tend to hold much of their equity in stock options that have finite expirations and convex slopes with respect to firm value, while much of the firm's equity takes the form of shares that have unlimited lives and linear slopes with respect to firm value. Moreover, the manager's inside debt may have a different duration than the debt securities issued externally by the firm.

Hence, Wei and Yermack introduce a new ratio called the *CEO relative incentive ratio*. This ratio estimates how a $1 increase in firm value affects the value of the CEO's inside debt compared to inside equity claims, divided by an estimate of how the value of the company's external debt versus external equity is affected by the same $1 change in firm value. The authors use the sum of the CEO's pension value and the total value of deferred compensation as the CEO's debt incentive. They measure CEO equity incentive as the delta of the CEO's shares of stock plus the delta of the CEO's option holdings.

Compared to Edmans and Liu (2011), Wei and Yermack (2011) include not only firm characteristics but also CEO characteristics to estimate the optimal inside debt-to-equity ratio. They suggest that their optimal relative incentive ratio explains better than the relative leverage ratio.

2.2 CEO inside debt and corporate risk taking

Diversified shareholders benefit from higher levels of firm risk, because shareholders receive large payoffs when risky investments perform well and bear only limited losses when these fail. Therefore, the addition of option-based compensation to managerial

compensation will encourage managers to increase firm risk. A considerable amount of literature has found that option-based compensation provides incentives to managers to increase corporate risk taking by changing the company's investment and financial policies (Guay, 1999; Rajgopal and Shevlin, 2002; Nam et al., 2003; Coles et al., 2006; Low, 2009; Sheikh, 2012).

On the other hand, debtholders receive only a fixed amount of payments when the firm succeeds in a risky project. If this risky project fails, debtholders will suffer substantial financial losses. Debtholders thus prefer conservative investment policies and lower levels of corporate risk, as well as conservative financial policies and lower levels of corporate debt. Because pension and deferred compensation (CEO inside debt) share the same characteristics with external debt, the value of the CEO's inside debt depends on the firm's likelihood of bankruptcy and the liquidation value of its assets (Edmans and Liu, 2011). It is well established in the literature that these characteristics of CEO inside debt motivate CEOs to reduce firm risk. Thus, inside debt aligns CEO interests with the interests of outside debtholders and leads to conservative investment and financial policies.

Jensen and Meckling introduced agency problems back in 1976. After that, researchers have extensively investigated inside equity and its implications. Because data on CEO inside debt became available only after 2006, few studies have examined the effect of CEO inside debt.

Sundaram and Yermack (2007) are among the earliest to have examined CEO inside debt. They employ CEO pension benefits to measure inside debt because of the lack of

deferred compensation data. Their results show that CEO inside debt holdings are negatively related to the firm's default risk, which induces CEOs to manage their firms conservatively. Similarly, Cheng and Warfield (2005) state that inside equity imposes firm risk on the CEO; therefore, inside debt creates personally risk-averse CEOs. Gerakos (2007) finds inside debt to be positively related to the firm's credit rating and negatively related to default risk. Wei and Yermack (2011) indicate that the disclosure of sizable inside debt positions will lead to an escalation in bond price and a reduction in equity volatility. They suggest that inside debt indicates a reduction in corporate risk.

Cassell et al. (2012) directly examine the effect of CEO inside debt on firm risk. They find a negative relation between CEO inside debt and the volatility of future stock returns, R&D expenditures, and financial leverage. They also find a positive relation between CEO inside debt and the extent of diversification and asset liquidity. For some industries, such as the insurance industry, Milldonis et al. (2019) find a negative relation between CEO inside debt and risk taking behavior. Phan (2014) indicates that, when CEOs have high levels of inside debt, they undertake mergers and acquisitions that will benefit bondholders, but at the cost of stockholders. Srivastav et al. (2018) find similar results. They examine the influence of inside debt on bank risk taking behaviors and find that CEOs with high inside debt like to engage in acquisitions that transfer wealth from stockholders to bondholders.

Collectively, the above research provides evidence that CEO inside debt negatively affects corporate risk taking. However, no study investigates the relation between CEO inside debt and corporate risk taking when the CEO's inside debt deviates from the optimal level. This study is the first to fill this void in the literature.

2.3 CEO overconfidence

One common observation in the psychology literature is that people tend to be overconfident (e.g., Kidd, 1970; Moore, 1977). Financial economists find that CEOs are no exception to this rule (Malmendier and Tate, 2005, 2008; Ben-David et al., 2013). Overconfidence is defined as the overestimation of one's own abilities (Danial et al., 1998). Overconfident CEOs believe they have a better understanding of situations (Hiller and Hambrick, 2005) and that they are "miracle workers" (Tang, Li, and Yang, 2012).

Behavioral literature has evidence that overconfident persons enjoy control (Stotz and Nitzsch, 2005). Overconfident individuals tend to have enormous pride, and there is a substantial literature highlighting the egos of business executives (Roll, 1986; Hiller and Hamrick, 2005). In addition, overconfident individuals have been found to be prone to a self-importance bias, and they tend to disregard the opinions of others (Miller and Ross, 1975). Collectively, the above suggests that overconfident CEOs are strong-willed individuals who dislike interference.

Studies over the past two decades have provided valuable information on CEO overconfidence and corporate risk. Odean (1998) finds that CEO overconfidence leads to excess firm risk and unexpected consequences. Studies have also found that overconfident CEOs are less conservative and more optimistic than rational CEOs (Campbell et al., 2011; Gervais et al., 2011). Therefore, overconfident CEOs are more likely to match diversified shareholders' risk preferences and tend to invest in risky projects (Goel and Thakor, 2008; Gervais et al., 2011). Furthermore, Goel and Thakor (2008) argue that overconfident CEOs can increase firm value by reducing the

underinvestment problem associated with risk-averse CEOs. Several authors have found that overconfident CEOs are associated with inferior investment, leverage, and share repurchase decisions (Malmendier and Tate, 2005, 2008; Yung et al., 2015). Overconfident CEOs are more likely to overinvest in risky projects when the firm has plenty of internal funds (Malmendier and Tate, 2008).

3. Hypothesis development

As mentioned in previous sections, there is evidence that CEO inside equity provides incentives for managers to increase corporate risk taking (Guay, 1999; Rajgopal and Shevlin, 2002; Nam et al., 2003; Coles et al., 2006; Low, 2009; Sheikh, 2012). In contrast, there is also empirical evidence showing a negative relation between CEO inside debt and corporate risk taking (Sundaram and Yermack, 2007; Edmans and Liu, 2011; Wei and Yermack, 2011; Cassel et al., 2012). When the actual CEO inside debt level is above the optimum, CEOs face greater risk exposure to the firm's leverage. Thus, we argue that positive deviations from the optimal inside debt level will be negatively related to firm risk taking. Vice versa, when there is a negative deviation from the optimal inside debt level, CEOs can improve their personal benefits by aligning with shareholder interests. Thus, we argue that negative deviations from the optimal level of inside debt is positively related to firm risk taking.

The behavioral finance literature has long established that hubris affects managerial risk attitudes (Roll, 1986; Heaton, 2002). Overconfident CEOs systematically overestimate their ability to process risk, causing them to engage in corporate risk taking activity. Compared to rational CEOs, who perceive firm risk correctly, overconfident CEOs tend to be more aggressive in taking on risky projects (Malmendier and Tate, 2005; Hirshleifer

et al., 2012). In addition, Malmendier et al. (2005, 2008) show that overconfident CEOs exhibit below-average levels of risk aversion by holding inside equity beyond rational thresholds. Hirshleifer et al. (2012) find that overconfident CEOs invest heavily in R&D, which leads to a higher level of innovation, but also a higher level of uncertainty.

How CEO overconfidence interacts with CEO inside debt to affect firm risk taking behavior is not yet known in the literature. Our study is the first to investigate the association between both CEO inside debt and CEO overconfidence and corporate risk taking at the same time.

We argue that the risk taking incentive of CEO overconfidence is mitigated when CEOs' inside debt levels are above the optimum (positive inside debt deviation), and elevated when CEOs' inside debt levels are below the optimum (negative inside debt deviation). This leads to the following hypotheses.

> *H1: Positive deviations of inside debt (i.e., actual debt greater than optimal) mitigate the risk taking activities of firms with overconfident CEOs*
>
> *H2: Negative deviations of inside debt (i.e., actual debt less than optimal) escalate the risk taking activities of firms with overconfident CEOs*.

Previous research findings on the effects of CEO overconfidence on firm value are inconsistent. One line of academic research investigates the positive effect of CEO overconfidence on firm performance. Shipman and Mumford (2011) argue that overconfident CEOs are charismatic leaders who can enhance firm value. In addition, CEO overconfidence has been suggested to potentially increase firm value by reducing

the underinvestment problem (Goel and Thakor, 2008; Campbell et al., 2011; Gervais et al., 2011; Hirshleifer et al., 2012). Another positive effect related to CEO overconfidence is innovation. Galasso and Simcoe (2011) find CEO overconfidence to have a positive effect on firm innovation and point out that this positive effect is more pronounced in competitive industries and when the firm is less financially constrained.

On the other hand, there is also significant evidence that CEO overconfidence has a negative effect on firm value. Overconfident CEOs tend to overestimate their ability and invest in value-destroying projects (Malmendier and Tate, 2005; Deshmukh et al., 2013).

CEOs with high levels of inside debt are found to be associated with conservative corporate policies. Liu, Mauer, and Zhang (2014) show that CEOs with higher inside debt holdings are more risk averse and hold more cash. Therefore, high levels of inside debt could lead to underinvestment. Wei and Yermack (2011) find that greater inside debt reduces risk, transfers value from equity to debt, and destroys overall firm value. He (2015) finds that CEOs with higher inside debt levels adopt more conservative accounting policies to prevent risky and value-destroying investments. We argue that overconfident CEOs mitigate risk aversion when CEO inside debt is above optimal and are thus associated with a positive impact on firm value. On the other hand, CEOs with inside debt below the optimal tend to increase firm risk and destroy firm value. We argue that CEO overconfidence exacerbates decreases in firm value.

To sum up, given the conflicting empirical evidence in the literature, we develop the following hypothesis.

H3: Positive (negative) deviations of inside debt are associated with increases (decreases) in the value of firms with overconfident CEOs.

4. Key variables, measurement, and empirical methodology

4.1 Measuring CEO overconfidence

The literature identifies overconfident CEOs as those who deliberately overexpose their personal wealth to the idiosyncratic risk of their firms (Lambert, Larcker, and Verrecchia, 1991; Hall and Murphy, 2002). We follow Malmendier and Tate (2005, 2008) and define a CEO as overconfident once the CEO postpones exercising vested options that are at least 67% in the money. The 67% threshold is based on a calculation by Hall and Murphy (2002), who suggest that failure to exercise an option that is 67% in the money implies a constant relative risk aversion value of three. Given no detailed information on CEO options holdings and the exercise price of each granted option, we follow prior studies (Campbell et al., 2009; Hirshleifer et al., 2012) in calculating the average moneyness of the CEO's option portfolio for each year. First, for each CEO–year, the average realizable value per option is calculated by dividing the total realizable value of the options by the number of options the CEO holds. The strike price is calculated as the fiscal year-end stock price minus the average realizable value. The average option moneyness is equal to the stock price divided by the estimated strike price minus one. In these computations, only the vested options are included. CEO overconfidence is represented by a dummy variable that has a value of one if the CEO is identified as overconfident, and zero otherwise. Similar to the argument of Hirshleifer et al. (2012), the overconfidence measure of a CEO remains unchanged over the sample period because personality traits are considered persistent. Malmendier, Tate, and Yan (2011) show that this measure of

overconfidence works well after controlling for past stock return performance. In addition, Campbell et al. (2011) show that this measure of overconfidence generates results similar to those of Malmendier and Tate (2005).

4.2 Measuring CEO inside debt

In this study, we employ several common measures of CEO inside debt following the literature. Sundaram and Yermack (2007) define *CEO leverage* as the ratio of the CEO's inside debt to the CEO's inside equity. The CEO's inside debt is the sum of the present value of accumulated pension benefits and deferred compensation, and the CEO's inside equity is the sum of the value of the CEO's stock and option holdings. The value of stock is calculated as the number of common stock and preferred stock held by the CEO, multiplied by the fiscal year-end stock price. We use the Black–Scholes (1973) option pricing model (Merton, 1973; Core and Guay, 2002) to calculate option value. The details of the calculation of option value are given in the Appendix. We define the CEO relative leverage ratio (Edmans and Liu, 2011; Cassell et al., 2012; Phan, 2014) as the ratio of the CEO's leverage divided by the firm's leverage. Following Edmans and Liu (2011), we refer to the CEO relative leverage ratio as *k*, calculated as

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

If $k = 1$, the CEO should have no incentive to engage in plans that transfer wealth from debtholders to stockholders or vice versa.

As mentioned by Wei and Yermack (2011), one limitation of the ratio *k* is that it does not capture changes in the values of debt and equity. Therefore, we follow Wei and Yermack and use the ratio *k**, which they call the *CEO's relative incentive ratio,* where *k** is calculated as

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

Following Wei and Yermack, we assume $\Delta D_{CEO}/\Delta D_{Firm} = D_{CEO}/D_{Firm}$. Thus, we use the following equation to calculate *k**:

$$k* \approx \frac{(D_{CEO} / D_{Firm})}{(\Delta E_{CEO} / \Delta E_{Firm})}$$

The calculations of the terms ΔE_{CEO} and ΔE_{Firm} are explained in detail in the Appendix.

4.3 Measuring the target CEO inside debt level

We draw upon the framework of Campbell et al. (2016) to estimate the target/optimal *relative CEO leverage ratio (k)* and *relative CEO incentive ratio (k*).* The regression model we use in this study to predict the optimal contracting-based target ratio is

$$\begin{aligned}\ln(k \text{ or } k^*) = {} & \gamma_0 + \gamma_1 \, Bookleverage + \gamma_2 \, Bond\ rating + \gamma_3 \, Idiosyncratic\ risk \\ & + \gamma_4 \, Market\ to\ book\ ratio + \gamma_5 \, R\&D/Sales + \gamma_6 \, Net\ PP\&E/Assets \\ & + \gamma_7 \, Size + \gamma_8 \, CEO\ age + \gamma_9 \, Tenure + \varepsilon\end{aligned}$$

We estimate the first-stage regression model using all available data, and we use the fitted values from this regression as our target ratios. After computing the target ratios for both *k* and *k**, we calculate the difference between the actual and optimal inside debt ratios to obtain the deviation variables.

4.4 Measuring firm risk taking behavior

Following previous studies, we measure firm risk taking behavior by capital expenditures (CAPEX/TA) and R&D expenses (R&D/TA), respectively. In addition, we use the leverage and cash levels as the dependent variable to measure firm risk taking behavior, as a robustness check.

4.5 Empirical methodology

Following previous studies (Cassell et al., 2012), we use the following model to estimate the effects of deviation from optimal inside debt on firm risk taking behavior:

$$Investment\ Activity_{it} = DISD_{it-1} * Overconfidence\ Dummy + Control\ variables_{it} + Fixed\ effects$$

where DISD is the deviation from the optimal inside debt. We used the actual *k* (*k**) ratio minus the optimal *k* (*k**) ratio to calculate the DISD variable. The control variables in the model include firm size (LnSales), CEO tenure, the ratio of cash to total assets, leverage (TL/TA), the market-to-book ratio, firm age, the sales growth rate, dividend payout (cash dividends/sales), the one-year stock return, governance measures—including a business common law (BCL) dummy—and board size. These controls are measured in the period

t. In another regression, we use controls measured in the period *t* - 1 to determine if the results change.

In addition to the base model, we expand our investigation by using different levels of CEO overconfidence. We change the CEO overconfidence dummy to a high-/low-overconfidence dummy and then examine the effects of different levels of CEO overconfidence on firm risk taking behavior when deviations occur.

4.6 Data and sample selection

To construct our sample, we use two data sets that are available from Wharton Research Data Services. We retrieve firm financial variables from Compustat, and CEO variables are obtained from ExecuComp. The initial sample consists of the intersection of firms included in both databases. The U.S. Securities and Exchange Commission increased disclosure requirements for all U.S. public firms after 2006 to include CEO inside debt. Because of this limitation, our sample period spans from 2006 to 2017. This study employs a sample of U.S. public firms, excluding firms that trade as American depositary receipts and firms operating in the utility sector (Standard Industrial Classification, or SIC, codes 4900–4999) or the financial sector (SIC codes 6000–6999). We delete observations missing data for key variables and winsorize all variables at the first and 99th percentiles. The final sample in this study consists of 1,706 firms, 2,449 CEOs, and 9.736 observations in total. However, because of missing data on CEO attributes, the final samples used to test each hypothesis are different. The variable definitions are given in the Appendix.

5. Results

5.1 Sample descriptive statistics

Table 1 presents descriptive statistics of the sample, including the mean, median, standard deviation, and 25th and 75th percentiles. The first part of Table 1 presents the variables associated with firm characteristics. All the firm-level variables' distribution statistics are consistent with those reported in the literature. The second part of Table 1 shows the variables associated with CEO characteristics. CEOs' relative debt-to-equity ratio (k) has a mean (median) of 0.3035 (0.061), and CEOs' relative incentive ratio (k^*) has a mean (median) of 9.058 (0.5279). These two ratios are consistent with the summary statistics of Wei and Yermack (2011) and Campbell et al. (2016). Table 1 also includes summary statistics for our optimal ratio and deviation variable estimates. The mean and median of our predicted values of k and k^* are similar to those of Campbell et al., (2016).

Insert Table 1 here

5.2 Main results

5.2.1 Target inside debt level and deviations

To estimate the optimum, or target, inside debt level, we follow the methodology of Campbell et al. (2016). For both the relative CEO leverage ratio (k) and relative CEO incentive ratio (k^*), we estimate the following first-stage regression models, using all available data, and then use the fitted values as our target ratios:

$$ln(k) = \gamma_0 + \gamma_1 Bookleverage + \gamma_2 Bond\ bating + \gamma_3 Idiosyncratic\ risk + \gamma_4 Market\ to\ book\ ratio + \gamma_5 R\&D/Sales + \gamma_6 Net\ PP\&E/Assets + \gamma_7 Size + \gamma_8 CEO\ age + \gamma_9 Tenure + \varepsilon \quad (1)$$

$$ln(k*) = \gamma_0 + \gamma_1 Bookleverage + \gamma_2 Bond\ bating + \gamma_3 Idiosyncratic\ risk$$
$$+\gamma_4 Market\ to\ book\ ratio + \gamma_5 R\&D/Sales + \gamma_6 Net\ PP\&E/Assets$$
$$+ \gamma_7 Size + \gamma_8 CEO\ age + \gamma_9 Tenure + \varepsilon \quad (2)$$

After computing the fitted value in model (1), we set it as the target value of ratio *k*. We use the actual *k* value minus the target value of the ratio *k* and we name this deviation variable DISD1, the deviation from the target inside debt *k* of model (1). We follow the same steps for model (2) and name the deviation of model (2) DISD2, the deviation from the target inside debt *k** of model (2).

Table 2 reports the univariate analysis of our deviation variables. We separate our sample into several subsamples. We note in Table 2 that the mean difference between overconfident CEOs and non-overconfident CEOs is negative for DISD1 and DISD2; that is, relative to non-overconfident CEOs, overconfident CEOs tend to have negative deviations. In other words, overconfident CEOs are associated with inside debt that is below the target level. The mean of DISD2 (DISD1) for overconfident CEOs is -2.5091 (-0.9028), whereas the mean of DISD2 (DISD1) for non-overconfident CEOs is 0.9406 (0.3347). For both DISD1 and DISD2, highly overconfident CEOs tend to have a greater negative deviation from the target inside debt level than CEOs with lower levels of overconfidence.

Insert Table 2 here

5.2.2 Firm risk taking activity

We use two proxies for measuring firm risk taking, namely, R&D expenditures and capital expenditures. R&D expenditures are defined as the ratio of R&D expenditures to total assets, R&D/TA (Opler and Titman, 1994; Mehran, 1995; Cassell et al., 2012), and capital expenditures are defined as the ratio of capital expenditures to total assets, CAPEX/TA (Cassel et al., 2012).

To examine the relation between firm risk taking and deviations from the optimal inside debt level, we follow the model of prior studies by adding the overconfidence dummy variable to the standard firm risk taking model, as follows:

$$\textit{Investment Activity}_{i,t} = \alpha_0 + \beta_1 \textit{DISD2}_{(i,t-1)} * \textit{Overconfidence Dummy} + \beta_2 \textit{DISD2}_{(i,t-1)} + \beta_3 \textit{Overconfidence Dummy} + \beta_4 \textit{Control variables}_{i,t} + \textit{Fixed effects} + \varepsilon_{it} \quad (3)$$

The regression results of model (3) are presented in Table 3. In column 1, the dependent variable, R&D/TA, includes all observations in the sample. Column 2 presents the results of the absolute value of inside debt deviation, while Columns 3 and 4 differ in terms of the sign of the deviation. Column 3 shows the results of positive inside debt deviations, and column 4 presents the results of negative inside debt deviations. The results of different levels of overconfidence (high vs. low) are also included in Table 3.

Table 3 shows several important findings. First, consistent with previous research, CEO overconfidence is positively associated with firm risk taking activity. Columns 1 and 2 of Panel A show that the coefficients of the overconfidence dummy, the high overconfidence dummy, and the low-overconfidence dummy are all positive. Second, the

last two columns of Panel A present the results of positive and negative deviations, respectively. Given negative deviations, the coefficients of the overall overconfidence and low-overconfidence dummies are both positive and significant. These results suggest that negative deviations of inside debt escalate the risk taking behavior of firms with overconfident CEOs. Thus, the results provide support for H2. By contrast, given positive deviations, the coefficients become negative. However, these results are not statistically significant in this case.

These coefficients do become significant when we use DISD1 as the control variable, as well as when we use the controls measured in the period *t* - 1. Detail results are given in Section 6 on robustness checks.

Third, we also find that our deviation variable is negatively related to the dependent variable. The first two columns of Table 3 show a negative coefficient of the variable DISD2. The results are more significant when we use the absolute value of the deviations. The results indicate that, when deviations exist, firms will decrease their risk taking behavior.

We also create a dummy variable for positive deviations, which we set equal to one if the inside debt deviation is positive, and zero if negative. Then we run the model as follows to test the different effects of firm risk taking behavior based on different signs of the deviation:

$$Investment\ Activity_{i,t} = \alpha_0 + \beta_1 Positive\ DEV + \beta_2 Positive\ DEV * Overconfidence\ Dummy + \beta_3 Overconfidence\ Dummy + \beta_4 Control\ variables_{i,t} + Fixed\ effects + \varepsilon_{it} \quad (3A)$$

Panel B of Table 3 presents the estimation results for model (3A). We find that the variable for positive inside debt deviations interacts with the variable for overconfident CEOs, mitigating firm risk taking activities. The coefficient of our interaction variable, -***Positive DEV*Overconfident Dummy,*** is negative and significant at the 10% level.

More in detail, in our model, once we add the interaction term, the effect of the overconfident dummy on R&D activity becomes **0.0038 - 0.0042**Positive dummy***. For positive deviations, Positive = 1, so the effect of CEO overconfidence on risk taking will become **0.0038 - 0.0042 = -0.0004**, indicating that positive inside debt deviations will alleviate overconfident CEO risk taking behavior. The results are more pronounced for CEOs with high levels of overconfidence. After the interaction term ***Positive DEV*High - Overconfidence*** is added, the effect of high levels of overconfidence on risk taking become **0.0064 - 0.0126 = -0.0062**. Previous studies point out a positive relation between CEO overconfidence and corporate risk taking behavior. The results from Panel B of Table 3 provide evidence that positive inside deviations will mitigate the risk taking behavior of firms with overconfident CEOs.

Panel C of Table 3 presents the results when the dependent variable is Capex/TA. The overall results show a positive correlation between CEO overconfidence and firm capital expenditures. However, Panel C shows that overconfident CEOs will increase capital expenditures given either a positive or a negative inside debt deviation. Our overall confidence dummy and dummy for high overconfidence are highly significant (p-value < 0.01) for all situations.

Panel D of Table 3 presents the results of equation (3A), where the dependent variable is Capex/TA. As in Panel C, we find that overconfidence is positively related to capital expenditures. We find that the coefficient of Positive DEV*Overconfidence is positive, indicating that CEOs will increase capital expenditures when their inside debt is above target levels. However, the t-test results are nonsignificant but approaching marginal levels of significance.

Collectively, some results in Table 3 (Panels A and B) are consistent with H1 and H2. Column 4 of Panel A suggests that negative inside debt deviations will increase the risk taking activities of firms with overconfident CEOs. This result is therefore in line with H2. Panel B presents a negative coefficient of the interaction variable Positive Dev*Overconfidence. The results are significant for both the overall overconfidence dummy and the dummy for high overconfidence. These results therefore indicate that positive inside debt deviations will mitigate the risk taking behavior of firms with overconfident CEOs. Therefore, these results support H1.

The results of Panel C of Table 3 show no differences in the effects of CEO overconfidence on the riskiness of firm investment activity between positive and negative deviations. The results of Panel D show the same finding as in Panels A and B, but without statistical significance.

Insert Table 3 here

5.2.3 Riskiness of firm financial policies

We capture the riskiness of firm financial policies by focusing on firm leverage and cash levels. Our measurement of leverage is defined as total liability scaled by total assets. We

measure a firm's cash level as total cash divided by total assets. Previous studies also show a negative relation between firm leverage and CEO inside debt and a positive relation between firm liquidity (cash level) and CEO inside debt (Cassell et al., 2012).

To examine the relation between the riskiness of firm financial policies and deviation of the optimal inside debt level, we add the overconfidence dummy variable to the model of prior study, as follows:

$$\textit{Leverage} \text{ or } \textit{Cash level}_{i,t} = \alpha_0 + \beta_1 DISD2_{(i,t-1)} * \textit{Overconfidence Dummy} + \beta_2 DISD2_{(i,t-1)} + \beta_3\, \textit{Overconfidence Dummy} + \beta_4 \textit{Control variables}_{i,t} + \textit{Fixed effects} + \varepsilon_{i,t} \quad (4)$$

The results of model (4) are presented in Table 4, which has a similar layout as that of Table 3. Consistent with previous studies (Malmendier et al., 2011; Atkas et al., 2019), our overconfidence dummy is negative and significantly (p-value < 0.01) related to firm leverage in all situations. We found a rather surprising outcome in column 2: the coefficient is positive and significant (0.0096, p-value < 0.01) for the interaction variable DISD2*High-overconfidence. Furthermore, the coefficient is negative and significant (-0.0014, p- value < 0.05) for the interaction variable DISD2*Low-overconfidence, indicating different effects for high compared to low levels of overconfidence. The results are consistent with previous studies (Engelen et al., 2015; Yung, Li, and Sun, 2015).

Even though the coefficients of the overall overconfidence dummy are negative for both positive and negative deviations (columns 3 and 4, respectively, in Table 4),

overconfident CEOs will tend to lower firm leverage under both scenarios, and the amount of the decrease is smallest for negative inside debt deviations.

The results of Panel B in Table 4 show a positive correlation between CEO overconfidence and firm leverage, given positive inside debt. The coefficient of the interaction variable Positive DEV*Overconfidence is 0.0502 and significant at the 5% level. Positive deviations of inside debt mitigate the incentives of overconfident CEOs to lower firm leverage. These results are also reported by Cassell et al. (2012), who argue that there is a positive relation between CEO inside debt level and firm leverage; this means that higher CEO inside debt is associated with greater firm leverage.

Panel C of Table 4 presents the results of model (4) where the dependent variable is the cash level (Cash/Total Assets). Even though previous studies find that overconfident CEOs prefer internal financing and thus hoard cash (e.g., Cassell et al., 2012), this differs from the finding presented here. Some researchers hold the opposite view. For example, Ferris et al. (2013) argue that CEO overconfidence is negatively associated with cash levels. A possible explanation for this could be dependent on the sufficiency of internal funds. When a firm has insufficient internal funds, overconfident CEOs will hoard cash, and once internal funds are sufficient, overconfident CEOs, compared to rational CEOs, will use this cash faster. This situation has also been reported by Malmendier and Tate (2008) and Malmendier, Tate, and Jon (2011). Malmendier and Tate (2008) find that overconfident CEOs will overinvest in risky projects when the firm has enough internal funds, thus leading to low cash levels. This argument explains the negative relation between overconfidence and cash levels. By contrast, when external funds are needed, overconfident CEOs will hoard cash and underinvest. This explains the positive relation

between overconfidence and cash levels. Further study with greater focus on financial constraint is therefore suggested.

Taking a close look at the results, we find that the deviation variables are positively related to firm cash levels. However, the results of Panel C in Table 4 show no differences between positive and negative deviations. Under both situations, our overall overconfident dummy and dummy for high overconfidence are negatively related to firm cash levels. We do find a different sign on the coefficient of the low-overconfidence dummy, but it is nonsignificant for negative deviations.

Panel D of Table 4 presents the results after we add the dummy variable Positive and the interaction variable to model (4). The overall results are consistent with those in Panel C. Overconfident CEOs will lower the firm's cash level given positive deviations. However, the amount of the decrease will be smaller for positive deviations compared to negative deviations. The effect of positive deviations on cash levels is -0.009 + 0.0033 = -0.0057 when inside debt levels are above target levels, compared to -0.009 when inside debt levels are below target levels. Nevertheless, the interaction variable is approaching—but does not reach—a marginal level of significance. Another important finding is that the signs of Positive Dev*High overconfidence and Positive Dev* Low overconfidence are different. The interaction variable Positive Dev* High overconfidence is positive and significant at the 10% level, indicating that positive inside debt deviations interact with high overconfidence to mitigate the decrease in cash levels. On the other side, Positive Dev * Low overconfidence is negative and significant, which implies that positive deviations escalate the inclination of low-overconfidence CEOs to reduce cash. Previous research finds a nonlinear effect of overconfidence for higher levels of overconfidence,

with greater effects for higher levels (Hirshleifer et al., 2012; Engelen et al., 2015; Yung, Li and Sun, 2015). The need for external financing can partly explain the positive coefficient for high-overconfidence CEOs and the negative coefficient for low-overconfidence CEOS. Compared to low-overconfidence CEOs, high-overconfidence CEOs expect firms to have higher needs for external financing, and they believe external financing to be costly; therefore, they are more likely to underinvest and to save cash.

In summary, the results of Table 4 are not very encouraging. The overall results show that overconfident CEOs lower firm leverage and cash levels under all situations. However, the results are unable to demonstrate the different effects of inside debt deviations on the riskiness of firms with overconfident CEOs.

Insert Table 4 here

5.2.4 Effects of deviation from optimal inside debt on firm value

The results of the tests investigating H3 are presented in Table 5. Using the specifications of the valuation regression of Fama and French (1998), we add our overconfidence dummy to examine the relation between deviations from optimal inside debt levels and firm value. The modified model is as follows:

$$MV\_TA = \alpha_0 + \beta_1 DISD2 + \beta_2 overconfidence + \beta_3 DISD2*overconfidence + \beta_4 Fama\ French\ variables + \varepsilon_{it} \quad (5)$$

The detailed explanations for the Fama–French variables are included in the Appendix. Meanwhile, we also investigate the effects of different levels of CEO overconfidence on firm value, using our high- and low-overconfidence dummies. Table 5 provides the

experimental data for model (5). Similar to the other tables, Table 5 presents the results for model (5) under four scenarios: all observations, unsigned (absolute value) observations, observations of positive deviations, and observations of negative deviations. Panel A reports the results of the estimation of model (5) in which the key independent variable is DISD2 (deviation of the inside debt ratio k^*).

The results of Table 5 generally show that our deviation variable (DISD2) is significantly positively related to firm value (p-value < 0.01 in the columns for all and unsigned observations). Consistent with previous findings, our overconfidence dummies are also positively related to firm value (Goel and Thakor, 2008; Gervais et al., 2011). Even though the coefficients in both the positive and negative deviation cases share the same sign, the positive effects are strong when CEO inside debt is above the optimal level. The coefficient for the overconfidence dummy is 0.4298 for a positive deviation, which is higher than 0.2152 for a negative inside debt deviation. We find the same patterns for our high-/low-overconfidence variables. These results show that positive inside debt deviations are associated with higher increases in firm value when the CEO is overconfident.

Panel B of Table 5 presents results consistent with those of Panel A. The coefficients of the overall overconfidence dummy, the high-overconfidence dummy, and the low-overconfidence dummy are all positive and significant at the 5% level. Furthermore, CEO overconfidence has a stronger positive effect on firm value given positive inside debt deviations.

To sum up, the results of Table 5 only partially support H3. We do not find a negative relation between CEO overconfidence and firm value under negative deviations. Instead, we find that CEO overconfidence is positively associated with firm value under both positive and negative deviations, but the positive effect is much stronger if the CEO's actual inside debt level is above the estimated target.

Insert Table 5 here

6. Robustness tests for the main analyses

6.1 Using DISD1 as the main control variable

In Section 5, for all our regressions, we use DISD2 as the key variable, where DISD2 is the deviation from the target inside debt k^* of model (2). Here, we switch to using DISD1, which is the deviation from the target inside debt k of model (1), as the key control variable. The difference between DISD1 and DISD2 has already been covered in previous sections.

Table 6 presents the results of models (3) to (5) while using DISD1 as the key control variable. Panels A and B present the new results of model (3), where the dependent variable is RD/TA. The overall results are in line with the results in Table 3. We note in Panel A that the coefficient of the high-overconfidence dummy is negative and significant under positive deviations, and positive and significant under negative deviations (-0.0080 for positive deviations, 0.0071 for negative deviations, p-value < 0.1). These results thus support both H1 and H2. Panel B further supports H1, in that positive inside debt deviations mitigate the risk taking activities of firms with overconfident CEOs. The coefficients for the interaction variables in Panel B are negative

and significant for the overall overconfidence dummy and the high-overconfidence dummy (-0.0042, at the 1% level of significance, and -0.0126, at the 5% level).

Panels C and D of Table 6 present results that are consistent with those of Table 3. CEO overconfidence has a positive effect on a firm's capital expenditures, but the results fail to identify any effects that differ between negative and positive deviations.

The new results of model (4) where leverage is the dependent variable are presented in Panels E and F of Table 6. We found that the overall results are consistent with those of Panels A and B in Table 4. The results of Panel E of Table 6 show that overconfident CEOs will lower firm leverage, given both negative and positive deviations, but the effect of the decrease is smaller given negative deviations.

Panels G and H of Table 6 present the results when the cash level is the dependent variable. Panel G shows that the overconfidence dummy is negatively related to firm cash levels under all situations, indicating a negative correlation between CEO overconfidence and corporate cash levels. The cash level is lowest when the CEO's inside debt is below the target level, which is associated with the highest level of financial risk. This result provides evidence that CEO overconfidence will increase corporate risk taking under negative deviations. These results further support H2. Panel H shows a positive correlation between CEO overconfidence and firm cash levels when the deviations of inside debt are positive. However, the results are nonsignificant.

The new results of model (5), using DISD1 as the key control variable, are shown in Panels I and G of Table 6. The results of Panel I are in line with those in Table 5. We find CEO overconfidence is positively related to firm value, and the positive effect is stronger

when the CEO's inside debt is above the target level (0.3913 compared to 0.2262 for negative deviations, both at the 1% level of significance). Therefore, overconfident CEOs mitigate risk aversion when their inside debt is above the optimum and are thus associated with a positive impact on firm value, which partially supports H3.

Insert Table 6 here

6.2 Measuring the control variable in period *t* - 1

The controls variables are measured in period *t* in Section 5. In all the regressions in this section, we use controls measured in the period *t* - 1, instead, to see if the results change. Because the Fama–French variables in model (5) are already calculated in periods *t* - 1 and *t* - 2, in this section we therefore present only the results of models (3) and (4). By using a one-year-lagged variable for all the control variables, the new models should look like the following:

$$Investment\ Activity_{i,t} = \alpha_0 + \beta_1 DISD2_{(i,t-1)} * Overconfidence\ Dummy + \beta_2 DISD2_{(i,t-1)} + \beta_3\ Overconfidence\ Dummy + \beta_4\ \mathbf{Control\ variables_{(i,t-1)}} + Fixed\ effects + \varepsilon_{it} \quad (3B)$$

$$Leverage\ or\ Cash\ level_{i,t} = \alpha_0 + \beta_1 DISD2_{(i,t-1)} * Overconfidence\ Dummy + \beta_2 DISD2_{(i,t-1)} + \beta_3\ Overconfidence\ Dummy + \beta_4\ \mathbf{Control\ variables_{(i,t-1)}} + Fixed\ effects + \varepsilon_{it} \quad (4A)$$

The results of these models are presented in Table 7. Panel A shows the results of model (3B), where the dependent variable is RD/AT. The results are consistent with those in Panel A of Table 3 and Panel A of Table 6. We find that the coefficient is negative and

significant when the CEO's inside debt is above the target level and positive and significant when the CEO's inside debt level is below the target level, especially for the high-overconfidence dummy (coefficients of -0.0093 and 0.0102, respectively, at the 10% level of significance). Thus, this finding supports both H1 and H2.

Panel B of Table 7 provides the results of model (3B), where the dependent variable is CAPX/AT. The overall results are in line with our previous findings , in that overconfident CEOs will increase firm capital expenditures. However, only the results under positive deviations are significant in this case.

Panels C and D of Table 7 present the results of model (4A). The overall results match our previous results. We find a different sign for the overconfidence dummy when we run the cash-level regressions, compared to previously (e.g., Table 4 of Panel C). The different sign indicates that overconfident CEOs will increase cash levels given positive deviations, and decrease cash levels given negative deviations. However, the results are not statistically significant.

Insert Table 7 here

Overall, the results of this section are in line with our findings in Section 5. The results of multiple regression provide support for H1 to H3.

7. Summary and conclusions

In this study, we investigate the relation between CEO overconfidence and CEO inside debt levels. Unlike prior studies that focus only on the effects of CEO inside debt on firm risk taking behavior, we also investigate the effect of CEO overconfidence on firm risk

taking activities given deviations from optimal levels. Our results show that deviations in inside debt play an important role in these relations.

Specifically, positive deviations of inside debt mitigate the risk taking behaviors of firms with overconfident CEOs. We use different methodologies to estimate the inside debt level and the optimal level. We also use different methodologies to estimate a firm's investment riskiness and financial policy riskiness. Using R&D as a way to estimate investment risk, we find that a positive deviation is negatively related to firm risk taking behaviors when the CEO is considered overconfident. We also find that CEO overconfidence will always increase the firm's capital expenditures, without the influence of deviations in inside debt. When we examine the effect of CEO overconfidence on the risk of financial policy, we find that CEO overconfidence is negatively related to firm leverage. This result indicates that overconfident CEOs will decrease firm leverage under both positive and negative deviations in inside debt. However, we do find that the amount of the decrease is smaller when the inside debt deviation is negative. On the other hand, when we investigate the effect of CEO overconfidence on firm cash levels, we find that overconfident CEOs tend to lower firm cash levels. We also find that if a CEO's inside debt is above the target level, the amount of the decrease is smaller. However, the results are nonsignificant. The results also show that low-overconfidence CEOs will increase amounts of cash when their inside debt is above the target level, but high-overconfidence CEOs will decrease cash levels. Nevertheless, the results are also statistically nonsignificant.

Additionally, we examine the moderating effects of CEO inside debt on firm value. We confirm the positive relation between deviations from the target inside debt level and firm

value. Our results also show that CEO overconfidence has a positive effect on firm value. This positive effect is more significant for positive deviations of inside debt than for negative deviations.

In spite of its limitations, this study adds to the literature on the effects of the deviations of inside debt levels on firm risk taking activity and firm value. Although the current study is based on a small data set on CEO inside debt, the findings show hints that different signs of CEO inside debt deviation will have different influences on firm value and risk. More information on CEO inside debt would help establish greater accuracy in this matter. Further research could explore not only the signs of the deviations of inside debt, but also the levels of the deviations, to closely examine the link between different level of deviations and firm value/risk.

Table 1 **Descriptive Statistics**

Firm characteristics						
Name	N	Mean	Std.Dev	25th	Median	75th
Firm equity	8,525	7,486.6040	15,625.9300	731.2880	2,007.4320	6,033.0270
Firm debt	8,941	2,480.2870	5,562.4260	144.4500	549.0000	1,947.0000
Firm debt to equity ratio	8,525	0.5271	1.3862	0.0945	0.2435	0.5440
Firm leverage	8,941	0.5822	0.2378	0.4321	0.5683	0.7123
Book leverage	8,941	0.2122	0.1924	0.0784	0.1887	0.3024
Market to book ratio	8,525	1.7254	0.9302	1.1465	1.4553	1.9859
Idiosyncratic risk	8,940	-3.9419	0.5049	-4.3106	-3.9727	-3.6264
Ln(asset)	8,941	7.9369	1.6305	6.7738	7.8240	8.9681
Ln(sale)	8,535	7.6295	1.5414	6.5960	7.5455	8.6413
R&D expense/total asset	8,941	0.0241	0.0528	0.0000	0.0000	0.0250
Sale growth rate	6,812	0.0218	0.2423	-0.0275	0.0490	0.1194
Dividend payour	8,372	0.0157	0.0259	0.0000	0.0035	0.0212
Capital expenditure	8,515	0.0471	0.0528	0.0164	0.0319	0.0587
Boardsize	8,187	9.4910	2.3457	8.0000	9.0000	11.0000
Firm age	4,101	14.3787	6.2015	10.0000	14.0000	19.0000
BCL dummy	8,941	0.9941	0.0768	1.0000	1.0000	1.0000
Delaware dummy	8,941	0.6260	0.4839	0.0000	1.0000	1.0000
Firm equity delta`	8,941	219.7709	438.4413	36.9895	73.9248	183.2080
CEO characteristics						
CEO age	8,889	55.8215	6.6980	51.0000	56.0000	60.0000
CEO overconfident dummy	8,941	0.2693	0.4436	0.0000	0.0000	1.0000
CEO tenure(years)	8,941	6.8082	6.7002	2.0000	5.0000	9.0000
CEO equity	8,941	88,299.2800	1,020,448.0000	6,081.5250	15,522.3700	40,239.1100

CEO debt	8,941	4,603.5490	7,156.7080	0.0000	1,021.3130	6,095.3610
CEO debt to equity ratio	8,941	0.3019	0.6146	0.0000	0.0614	0.3167
CEO equity delta	8,941	989.1521	10,353.8500	76.5698	205.9525	540.0865
CEO relative debt to equity ratio (K)	8,941	0.3036	0.6248	0.0000	0.0614	0.3167
CEO relative incentive ratio (K*)	8,941	9.0581	42.0224	0.0000	0.5279	2.8578
Estimated Optimal ratio						
CEO relative debt to equity ratio*	8,246	2.5249	2.1845	1.4056	2.6187	3.8814
CEO relative incentive ratio*	8,246	6.4502	4.8968	3.6438	6.4636	9.6276
Deviations						
DISD1 (Actual k-estimate k)	8,246	-0.0091	9.7304	-2.9816	-1.4694	0.0026
DISD2 (Actual k*-estimate k*)	8,246	-0.0179	22.2498	-7.6147	-3.8741	-0.4434

Table 2 Univariate test table

	All firms	Overconfidence Firms	High overconfidence Firms	Median overconfidence Firms	Low overconfidence Firms	No overconfidence Firms
DISD2	1	2	3	4	5	6
Mean	-0.0179	-2.5091	-3.8983	-2.3784	-2.1552	0.9406
Median	-3.8741	-4.7184	-6.0668	-5.0373	-4.0919	-3.5407
DISD1	1	2	3	4	5	6
Mean	-0.0091	-0.9028	-1.2220	-0.7573	-0.8874	0.3347
Median	-1.4694	-2.1365	-2.7567	-2.2167	-1.9293	-1.2457

DISD2	1 vs 2	1 vs 3	1 vs 4	1 vs 6	2 vs 6	3 vs 5
Difference between means	2.4912	3.8805	2.3606	-0.9584	-3.4496	-1.7432
difference between medians	0.8443	2.1927	1.1632	-0.3334	-1.1777	-1.9749
DISD1	1 vs 2	1 vs 3	1 vs 4	1 vs 6	2 vs 6	3 vs 5
Difference between means	0.8936	1.2129	0.7481	0.6653	-1.2374	-0.3346
difference between medians	0.6671	1.2873	0.7473	-0.2238	-0.8908	-0.8274

Table 3 Panel A	Unsigned DISD2		Abs(DISD2)		Positive DISD2		Negative DISD2	
	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA
DISD2	-0.0001*	-0.0001	-0.0001**	-0.0001**				
Oveconf_dummy	0.0035**		0.0035**		-0.0001		0.0034***	
DISD2*Overconf.	0.0001		0.0000					
DISD2*High_over		0.0001		0.0000				
DISD2*Low_over		0.0001		0.0000				
High_over		0.0061*		0.0064		-0.0055		0.0062
Low_over		0.0037**		0.0035*		0.0020		0.0040**
Ceo tenure	0.0002*	0.0002*	0.0002*	0.0002*	-0.0001	-0.0001	0.0002**	0.0003**
Ln(sales)	-0.0048***	-0.0048***	-0.0049***	-0.0049***	-0.0039***	-0.0039***	-0.0050***	-0.0050***
Cash/ta	0.1905***	0.1908***	0.1912***	0.1913***	0.2212***	0.2211***	0.1703***	0.1704***
Salesgrowth	0.0198***	0.0198***	0.0197***	0.0197***	0.0236***	0.0237***	0.0202***	0.0202***
ROA	-0.1300***	-0.1293***	-0.1305***	-0.1297***	-0.1534***	-0.1532***	-0.1280***	-0.1274***
TL/TA	-0.0063***	-0.0062***	-0.0068***	-0.0069***	-0.0059*	-0.0056	-0.0112***	-0.0111***
Stock return	0.0171***	0.0173***	0.0175***	0.0176***	0.0227***	0.0228***	0.0134***	0.0136***
Firm age	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0001	-0.0001	-0.0006***	-0.0006***
Dividend payout	0.0976***	0.0960***	0.0952***	0.0939***	0.1115***	0.1093***	0.0558*	0.0550*
BCL dummy	-0.0335***	-0.0334***	-0.0333***	-0.0333***	-0.0131	-0.0130	-0.0410***	-0.0409***
Board size	0.0007*	0.0007*	0.0006*	0.0006*	0.0003	0.0003	0.0007*	0.0007*
Intercept	0.0986***	0.0983***	0.0994***	0.0994***	0.0553***	0.0559***	0.1199***	0.1196***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.2390	0.2392	0.2389	0.2391	0.3198	0.3203	0.2166	0.2169
N	5,150	5,150	5,150	5,150	2,241	2,241	3,982	3,982

Table 3 Panel B	All OBS		
	RD/AT	RD/AT	RD/AT
Positive Dummy	0.0001	-0.0006	-0.0007
POS*OverCon	-0.0042*		
Overconfidence	0.0038**		
Pos*High OC		-0.0126**	
POS*Low OC			-0.0018
High Overconfidence		0.0064*	
Low Overcon			0.0038**
Ceo tenure	0.0001	0.0001	0.0001
Ln(sales)	-0.0046***	-0.0047***	-0.0047***
Cash/ta	0.1910***	0.1915***	0.1910***
Salesgrowth	0.0217***	0.0220***	0.0219***
ROA	-0.1401***	-0.1382***	-0.1392***
TL/TA	-0.0082***	-0.0082***	-0.0082***
Stock return	0.0176***	0.0181***	0.0178***
Firm age	-0.0004***	-0.0004***	-0.0004***
Dividend payout	0.0819***	0.0790***	0.0807***
BCL dummy	-0.0252***	-0.0247***	-0.0251***
Board size	0.0005	0.0005	0.0005
Intercept	.0906***	0.0907***	0.0915***
Number of Obs	6,223	6,223	6,223
R-Square	0.2549	0.2548	0.2548

Table 3 Panel C	Unsigned DISD2		Abs(DISD2)		Positive DISD2		Negative DISD2	
	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA
DISD2	-0.0001***	-0.0001***	-0.0001	0.0000				
Oveconf_dummy	0.0067***		0.0061***		0.0064**		0.0060***	
DISD2*Overconf.	0.0000		0.0001					
DISD2*High_over		0.0000		0.0006				
DISD2*Low_over		-0.0001		0.0001				
High_over		0.0160***		0.0117*		0.0149***		0.0174***
Low_over		0.0029		0.0027		0.0001		0.0042*
Ceo tenure	-0.0001	-0.0001	-0.0001	-0.0001	-0.0002	-0.0002	0.0000	0.0000
Ln(sales)	-0.0020***	-0.0020***	-0.0020***	-0.0020***	-0.0009	-0.0008	-0.0021***	-0.0020***
Cash/ta	-0.1126***	-0.1114***	-0.1141***	-0.1132***	-0.0762***	-0.0752***	-0.1246***	-0.1241***
Salesgrowth	0.0053**	0.0055*	0.0055*	0.0056*	0.0072*	0.0075**	0.0058	0.0055
ROA	0.0188**	0.0209**	0.0179**	0.0197**	0.0377***	0.0398***	0.0170	0.0179*
TL/TA	0.0010	0.0007	0.0006	-0.0003	-0.0034	-0.0039	0.0023	0.0023
Stock return	0.0011	0.0017	0.0011	0.0015	-0.0036	-0.0027	0.0059	0.0061
Firm age	0.0002*	0.0002*	0.0002*	0.0002*	0.0001	0.0001	0.0001	0.0001
Dividend payout	0.0406	0.0376	0.0378	0.0349	-0.0566*	-0.0583*	0.0690*	0.0697*
BCL dummy	0.0024	0.0030	0.0034	0.0039	0.0121	0.0125	-0.0029	-0.0024
Board size	-0.0011***	-0.0011**	-0.0011**	-0.0011**	-0.0010*	-0.0010*	-0.0015**	-0.0015***
Intercept	0.0692***	0.0677***	0.0691***	0.0683***	0.0551***	0.0544***	0.0866***	0.0848***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.0587	0.0593	0.0568	0.0578	0.0511	0 .0520	0.0596	0.0605
N	5,147	5,147	5,147	5,147	2,234	2,234	3,980	3,980

Table 3 Panel D	All OBS		
	CAPX/AT	CAPX/AT	CAPX/AT
Positive Dummy	-0.0055***	-0.0052***	-0.0047***
POS*OverCon	0.0022		
Overconfidence	0.0053***		
Pos*High OC		0.0001	
POS*Low OC			-0.0028
High Overconfidence		0.0158***	
Low Overcon			0.0027
Ceo tenure	-0.0001	-0.0001	0.0001
Ln(sales)	-0.0016***	-0.0015***	-0.0016***
Cash/ta	-0.1065***	-0.1054***	-0.1057***
Salesgrowth	0.0066**	0.0067***	0.0075***
ROA	0.0237***	0.0261***	0.0285***
TL/TA	-0.0013	-0.0017	-0.0012
Stock return	0.0023	0.0029	0.0037
Firm age	0.0001	0.0001	0.0001
Dividend payout	0.0059	0.0037	0.0043
BCL dummy	0.0057	0.0064	0.0069
Board size	-0.0013***	-0.0013***	-0.0013***
Intercept	0.0733***	0.0717***	0.0736***
Number of Obs	6,214	6,214	6,214
R-Square	0.0552	0.0561	0.0528

Table 4 Panel A	Unsigned DISD2		Abs(DISD2)		Positive DISD2		Negative DISD2	
	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage
DISD2	-0.0002	-0.0001	-0.0010***	-0.0011***				
Oveconf_dummy	-0.0268***		-0.0257***		-0.0451***		-0.0180***	
DISD2*Overconf.	0.0016***		-0.0007*					
DISD2*High_over		0.0083***		0.0096***				
DISD2*Low_over		0.0011**		-0.0014**				
High_over		-0.0015		-0.1071***		-0.0181		-0.0256**
Low_over		-0.0241**		-0.0163**		-0.0252		-0.0203**
Ceo tenure	-0.0017***	-0.0018***	-0.0018***	-0.0019***	-0.0029***	-0.0031***	-0.0008***	-0.0009**
Ln(sales)	0.0417***	0.0416***	0.0406***	0.0410***	0.0373***	0.0378***	0.0431***	0.0431***
MB	0.0439***	0.0428***	0.0452***	0.0423***	0.0729***	0.0691***	0.0161***	0.0159***
ROA	-0.5525***	-0.5573***	-0.5465***	-0.5541***	-0.4039***	-0.4117***	-0.5873***	-0.5906***
PPE_at	0.0655***	0.0654***	0.0645***	0.0643***	0.0844***	0.0857***	0.0438***	0.0438***
RD_at	-0.5153***	-0.4997***	-0.5129***	-0.4897***	-0.7683***	-0.7402***	-0.3044***	-0.3011***
Stock return	0.0325	0.0306	0.0358	0.0327	0.1392***	0.1294***	-0.0001	-0.0014
BCL dummy	-0.0150	-0.0158	-0.0277	-0.0310	0.0732	0.0677	-0.0913**	-0.0923**
Board size	0.0028*	0.0029*	0.0020	0.0020	0.0024	0.0025	0.0042**	0.0042**
Intercept	0.1735***	0.1739***	0.2108***	0.2140***	0.1137***	0.1145***	0.2510***	0.2516***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.1465	0.1529	0.1506	0.1547	0.1120	0.1089	0.2150	0.2153
N	6,229	6,229	6,229	6,229	2,752	2,752	4,821	4,821

Table 4 Panel B	All OBS		
	Leverage	Leverage	Leverage
Positive Dummy	0.1020***	0.1096***	0.1143***
POS*OverCon	0.0502***		
Overconfidence	-0.0324***		
Pos*High OC		0.1611***	
POS*Low OC			0.0052
High Overconfidence		-0.0412***	
Low Overcon			-0.0182**
Ceo tenure	-0.0015***	-0.0016***	-0.0016***
Ln(sales)	0.0406***	0.0405***	0.0409***
MB	0.0375***	0.0356***	0.0352***
ROA	-0.4853***	-0.4946***	-0.4903***
PPE_at	0.0538***	0.0539***	0.0537***
RD_at	-0.4694***	-0.4594***	-0.4515***
Stock return	0.0319***	0.0225	0.0266
BCL dummy	0.0088	0.0052	0.0069
Board size	0.0025**	0.0025*	0.0025*
Intercept	0.1503***	0.1497***	0.1462***
Number of Obs	7,573	7,573	7,573
R-Square	0.1818	0.1816	0.1793

Table 4 Panel C	Unsigned DISD2		Abs(DISD2)		Positive DISD2		Negative DISD2	
	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset
DISD2	0.0002***	0.0003***	0.0005***	0.0005***				
Oveconf_dummy	-0.0071***		-0.0128***		-0.0084***		-0.0082***	
DISD2*Overconf.	0.0002		0.0007***					
DISD2*High_over		0.0001		0.0006				
DISD2*Low_over		0.0001		0.0008***				
High_over		-0.0280***		-0.0325***		-0.0181**		-0.0266***
Low_over		0.0004		-0.0057		-0.0120**		0.0001
Ceo tenure	-0.0005***	-0.0006***	-0.0005***	-0.0006***	0.0003	0.0003	-0.0009***	-0.0009***
Ln(sales)	-0.0101***	-0.0103***	-0.0090***	-0.0092***	-0.0127***	-0.0128***	-0.0099***	-0.0101***
MB	0.0180***	0.0187***	0.0181***	0.0187***	0.0225***	0.0228***	0.0164***	0.0170***
ROA	0.0540***	0.0507***	0.0495***	0.0473***	0.0119	0.0112	0.0769***	0.0726***
PPE_at	-0.0487***	-0.0487***	-0.0486***	-0.0487***	-0.0532***	-0.0536***	-0.0483***	-0.0484***
RD_at	0.5070***	0.5023***	0.5013***	0.4972***	0.5513***	0.5468***	0.4740***	0.4699***
Stock return	-0.0224***	-0.0218***	-0.0229**	-0.0227**	-0.0084	-0.0082	-0.0247**	-0.0244**
BCL dummy	0.0134	0.0138	0.0129	0.0128	-0.0091	-0.0084	0.0507**	0.0501**
Board size	-0.0024***	-0.0024***	-0.0020***	-0.0021***	-0.0021**	-0.0021**	-0.0020***	-0.0021***
Intercept	0.1746***	0.1749***	0.1593***	0.1603***	0.2069***	0.2074***	0.1388***	0.1398***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.2641	0.2640	0.2731	0.2747	0.3031	0.3043	0.2517	0.2402
N	6,132	6,132	6,132	6,132	2,703	2,703	4,757	4,757

Table 4 Panel D	All OBS		
	CASH	CASH	CASH
Positive Dummy	0.0014	0.0017	0.0042*
POS*OverCon	0.0033		
Overconfidence	-0.0090***		
Pos*High OC		0.0177*	
POS*Low OC			-0.0112*
High Overconfidence		-0.0298***	
Low Overcon			0.0021
Ceo tenure	-0.0005***	-0.0005***	-0.0005***
Ln(sales)	-0.0108***	-0.0109***	-0.0107***
MB	0.0189***	0.0193***	0.0180***
ROA	0.0463***	0.0430***	0.0429***
PPE_at	-0.0504***	-0.0504***	-0.0506***
RD_at	0.5042***	0.5013***	0.5091***
Stock return	-0.0181**	-0.0182**	-0.0177**
BCL dummy	0.0136	0.0134	0.0201
Board size	-0.0021***	-0.0022***	-0.0022***
Intercept	0.1776***	0.1782***	0.1768***
Number of Obs	7,460	7,460	7,460
R-Square	0.2589	0.2602	0.2582

Table 5 Panel A	All OBS		Abs Obs		Positive Obs		Negative Obs	
	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT
DISD2	0.0018***	0.0017**	0.0021***	0.0022***				
DISD2*OverCon	0.0024***		0.0034**					
Overconfidence	0.2844***		0.2512***		0.4298***		0.2152***	
Deviation*High OC		0.0110***		0.0261***				
Deviation*Low OC		0.0019		0.0007				
High Overcon		0.5248***		0.2845***		0.4524***		0.4470***
Low Overcon		0.1978***		0.1894***		0.3996***		0.1349***
Et	0.0001***	0.0001***	0.0001***	0.0001***	0.0001	0.0001	0.0001***	0.0001***
d1Et	-0.2705*	-0.2457*	-0.2778*	-0.2557**	-0.4387*	-0.4179*	-0.2517*	-0.2339*
d2Et	0.0974	0.0737	0.0912	0.0705	0.4101*	0.3844*	-0.0280	-0.0493
d1At	-0.5016***	-0.5057***	-0.4932***	-0.4875***	-0.5069***	-0.4960**	-0.5522***	-0.5604***
d2At	-0.4255***	-0.4060***	-0.4301***	-0.4111***	-0.6637***	-0.6724***	-0.2081***	-0.1859***
d1Rd	0.4433	0.5055	0.4337	0.5575	0.6074	0.5807	0.8274	0.8143
d2Rd	0.2529	0.2600	0.2317	0.2260	0.3652	0.4228	0.8593	0.8836
d1It	-5.0181*	-5.1016*	-4.9502*	-5.0151*	-11.8250*	-11.8085*	-0.7937	-0.9811
d2It	4.6248***	4.3413**	4.9457**	4.7418**	11.3587**	11.4140**	-0.9206	-1.0944
d1Dt	0.4315	0.4713	0.4469	0.4926	1.3688**	1.4482**	-0.9024*	-0.8744*
d2Dt	-0.3020	-0.2997	-0.2985	-0.3214	-0.1891	-0.1484	-0.7885*	-0.7557*
d1Vt	0.4653***	0.4620***	0.4634***	0.4598***	0.5508***	0.5514***	0.4392***	0.4411***
d2Vt	0.4748***	0.4863***	0.4756***	0.4837***	0.3532***	0.3717***	0.5287***	0.5323***
Intercept	0.4883***	0.5117***	0.4678***	0.4904***	0.5313***	0.5539***	0.4632***	0.4830***
Number of Obs	5,331	5331	5331	5331	1,311	1,311	4,037	4,037
R-Square	0.3727	0.3707	0.3737	0.3751	0.2978	0.2834	0.4209	0.4202

Table 5 Panel B	All OBS		
	MV/AT	MV/AT	MV/AT
Positive Dummy	0.0691***	0.0749**	0.0576**
POS*OverCon	0.0999*		
Overconfidence	0.2613***		
Pos*High OC		-0.1109	
POS*Low OC			0.1734**
High Overcon		0.4778***	
Low Overcon			0.1322***
Et	0.0001***	0.0001***	0.0001***
d1Et	-0.2661*	-0.2453*	-0.2494*
d2Et	0.0891	0.0661	0.0718
d1At	-0.5197***	-0.5193***	-0.5286***
d2At	-0.4179***	-0.3927***	-0.4022***
d1Rd	0.4262	0.5175	0.4554
d2Rd	0.3041	0.3504	0.2556
d1It	-5.0105*	-5.2496*	-5.2296*
d2It	4.4221**	4.1957**	4.2572**
d1Dt	0.4069	0.4765	0.4241
d2Dt	-0.3032	-0.2757	-0.2701
d1Vt	0.4653***	0.4737***	0.4814***
d2Vt	0.4757***	0.4952***	0.5076***
Intercept	0.4726***	0.5202***	0.5156***
Number of Obs	5,348	5,348	5,348
R-Square	0.3712	0.3626	0.3599

Table 6 Panel A	Unsigned DISD1		Abs(DISD1)		Positive DISD1		Negative DISD1	
	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA
DISD1	-0.0001	-0.0001	0.0001	-0.0001				
Oveconf_dummy	0.0027**		0.0021		-0.0005		0.0034**	
DISD1*Overconf.	0.0002		0.0002					
DISD1*High_over		-0.0003		-0.0001				
DISD1*Low_over		0.0004		0.0004				
High_over		0.0022		0.0027		-0.0080*		0.0071*
Low_over		0.0037**		0.0022		0.0033		0.0032*
Ceo tenure	0.0001	0.0001	0.0001	0.0001	-0.0003*	-0.0003**	0.0004***	0.0004***
Ln(sales)	-0.0049***	-0.0050***	-0.0049***	-0.0049***	-0.0045***	-0.0046***	-0.0047***	-0.0047***
Cash/ta	0.1901***	0.1900***	0.1886***	0.1884***	0.2228***	0.2226***	0.1708***	0.1710***
Salesgrowth	0.0215***	0.0215***	0.0216***	0.0217***	0.0173***	0.0174***	0.0265***	0.0265***
ROA	-0.1424***	-0.1417***	-0.1435***	-0.1427***	-0.1309***	-0.1311***	-0.1467***	-0.1460***
TL/TA	-0.0076***	-0.0075***	-0.0070***	-0.0069***	-0.0062*	-0.0058*	-0.0098*	-0.0098*
Stock return	0.0182***	0.0185***	0.0181***	0.0183***	0.0165***	0.0166***	0.0173***	0.0175***
Firm age	-0.0004***	-0.0004***	-0.0004***	-0.0004***	0	0	-0.0007***	-0.0007***
Dividend payout	0.1038***	0.1017***	0.1042***	0.1024***	0.0769***	0.0750***	0.0841*	0.0838*
BCL dummy	-0.0288***	-0.0287***	-0.0282***	-0.0282***	-0.0106	-0.0107	-0.0438***	-0.0436***
Board size	0.0006*	0.0006*	0.0007*	0.0007*	0.0006	0.0006	0.0005	0.0005
Intercept	0.0950***	0.0950***	0.0941***	0.0943***	0.0491***	0.0502***	0.1264***	0.1259***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.239	0.2565	0.2565	0.2568	0.3198	0.3001	0.2166	0.2324
N	6,142	6,142	6,142	6,142	2,363	2,363	3,860	3,860

Table 6 Panel B	All OBS		
	RD/AT	RD/AT	RD/AT
Positive Dummy	-0.0011	-0.0016	-0.0022
POS*OverCon	-0.0039*		
Overconfidence	0.0037**		
Pos*High OC		-0.0161**	
POS*Low OC			-0.0012
High Overconfidence		0.0076*	
Low Overcon			0.0028*
Ceo tenure	0.0001	0.0001	0.0001
Ln(sales)	-0.0047***	-0.0047***	-0.0047***
Cash/ta	0.1910***	0.1914***	0.1910***
Salesgrowth	0.0217***	0.0220***	0.0219***
ROA	-0.1402***	-0.1385***	-0.1395***
TL/TA	-0.0078***	-0.0077***	-0.0078***
Stock return	0.0178***	0.0184***	0.0180***
Firm age	-0.0004***	-0.0004***	-0.0004***
Dividend payout	0.0831***	0.0800***	0.0820***
BCL dummy	-0.0254***	-0.0249***	-0.0254***
Board size	0.0005	0.0005	0.0005
Intercept	0.0912***	0.0912***	0.0924***
Number of Obs	6,223	6,223	6,223
R-Square	0.2552	0.2554	0.2550

Table 6 Panel C	Unsigned DISD1		Abs(DISD1)		Positive DISD1		Negative DISD1	
	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA
DISD1	-0.0001	-0.0001	-0.0002**	-0.0002				
Oveconf_dummy	0.0063***		0.0059***		0.0061**		0.0062***	
DISD1*Overconf.	0.0001		0.0001					
DISD1*High_over		-0.0001		0.0002				
DISD1*Low_over		-0.0001		0.0001				
High_over		0.0167***		0.0159***		0.0155**		0.0164***
Low_over		0.0027*		0.0028		0.0002		0.0042*
Ceo tenure	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
Ln(sales)	-0.0022***	-0.0021***	-0.0022***	-0.0021***	-0.001	-0.0009	-0.0019**	-0.0018**
Cash/ta	-0.1103***	-0.1096***	-0.1093***	-0.1084***	-0.0951***	-0.0940***	-0.1149***	-0.1144***
Salesgrowth	0.0067**	0.0067**	0.0067**	0.0067**	0.0025	0.0026	0.0110**	0.0109**
ROA	0.0215**	0.0229**	0.0220***	0.0235***	0.0264**	0.0284**	0.0229**	0.0239**
TL/TA	-0.0006	-0.001-	-0.0013	-0.0018	-0.0024	-0.0029	-0.0027	-0.0028
Stock return	0.0034	0.0038	0.0035	0.0039	-0.0045	-0.0039	0.0043	0.0047
Firm age	0.0001	0.0002	0.0002	0.0002	-0.0002	-0.0002	0.0003*	0.0003*
Dividend payout	0.043	0.0422	0.0426	0.0412	-0.0707*	-0.0724*	0.0648*	0.0652*
BCL dummy	0.0042	0.0046	0.004	0.0044	0.0147	0.0149	-0.0013	-0.0007
Board size	-0.0011***	-0.0011***	-0.0011***	-0.0011***	-0.0014*	-0.0014*	-0.0013***	-0.0013***
Intercept	0.0719***	0.0703***	0.0728***	0.0712***	0.0744***	0.0734***	0.0723***	0.0706***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.0563	0.0575	0.0567	0.0579	0.0513	0 .0520	0.0584	0.0598
N	6,139	6,139	6,139	6,139	2,354	2,354	3,860	3,860

Table 6 Panel D	All OBS		
	CAPX/AT	CAPX/AT	CAPX/AT
Positive Dummy	-0.0004	-0.0007	-0.0001
POS*OverCon	0.0001		
Overconfidence	0.0062***		
Pos*High OC		0.0004	
POS*Low OC			-0.004
High Overconfidence		0.0154***	
Low Overcon			0.0032
Ceo tenure	-0.0001	-0.0001	-0.0001
Ln(sales)	-0.0015***	-0.0014***	-0.0015***
Cash/ta	-0.1070***	-0.1060***	-0.1063***
Salesgrowth	0.0066***	0.0068***	0.0076***
ROA	0.0239***	0.0264***	0.0288***
TL/TA	-0.0026	-0.0031	-0.0027
Stock return	0.0022	0.0029	0.0036
Firm age	0.0001	0.0001	0.0001
Dividend payout	-0.0037	-0.0056	-0.0132
BCL dummy	0.0067	0.0074	0.0079
Board size	-0.0014***	-0.0014***	-0.0014***
Intercept	0.0705***	0.0693***	0.0710***
Number of Obs	6,214	6,214	6,214
RSquare	0.0531	0.0538	0.0508

Table 6 Panel E	Unsigned DISD1		Abs(DISD1)		Positive DISD1		Negative DISD1	
	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage
DISD1	-0.0004	-0.0003	-0.0032***	-0.0032***				
Oveconf_dummy	-0.0320***		-0.0327***		-0.0433***		-0.0193***	
DISD1*Overconf.	0.0015*		-0.0009					
DISD1*High_over		0.0043***		-0.0001				
DISD1*Low_over		0.0005		-0.0014				
High_over		-0.0243**		-0.0325**		-0.0084		-0.0349**
Low_over		-0.0247***		-0.0229**		-0.0284*		-0.0187**
Ceo tenure	-0.0017***	-0.0018***	-0.0016***	-0.0017***	-0.0019***	-0.0021**	-0.0013***	-0.0013***
Ln(sales)	0.0419***	0.0420***	0.0409***	0.0410***	0.0353***	0.0360***	0.0435***	0.0434***
MB	0.0417***	0.0399***	0.0453***	0.0432***	0.0649***	0.0611***	0.0225***	0.0227***
ROA	-0.5068***	-0.5147***	-0.4889***	-0.4973***	-0.4545***	-0.4629***	-0.5293***	-0.5336***
PPE_at	0.0577***	0.0578***	0.0545***	0.0546***	0.0824***	0.0837***	0.0385***	0.0383***
RD_at	-0.5081***	-0.4927***	-0.5020***	-0.4882***	-0.7060***	-0.6768***	-0.3369***	-0.3360***
Stock return	0.0411**	0.0352	0.0419**	0.0366*	0.1188***	0.1093***	-0.004	-0.005
BCL dummy	-0.0164	-0.0188	-0.0218	-0.0254	0.0802	0.0749	-0.0804**	-0.0813**
Board size	0.0036**	0.0037**	0.0026*	0.0027*	0.0021	0.0022	0.0047***	0.0047***
Intercept	0.1741***	0.1744***	0.2023***	0.2046***	0.1352***	0.1346***	0.2231***	0.2240***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.1413	0.1403	0.1562	0.1543	0.1012	0.0984	0.2076	0.208
N	7,533	7,533	7,533	7,533	2,902	2,902	4,671	4,671

Table 6 Panel F	All OBS		
	Leverage	Leverage	Leverage
Positive Dummy	0.0643***	0.0644***	0.0669
POS*OverCon	0.0088		
Overconfidence	-0.0324***		
Pos*High OC		0.0768***	
POS*Low OC			0.0037
High Overconfidence		-0.0522***	
Low Overcon			-0.0210**
Ceo tenure	-0.0016***	-0.0017***	-0.0017***
Ln(sales)	0.0411***	0.0410***	0.0413***
MB	0.0398***	0.0375***	0.0367***
ROA	-0.4952***	-0.5073***	-0.5029***
PPE_at	0.0549***	0.0558***	0.0554***
RD_at	-0.4800***	-0.4624***	-0.4590***
Stock return	0.0376	0.0313	0.0305
BCL dummy	-0.0022	-0.0073	-0.0068
Board size	0.0035**	0.0036**	0.0037**
Intercept	0.1445***	0.1459***	0.1445***
Number of Obs	7,573	7,573	7,573
R-Square	0.159	0.1577	0.1571

Table 6 Panel G	Unsigned DISD1		Abs(DISD1)		Positive DISD1		Negative DISD1	
	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset	Cash/Asset
DISD1	0.0006***	0.0005***	0.0010***	0.0009***				
Oveconf_dummy	-0.0074**		-0.0087***		-0.0070*		-0.0086***	
DISD1*Overconf.	0.0001		0.0004					
DISD1*High_over		-0.0005		-0.0005				
DISD1*Low_over		0.0005		0.0012**				
High_over		-0.0241***		-0.0207***		-0.0204**		-0.0246***
Low_over		-0.0026		-0.0069**		-0.0106**		-0.0003
Ceo tenure	-0.0005***	-0.0005***	-0.0006***	-0.0006***	0.0003	0.0003	-0.0009***	-0.0009***
Ln(sales)	-0.0108***	-0.0110***	-0.0104***	-0.0106***	-0.0106***	-0.0108***	-0.0110***	-0.0112***
MB	0.0194***	0.0197***	0.0182***	0.0188***	0.0244***	0.0249***	0.0151***	0.0155***
ROA	0.0419***	0.0397***	0.0382***	0.0355***	-0.0088	-0.0091	0.0939***	0.0897***
PPE_at	-0.0506***	-0.0506***	-0.0495***	-0.0495***	-0.0516***	-0.0520***	-0.0488***	-0.0488***
RD_at	0.5047***	0.5005***	0.5036***	0.4985***	0.5404***	0.5343***	0.4869***	0.4846***
Stock return	-0.0174**	-0.0174**	-0.0177**	-0.0178**	-0.0018	-0.0012	-0.0308**	-0.0310**
BCL dummy	0.0148	0.0147	0.015	0.015	-0.016	-0.015	0.0510**	0.0502**
Board size	-0.0021***	-0.0022***	-0.0019***	-0.0019***	-0.0023**	-0.0024**	-0.0018***	-0.0019***
Intercept	0.1773***	0.1784***	0.1700***	0.1704***	0.1958***	0.1965***	0.1468***	0.1477***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.2636	0.2651	0.2686	0.2706	0.3015	0.303	0.2397	0.2408
N	7,420	7,420	7,420	7,420	2,852	2,852	4,608	4,608

Table 6 Panel H	All OBS		
	CASH	CASH	CASH
Positive Dummy	0.0006	0.0016	0.0035
POS*OverCon	0.0048		
Overconfidence	-0.0096***		
Pos*High OC		0.0133	
POS*Low OC			-0.0092
High Overconfidence		-0.0284***	
Low Overcon			0.0016
Ceo tenure	-0.0005***	-0.0005***	-0.0006***
Ln(sales)	-0.0108***	-0.0110***	-0.0107***
MB	0.0190***	0.0193***	0.0180***
ROA	0.0463***	0.0431***	0.0433***
PPE_at	-0.0504***	-0.0505***	-0.0503***
RD_at	0.5041***	0.5013***	0.5097***
Stock return	-0.0182***	-0.0185***	-0.0203***
BCL dummy	0.0135	0.0133	0.012
Board size	-0.0021***	-0.0022***	-0.0021***
Intercept	0.1779***	0.1783***	0.1772***
Number of Obs	7,460	7,460	7,460
R-Square	0.2589	0.26	0.258

Table 6 Panel I	All OBS		Abs Obs		Positive Obs		Negative Obs	
	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT	MV/AT
DISD1	0.0058***	0.0051***	0.0106***	0.0107***				
DISD1*OverCon	-0.0023		0.0053**					
Overconfidence	0.2797***		0.2583***		0.3913***		0.2262***	
Deviation*High OC		-0.0033		0.0222***				
Deviation*Low OC		0.0012		0.0033				
High Overcon		0.5004***		0.4000***		0.4060***		0.4882***
Low Overcon		0.1969***		0.1858***		0.3597***		0.1443***
Et	0.0000***	0.0000***	0.0000***	0.0000***	0.0001***	0.0000***	0.0001***	0.0000***
d1Et	-0.2931*	-0.2705*	-0.3054**	-0.2800**	-0.3726*	-0.3627*	-0.2426*	-0.2217*
d2Et	0.093	0.0669	0.086	0.061	0.3849*	0.3796*	-0.073	-0.102
d1At	-0.4976***	-0.5017***	-0.4784***	-0.4769***	-0.3665**	-0.3735**	-0.5549***	-0.5596***
d2At	-0.4384***	-0.4200***	-0.4423***	-0.4250***	-0.5460***	-0.5430***	-0.2754***	-0.2492***
d1Rd	0.5011	0.5023	0.4872	0.5239	0.9544	0.8779	0.5413	0.4863
d2Rd	0.2541	0.2498	0.1193	0.1451	-0.0012	0.0723	1.0145	1.0265
d1It	-5.0719*	-5.1810*	-5.1544*	-5.2374*	-9.9667*	-9.8990*	-1.8282	-1.9901
d2It	4.6820**	4.4605**	5.3179**	5.0852**	8.0207**	7.9388**	0.3789	0.2285
d1Dt	0.443	0.4756	0.4463	0.4807	1.4325**	1.4219**	-0.0746*	-0.0261*
d2Dt	-0.295	-0.2715	-0.2855	-0.2721	-0.2065	-0.1928	-0.4617*	-0.4002*
d1Vt	0.4637***	0.4634***	0.4547***	0.4510***	0.4182***	0.4274***	0.4688***	0.4660***
d2Vt	0.4789***	0.4885***	0.4719***	0.4821***	0.3137***	0.3255***	0.5365***	0.5412***
Intercept	0.4884***	0.5120***	0.4518***	0.4744***	0.4901***	0.5089***	0.4740***	0.4953***
Number of Obs	5,331	5331	5331	5331	1452	1452	3896	3896
R-Square	0.3727	0.369	0.3836	0.3821	0.2041	0.1976	0.4416	0.4412

Table 7 Panel A	Unsigned DISD2		Positive DISD2		Negative DISD2	
	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA	RD/TA
DISD2	-0.0001***	-0.0001**				
Oveconf_dummy	0.0025*		-0.002		0.0039***	
DISD2*Overconf.	0.0002**					
DISD2*High_over		0.0001				
DISD1*Low_over		0.0002				
High_over		0.0026		-0.0093*		0.0102**
Low_over		0.0028		0.0001		0.0034
Ceo tenure(n-1)	0.0001	0.0001	-0.0001	0.0001	0.0001	0.0001
Ln(sales)(n-1)	-0.0048***	-0.0049***	-0.0034***	-0.0034***	-0.0050***	-0.0050***
Cash/ta(n-1)	0.1862***	0.1866***	0.2199***	0.2197***	0.1653***	0.1656***
Salesgrowth(n-1)	0.0191***	0.0192***	0.0248***	0.0250***	0.0169***	0.0170***
ROA(n-1)	-0.1112***	-0.1104***	-0.1043***	-0.1042***	-0.1120***	-0.1120***
TL/TA(n-1)	-0.0079***	-0.0075***	-0.0044	-0.0041	-0.0124***	-0.0124***
Stock return(n-1)	0.0162***	0.0166***	0.0260***	0.0265***	0.0089	0.0095
Firm age(n-1)	-0.0004***	-0.0004***	-0.0001	-0.0001	-0.0005***	-0.0005***
Dividend payout(n-1)	0.0756***	0.0738***	0.0496	0.0482	0.0582	0.0592
BCL dummy(n-1)	-0.0294***	-0.0291***	-0.0379***	-0.0378***	-0.0069	-0.0067
Board size(n-1)	0.0008**	0.0008**	0.0006	0.0006	0.0008*	0.0008*
Intercept	0.0909***	0.0907***	0.0710***	0.0718***	0.0827***	0.0824***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.2416	0.2414	0.2883	0.2891	0.2165	0.217
N	4,994	4,994	1,796	1,796	3,276	3,276

Table 7 Panel B	Unsigned DISD2		Positive DISD2		Negative DISD2	
	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA	CAPX/TA
DISD2	-0.0001**	-0.0001**				
Oveconf_dummy	0.0032**		0.0046**		0.0021	
DISD2*Overconf.	0.0001					
DISD2*High_over		0.0001				
DISD1*Low_over		-0.0001				
High_over		0.0062		0.0102**		0.0034
Low_over		0.0029		0.0009		0.0036
Ceo tenure(n-1)	0.0001	0	-0.0002	-0.0002	0.0001	0
Ln(sales)(n-1)	-0.0020***	-0.0020***	-0.0008	-0.0008	-0.0021***	-0.0021***
Cash/ta(n-1)	-0.0921***	-0.0918***	-0.0600***	-0.0592***	-0.1061***	-0.1061***
Salesgrowth(n-1)	0.0077***	0.0078***	0.0078***	0.0077***	0.0080***	0.0080***
ROA(n-1)	0.0360***	0.0363***	0.0396***	0.0407***	0.0386***	0.0383***
TL/TA(n-1)	-0.0027	-0.0028	-0.0031	-0.0034	-0.0002	0
Stock return(n-1)	0.0072	0.0075	-0.0069	-0.0071	0.0121*	0.0122*
Firm age(n-1)	0.0002*	0.0002*	0.0001	0.0001	0.0002	0.0002
Dividend payout(n-1)	0.0612**	0.0604**	-0.0322	-0.035	0.0907**	0.0912**
BCL dummy(n-1)	0.0074	0.0076	0.015	0.0152	0.0008	0.0007
Board size(n-1)	-0.0010**	-0.0010**	-0.0007	-0.0007	-0.0014**	-0.0014**
Intercept	0.0595***	0.0593***	0.0432***	0.0426***	0.0717***	0.0718***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	YEs	Yes	Yes	Yes
Adj r2	0.0506	0.0507	0.0402	0.0404	0.0544	0.0549
N	4,993	4,993	1,774	1,774	3,276	3,276

Table 7 Panel C	Unsigned DISD2		Positive DISD2		Negative DISD2	
	Leverage	Leverage	Leverage	Leverage	Leverage	Leverage
DISD2	-0.0001	-0.0001				
Oveconf_dummy	-0.0257***		-0.0185		-0.0267***	
DISD2*Overconf.	0.0014***					
DISD2*High_over		0.0074***				
DISD2*Low_over		0.0005				
High_over		0.0198		0.0268		-0.0208
Low_over		-0.0243***		-0.0149		-0.0273***
Ceo tenure(n-1)	-0.0014***	-0.0015***	-0.0031***	-0.0032***	-0.0004	-0.0005
Ln(sales)(n-1)	0.0409***	0.0411***	0.0378***	0.0385***	0.0414***	0.0416***
MB(n-1)	0.0382***	0.0365***	0.0866***	0.0849***	0.0085***	0.0074***
ROA(n-1)	-0.4554***	-0.4609***	-0.5527***	-0.5567***	-0.3926***	-0.3962***
PPE_at(n-1)	0.0530***	0.0532***	0.0702***	0.0707***	0.0421***	0.0423***
RD_at(n-1)	-0.5003***	-0.4898***	-0.9560***	-0.9420***	-0.2266***	-0.2194***
Stock return(n-1)	0.0414*	0.0372*	0.0451	0.0379	0.0430*	0.0405*
BCL dummy(n-1)	-0.0064	-0.0082	0.0328	0.0289	-0.0282	-0.0304
Board size(n-1)	0.0032**	0.0034**	0.0005	0.0006	0.0045***	0.0046***
Intercept	0.1840***	0.1817***	0.1678**	0.1644**	0.2070***	0.2066***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.1296	0.1342	0.1105	0.1105	0.185	0.1842
N	6,304	6,304	2,264	2,264	4,076	4,076

Table 7 Panel D	Unsigned DISD2		Positive DISD2		Negative DISD2	
	CH/AT	CH/AT	CH/AT	CH/AT	CH/AT	CH/AT
DISD2	0.0003***	0.0002***				
Oveconf_dummy	0.0022		0.0018		-0.0003	
DISD2*Overconf.	0.0003**					
DISD2*High_over		0.0002				
DISD2*Low_over		0.0001				
High_over		-0.0152**		-0.0095		-0.0205***
Low_over		0.0033		-0.0043		0.0046
Ceo tenure(n-1)	-0.0006***	-0.0006***	0.0002	0.0002	-0.0010***	-0.0010***
Ln(sales)(n-1)	-0.0082***	-0.0086***	-0.0097***	-0.0098***	-0.0075***	-0.0076***
MB(n-1)	0.0155***	0.0175***	0.0224***	0.0230***	0.0146***	0.0153***
ROA(n-1)	0.0026	-0.0142	-0.0977***	-0.0967***	0.0379***	0.0374***
PPE_at(n-1)	-0.0458***	-0.0465***	-0.0477***	-0.0480***	-0.0456***	-0.0456***
RD_at(n-1)	0.5334***	0.5385***	0.5836***	0.5782***	0.4989***	0.4963***
Stock return(n-1)	-0.0337***	-0.0242***	-0.002	-0.0005	-0.0404***	-0.0404***
BCL dummy(n-1)	0.0017	0.0148	-0.0027	-0.001	0.0431*	0.0430*
Board size(n-1)	-0.0031***	-0.0029***	-0.0027	-0.0028	-0.0028***	-0.0029***
Intercept	0.1824***	0.1697***	0.1832***	0.1836***	0.1368***	0.1377***
Industry fe	Yes	Yes	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes	Yes	Yes
Adj r2	0.2463	0.2529	0.3033	0.3037	0.226	0.2279
N	6,200	6,200	2,219	2,219	4,017	4,017

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Appendix 2.A: Variable definitions

Ch_at: Cash scale by book value of total assets.

Size: natural log of book value of assets.

Divdummy: Dividend dummy set to 1 if the company pays dividend otherwise zero.

Cashflow: calculated as: EBITDA-interest-taxes- common dividends, and then scale by total assets.

Nwcap: net working capital is net working capital minus cash and marketable securities and then scale by

total assets.

Capx_TA: capital expenditures scaled by total assets.

Leverage: market debt ratio calculated by book value of liability/market value of asset.

MB: market to book ratio of assets: (book liabilities + market value of equity)/total assets.

Rddummy: R&D dummy set to one if firm did not report R&D expenses.

Rd_ta: R&D expense scale by total assets.

Lnta: log of asset size, measured in 1983 dollars.

Dep-at: depreciation (Compustat item [14]) as a proportion of total assets

Overceo: overconfident CEO dummy set to one if CEO consider as overconfident.

Delaware: Delaware dummy set to one is the firm incorporated in Delaware otherwise 0.

After95: after 95 dummy set to one for firm years after 1995, and zero otherwise.

BCL: BCL dummy set to one if firm incorporated in a stat and in a year that business combination law has passed.

Sales growth rate: The ratio of total sales (revt) in year *t* to total sales in year *t*-1.

Firm Equity: Market value of firm equity

Firm debt: Current debt and long-term debt of firms

CEO age: The age of the CEO at fiscal year t.

CEO tenure: CEO tenure is the number of years that the current CEO has served in that capacity as reported in the ExecuComp database.

CEO equity: Sum of the value of stock and stock option**.**

CEO debt: Sum of the present value ofa ccumulated pension benefits and deferred compensation as reported in Execucomp.

CEO debt to equity ratio: CEO debt divided by CEO equity

CEO relative leverage ratio (k): CEO's debt-to-equity ratio divided by the firm's debt-to-equity ratio.

CEO relative incentive ratio (k*): the ratio of the marginal change in the value of CEO inside debt holdings to the marginal change in CEO inside equity holdings given the change in firm value, all scaled by the firm's respective ratio.

DISD1: Actual k ratio minus the optimal k ratio

DISD2: Actual k* ratio minus the optimal k* ratio

Appendix 2.B. Estimating Option value

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

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

Where

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

N = Cumulative probability function for the normal distribution

S = Underlying stock price

X = Option exercise price

T = Time to maturity of the option (in years)

d = Natural log of expected dividend yield over the life of the option

r = Natural log of risk-free interest rate

σ = Expected stock return volatility over the life of the option

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

i) Exercise price for unexercised options: To estimate the average exercise price forunexercised exercisable options, We follow a two-step process. First, Wecompute

the ratio of the realizable value of in-the-money exercisable options and the number of unexercised exercisable options. Second, We subtract this ratio from the fiscal yearend stock price. The resulting number is an estimate of the average exercise price for unexercised exercisable options held by executives. Similarly, an estimate of the average exercise price of unexercised unexercisable options can be obtained by subtracting the ratio of in-the-money unexercisable options to the number of unexercised unexercisable options from the fiscal year-end stock price.

ii) Option maturity for unexercised exercisable options: The maturity of unexercised exercisable options is assumed to be 4 years less than the average maturity of the new grants. In case no grants are made this year, the maturity is set at 6 years. The maturity of unexercisable options is set at 1 less than the average maturity of the new grants. In case no grants are made this year, the maturity is set at 9 years.

iii) Stock price, risk-free rate, dividend yield, and volatility: These inputs are obtained from Compustat, CRSP, and ExecuComp databases

Appendix 2.C. Fama French 1998 firm value variables

We estimate regressions using the method of Fama and MacBeth (1973). Each regression includes cross-sections. *Xt* is the level of variable *X* in year *t* divided by the of assets in year t. *dXt* is the change in the level of *X* from year *t*-1 to year *t* divided by total assets year *t ((Xt - Xt-1)/At). A* is the book value of assets. *dXt-1*, is the change in the level of *X* from year *t+1* divided by assets in year *t ((Xt 1 - Xt)/At). V* is the market value of the equity plus the value of debt. *E* is earnings defined as earnings before extraordinary items plus interest plus deferred tax credits plus investment tax credits. *NA* is net assets, which is defined as total assets minus *RD* is research and development expense. When R&D is missing, it is set to zero. I is interest expense. *D* is common dividends. *L* is liquid assets, defined as cash and cash equivalents.

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EDUCATION

Old Dominion University, Strome College of Business May, 2020
PhD degree in Finance

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CONFERENCE PAPERS

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FELLOWSHIPS, AWARDS & MISCELLANEOUS SERVICES

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[3] Outstanding Graduate Student Award 2011
[4] Vice President and Treasurer of Chinese Students and Scholars Association 2011
[5] Organizer of Global student friendship organization 2010-2016
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