

Internet Appendix  
for  
Managerial Beliefs and Corporate Financial Policies\*

Ulrike Malmendier, Geoffrey Tate, and Jon Yan

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## I. Model of Capital Structure with CEO Overconfidence

In this Section, we provide a simple theoretical framework to examine the capital structure predictions of one specific variation in managerial beliefs: CEO (over-)confidence. The model formalizes the hypothesis development of the main paper and helps to clarify the more subtle predictions such as the conditions under which the preference of overconfident CEOs for debt over equity are reversed.

We define overconfidence as the overestimation of mean future cash flows. The emphasis on the mean distinguishes our approach from previous theoretical literature on overconfidence. Hackbarth (forthcoming) models the underestimation of variance to generate different capital-structure implications. Heaton (2002) models an upward shift in the probability of the good (high cash flow) state, which does not disentangle which theoretical results are generated by the implied bias in means and which by the implied bias in variance. Relatedly, one theoretical contribution of our paper lies in showing that the overestimation of cash flows in non-default states (i.e. overvaluation of the residual claim) generates a preference between risky debt and equity. The modeling approach of Heaton (shift in probabilities) does not allow for this mechanism.

We abstract from market frictions like agency costs and asymmetric information. However, such factors do not change our predictions as long as they affect managers uniformly and are not sufficient to create boundary solutions (e.g. full debt financing for a rational CEO). In our empirical work, we use a variety of controls and identification strategies to control for such imperfections and, hence, identify residual CEO-level variation which is unexplained by traditional theories.

We consider a manager's decision to undertake and finance a single, non-scalable investment project with cost  $I$  and stochastic return  $\tilde{R}$ , given by  $R_G$  with probability  $p \in (0; 1)$  and  $R_B$  with probability  $1 - p$ , where  $R_G > I > R_B$ . The investment cost and the return distribution are common knowledge. To fix the rational capital-structure choice, we allow for two frictions, taxes and bankruptcy costs. The firm pays a marginal rate  $\tau$  on the net return  $\tilde{R} - I$  if  $\tilde{R} > I$  and incurs a deadweight loss  $L$  in the case of bankruptcy. We assume perfectly competitive debt and equity markets and normalize the risk-free interest rate to zero. The firm has existing assets  $A$  and internal funds  $C$ . The CEO maximizes the perceived value of the company to existing shareholders. Note that a shareholder-value maximizing CEO never buys back shares since it is a zero-sum game from the perspective of shareholders: Some current shareholders are helped at the expense of other current shareholders. We allow for the possibility that the CEO overestimates (after-tax) project returns  $\tilde{R} - \tau 1_{\{\tilde{R} > I\}}(\tilde{R} - I)$ :  $\hat{E}[\cdot] > E[\cdot]$ . He may also overestimate the value of assets in place  $A$ ,  $\hat{A} > A$ .

We proceed in two steps. We first consider the unconditional choice between internal and external financing. We then condition on accessing external financing and analyze the choice between risky debt and equity.

Starting from the unconditional choice between internal and external financing, we first compare using cash and riskless debt, denoted by  $c \leq C$ , to using equity. (Later, we consider the possibility that the CEO exhausts cash and riskless debt capacity, creating a choice between risky debt and equity.) We assume that the firm has  $s > 0$  shares outstanding and denote by  $s' \geq 0$  the number of new shares issued as part of the financing plan. We also assume that the bias in the CEO's expectation of project returns and in his valuation of existing assets does not depend on  $c$ .<sup>1</sup>

**Proposition 1** *Overconfident CEOs strictly prefer internal finance to equity and use weakly more internal financing than rational CEOs.*

*Proof.* The participation constraint of new shareholders to provide equity financing is

$$\frac{s'}{s + s'} \left( E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - c \right) = I - c.$$

Thus, the manager's perception of the value of current shareholders' claims after equity financing is

$$\begin{aligned} G &= \left( 1 - \frac{s'}{s + s'} \right) \left( \widehat{E}[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + \widehat{A} + C - c \right) \\ &= \frac{\widehat{E}[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + \widehat{A} + C - c}{E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - c} \left( E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - I \right). \end{aligned}$$

Then

$$\begin{aligned} \frac{\partial G}{\partial c} &= \frac{\left( \widehat{E}[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] - E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] \right) + (\widehat{A} - A)}{\left( E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - c \right)^2} \\ &\quad \left( E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - I \right). \end{aligned}$$

Notice that the numerator of the fraction is zero if the CEO is rational,  $\widehat{E}[\cdot] = E[\cdot]$  and  $\widehat{A} = A$ , and that it is positive for overconfident CEOs by the definition of overconfidence. Hence,  $\frac{\partial G}{\partial c} = 0$  for unbiased CEOs, and  $\frac{\partial G}{\partial c} > 0$  for overconfident CEOs if and only if  $E[\tilde{R} - \tau \mathbf{1}_{\{R > I\}}(\tilde{R} - I)] + A + C - I > 0$ . That is, as long as firm value is positive, an overconfident CEO maximizes the perceived value on  $c \in [0, I]$  by setting the internal financing  $c$  as high as possible. A rational CEO, instead, is indifferent among all financing plans and, hence, uses

weakly less internal funding than overconfident CEOs. Q.E.D.

The intuition for Proposition 1 is that overconfident CEOs perceive the price investors are willing to pay for new issues  $s'$  to be too low since they believe markets underestimate future returns. This logic immediately extends to the CEO's preference between internal finance (if available) and risky debt if the CEO overestimates cash flows in the default state ( $R_B$ ): Since he overestimates cash flows going to creditors, he perceives interest payments on debt to be too high. Thus, overconfident CEOs have a strict preference for internal financing over any form of external finance and exhaust cash reserves and riskless debt capacity before issuing risky securities.

Next, we analyze the choice between the two types of risky external financing, risky debt and equity, conditional on accessing external capital markets. From Proposition 1, overconfident CEOs will exhaust all cash and riskless debt capacity before raising risky capital. Thus, for simplicity, we set cash and existing assets (which can be collateralized) equal to 0,  $\hat{A} = A = C = 0$ . Conditional on implementing the project, the resulting maximization problem is:

$$\max_{d,s} \frac{s}{s+s'} \hat{E}[(\tilde{R} - \tau \mathbf{1}_{\{R>I\}}(\tilde{R} - I - [w - d]) - w)^+] \quad (1)$$

$$\text{s.t.} \quad \frac{s'}{s+s'} E[(\tilde{R} - \tau \mathbf{1}_{\{R>I\}}(\tilde{R} - I - [w - d]) - w)^+] = I - d \quad (2)$$

$$E[\min\{w, \tilde{R} - L\}] = d \quad (3)$$

$$R_B \leq d \leq I \quad (4)$$

where  $w$  is the face value of debt,  $d$  the market value of debt, and  $L$  the deadweight loss from bankruptcy. Interest payments  $w - d$  are tax deductible. The CEO maximizes the perceived expected returns accruing to current shareholders after subtracting taxes and repaying debt.

Constraints (2) and (3) are the participation constraints for new shareholders and lenders, respectively. Note that the compensation required for equity and debt financing depends on investors' unbiased beliefs rather than managerial perception. Condition (4) reflects that we are considering the case of risky debt, i. e., the choice between debt and equity after exhausting all riskless debt capacity created by the project.

The following Proposition characterizes the financing choice of rational CEOs ( $\hat{E}[\cdot] = E[\cdot]$ ):

**Proposition 2** *Rational CEOs finance the risky portion of investment,  $I - R_B$ , using only risky debt if the tax benefits are high relative to bankruptcy costs,  $\frac{\tau(I-R_B)}{1-\tau} > L$ . They use only equity if the tax benefits are low relative to bankruptcy costs,  $\frac{\tau(I-R_B)}{1-\tau} < L$ . They are indifferent if  $\frac{\tau(I-R_B)}{1-\tau} = L$ .*

*Proof.* For notational simplicity, define  $Q \equiv E[(\tilde{R} - \tau 1_{\{R > I\}}(\tilde{R} - I - [w - d]) - w)^+]$ . Using the participation constraint for shareholders (2) and the fact that  $E[\cdot] = \hat{E}[\cdot]$  for rational CEOs, we can re-write the maximand as  $Q - (I - d)$ . We consider separately the case in which the CEO uses at least some risky debt ( $w > d > R_B$ ) and the case in which the CEO uses no risky debt,  $w = d = R_B$ . The latter case is the lower boundary of (4).

In the first case, i.e. if  $w > R_B$ , the firm defaults in the bad state and, hence  $Q$  becomes

$$\begin{aligned} Q &= (1 - \tau)pR_G + p\tau I - (1 - \tau)pw - p\tau d \\ \iff Q - (I - d) &= (1 - \tau)pR_G - (1 - p\tau)I - (1 - \tau)pw + (1 - p\tau)d. \end{aligned} \tag{5}$$

Using (3) to substitute for  $w$ , the maximand  $Q - (I - d)$  becomes:

$$Q - (I - d) = (1 - \tau)pR_G - (1 - p\tau)I + (1 - \tau)(1 - p)(R_B - L) + \tau(1 - p)d. \tag{6}$$

Since  $d$  enters positively, value is maximized by setting  $d$  as high as possible. Thus, given boundary (4), the optimal level of debt is  $d^* = I$ . Substituting back into the maximand yields

$$Q - (I - d^*) = (1 - \tau)[pR_G + (1 - p)(R_B - L) - I].$$

In the second case,  $w = R_B$ , the firm uses only riskless debt and equity. Thus, there is no default, and we have:

$$Q = (1 - \tau)pR_G + p\tau I + (1 - p)R_B - d \quad (7)$$

$$\iff Q - (I - d) = (1 - \tau)pR_G - (1 - p\tau)I + (1 - p)R_B. \quad (8)$$

Comparing the value function at the two boundaries, we find that the manager will choose full debt financing if:

$$(1 - \tau)[pR_G + (1 - p)(R_B - L) - I] > (1 - \tau)pR_G - (1 - p\tau)I + (1 - p)R_B, \quad (9)$$

which simplifies to  $\frac{\tau(I - R_B)}{1 - \tau} > L$ . For the reverse inequality, the manager will choose full equity financing, and he is indifferent in the case of equality. **Q.E.D.**

If a CEO chooses to raise debt, it is optimal to set the debt level as high as possible since tax benefits are increasing in the amount of debt while bankruptcy costs are fixed. If the CEO chooses full equity financing, he avoids bankruptcy costs, but gives up the tax benefits of debt. The optimum, then, is either full debt or full equity financing, depending on whether the expected tax benefits,  $\tau p(w - d)$ , outweigh expected bankruptcy costs,  $(1 - p)L$ . Note that, in

the simple two-state setup, the optimal capital structure never includes both risky debt and equity. However, interior leverage choices become optimal if we add an intermediate state in which the firm may or may not default depending on the level of debt chosen.

Now consider a CEO who overestimates the returns to investment,  $\hat{E}[\cdot] > E[\cdot]$ . Specifically, assume that the CEO overestimates returns by a fixed amount  $\Delta$  in the good state,  $\hat{R}_G = R_G + \Delta$ , but correctly perceives returns in the bad state,  $\hat{R}_B = R_B$ . This assumption allows us to isolate the mechanism which generates a preference for risky debt: over-valuation of the residual claim on cash flows in the good state.

**Proposition 3** *For the risky portion of investment, overconfident CEOs choose full debt financing (rather than equity financing) more often than rational CEOs.*

*Proof.* Let  $Q \equiv E[(\tilde{R} - \tau \mathbf{1}_{\{\tilde{R} > I\}}(\tilde{R} - I - [w - d]) - w)^+]$ . Denote as  $\hat{Q}$  an overconfident manager's perception of  $Q$ . Then,  $\hat{Q} = Q + p(1 - \tau)\Delta$ . Using (2), we can write the objective function of the overconfident CEO's maximization problem as  $[Q - (I - d)]\frac{\hat{Q}}{Q}$ .

Consider first the case that the CEO uses at least some risky debt ( $w > d > R_B$ ). Then, using equations (5) and (6) and constraint (3), the maximand becomes

$$\begin{aligned} [Q - (I - d)]\frac{\hat{Q}}{Q} &= [Q - (I - d)] \left[ 1 + \frac{p(1 - \tau)\Delta}{Q} \right] \\ &= [(1 - \tau)pR_G - (1 - p\tau)I + (1 - \tau)(1 - p)(R_B - L) + \tau(1 - p)d] \cdot \\ &\quad \left[ 1 + \frac{p(1 - \tau)\Delta}{(1 - \tau)pR_G + p\tau I - (1 - \tau)[d - (1 - p)(R_B - L)] - p\tau d} \right]. \end{aligned}$$

Differentiating with respect to  $d$  yields

$$\frac{\partial}{\partial d} \left[ \frac{Q - (I - d)}{Q} \hat{Q} \right] = \tau(1 - p) + \frac{\tau(1 - p)p(1 - \tau)\Delta}{Q} + \frac{p(1 - \tau)\Delta [(1 - \tau) + p\tau]}{Q^2} [Q - (I - d)].$$



The derivative is strictly positive if  $Q > 0$  and hence  $s/(s + s')Q = Q - (I - d) > 0$ . We know that  $Q \geq 0$  since it is defined as the expectation over values truncated at 0 ( $Q \equiv E[(\tilde{R} - \tau 1_{\{R > I\}}(\tilde{R} - I - [w - d]) - w)^+]$ ). Since  $Q = p[(1 - \tau)(R_G - w) + \tau(I - d)]$  in the case of risky debt by (5), and  $R_G - w \geq 0$  (since  $w > R_G$  would yield lower payoffs to bondholders and stockholders than  $w = R_G$  due to default costs in both states), and since  $I - d \geq 0$  by (4),  $Q = 0$  if and only if  $R_G - w = 0$  and  $I - d = 0$ . Thus, we have either  $Q > 0$ , in which case the derivative is strictly positive and the manager sets  $d$  as high as possible,  $d^* = I$ , or we have  $Q = 0$ , which occurs also for  $d = I$ . In both cases, the maximand becomes:

$$[Q - (I - d)] \frac{\widehat{Q}}{Q} = \widehat{Q} = (1 - \tau)[pR_G + (1 - p)(R_B - L) - I] + p(1 - \tau)\Delta.$$

Now consider the case that  $w = d = R_B$ . Then, the firm finances  $I$  using only riskless debt and equity. There is no default and using (7) and (8) the maximand becomes

$$\begin{aligned} [Q - (I - d)] \frac{\widehat{Q}}{Q} &= [Q - (I - d)] \left[ 1 + \frac{p(1 - \tau)\Delta}{Q} \right] \\ &= [(1 - \tau)pR_G - (1 - p\tau)I + (1 - p)R_B] \cdot \\ &\quad \left[ 1 + \frac{p(1 - \tau)\Delta}{(1 - \tau)pR_G + (1 - p)R_B - R_B + p\tau I} \right]. \end{aligned}$$

Comparing the values of the objective function using the optimal amount of risky debt and all equity, we find that the manager chooses risky debt financing if and only if

$$\begin{aligned} &(1 - \tau)[pR_G + (1 - p)(R_B - L) - I] + p(1 - \tau)\Delta \\ &> \left[ 1 + \frac{p(1 - \tau)\Delta}{(1 - \tau)pR_G + (1 - p)R_B - R_B + p\tau I} \right] [(1 - \tau)pR_G - (1 - p\tau)I + (1 - p)R_B]. \end{aligned}$$

Or,

$$\tau(1-p)(I-R_B) + \left\{ p(1-\tau)\Delta \left[ 1 - \frac{(1-\tau)pR_G + (1-p)R_B - I + p\tau I}{(1-\tau)pR_G + (1-p)R_B - R_B + p\tau I} \right] \right\} > (1-\tau)(1-p)L.$$

Comparing this condition to condition (9) in Proposition 1, we see that the overconfident CEO will be more likely to use debt if and only if the term in  $\{ \}$  is positive. Since  $I > R_B$  by assumption, the term in  $[ ]$  is positive, yielding the result. **Q.E.D.**

An overconfident CEO is more likely to choose full debt financing than a rational CEO for two reasons. First, the CEO overestimates the tax benefits of debt since he overestimates future returns (i.e., overestimates cash flow  $R_G$  by  $\Delta$ ). Second, he perceives equity financing to be more costly since new shareholders obtain a partial claim on  $\Delta$  without paying for it. In our simple set-up, the CEO agrees with the market about the fair interest rate on risky debt since there is no disagreement about the probability of default or the cash flow in default states.

In our simple setting, overconfidence does not affect the decision to implement a project, conditional on external financing. Since capital markets do not finance negative net present value projects, overconfident CEOs destroy value ‘only’ by using risky debt in some cases in which equity would be cheaper. If we re-introduce  $A$  or  $C$ , overconfident CEOs may over-invest since they overvalue returns from investment and can finance negative net present value projects by diluting  $A$  or spending out of  $C$ . Likewise, if we allow for CEOs to perceive  $\hat{A} > A$ , overconfident CEOs might under-invest due to concern over diluting claims on existing assets.<sup>2</sup>

Since we used  $\hat{R}_B > R_B$  to argue that overconfident CEOs prefer internal finance to risky debt, we briefly consider the choice between risky debt and equity in the same setting, i.e., for

a CEO who overestimates not only  $R_G$  but also  $R_B$ , e.g.  $\hat{R}_B = R_B + \Delta$ . In most cases, the conclusions of Proposition 3 go through. Only if  $\hat{R}_B \geq w \geq R_B$ , i.e., if the CEO mistakenly believes that risky debt is riskless, is it possible, for a specific range of parameters, that the overconfident CEO prefers equity over risky debt. This case requires the probability of the bad state to be very large and  $\Delta$  to be sufficiently small (and an appropriate choice of the other parameters). The first parameter restriction, a high probability of the bad state, is needed so that the terms offered for debt financing seem particularly costly: The CEO believes that the required interest is unduly high (since creditors perceive cash flows to be lower by  $\Delta$  in the bad state) and that he will have to pay the overly high interest not only in the (low-probability) good state, but also in the (high-probability) bad state. Under equity financing, instead, he believes that he will maintain a fraction of  $\Delta$  in all states. The second parameter restriction, a small  $\Delta$ , is needed since the cost of equity but not of debt depend on  $\Delta$ : The perceived cost of equity increases in  $\Delta$  since new equity holders receive a fractional claim on all firm cash flows. The perceived cost of debt, instead, does not depend on  $\Delta$  since both the interest charged by creditors and the cost the CEO misperceives to be appropriate, 0, are independent of  $\Delta$ . Thus, the perceived cost of debt relative to equity can dominate the perceived benefit – namely the value of retaining the residual claim on  $\Delta$  in the good state (and the extra tax benefit on the high interest) – only if  $\Delta$  is sufficiently small. In summary, the reversed preference for equity over debt applies on only a small portion of the parameter space and, due to the required large probability of default, is unlikely to apply to our sample of *Forbes 400* firms.

Overall, our analysis demonstrates that overconfidence can generate a preference for risky debt over equity, conditional on accessing external capital markets. This preference arises because overconfident CEOs prefer being the residual claimant on the full cash flow in non-

default states to giving up a fraction of cash flows in all states. In addition, overconfident CEOs may exhibit debt conservatism. They raise little external financing of any kind, in particular less risky debt than rational CEOs. In other words, the absolute amount of debt used by overconfident CEOs can be smaller even if leverage is higher (due to less frequent equity issuance).

## II. Overconfidence Measures on Extended Sample

Below we provide details on the construction of our alternative measures of overconfidence on the 1992 to 2007 sample of *Execucomp* and *Thomson Financial* data. We also discuss their limitations relative to our original measures:

*Longholder\_Exec.* Our core measure of overconfidence exploits package-level information about strike prices and remaining duration to identify late option exercise. *Execucomp* contains such information for all CEO option packages outstanding at the end of each fiscal year, beginning in 2006. Using this data, we exactly replicate the *Longholder* measure. The drawback of this measure is the limited availability. In particular, the short time series includes very few CEO changes in a given firm, precluding fixed-effects analyses, and shows the exercise decisions of newly hired CEOs for at most 2 years.

*Longholder\_CJRS.* For years prior to 2006, *Execucomp* contains fewer details about the new options granted (total number and value) and only aggregated information on the number and value of exercised as well as outstanding options. Package-level strike prices and remaining duration, are not available.<sup>3</sup> Thus, the data does not allow us to determine whether a CEO held an option to expiration as required by the *Longholder* measure and how much it was in

the money. The closest approximation feasible with the older *Execucomp* data is the approach proposed by Campbell et al. (2009) and Hirshleifer, Teoh, and Low (2010): They use the aggregate data to calculate average strike prices and, therefore, the average moneyness of the options, assuming the options are not underwater. A CEO is then classified as overconfident for all sample years after he first holds exercisable options that are, on average, at least 67% in the money at the end of a fiscal year, mirroring our *Holder 67* measure. In addition, the CEO must fail to exercise such options at least one additional time during the sample period. Under this approach, it is not possible to impose a restriction on remaining option duration (though such a restriction is theoretically required) since the data does not allow inferences about remaining duration, even on average.

*Longholder\_Thomson (\_Fill)*. *Thomson Financial* contains transaction-level data, including the expiration date and strike price of each exercised CEO option from 1996 to the present. Thus, it should be possible to replicate the original *Longholder* measure constructed from annual snapshots of CEO option-holdings. To do so, we follow a procedure similar to Otto (2009) and classify a CEO as overconfident if the CEO exercises an option in the final year of its duration and the option is at least 40% in-the-money one year prior to its expiration date. However, we find that the insider filings, particularly for derivative transactions, are noisy. We must drop more than 25% of CEO option exercises due to cleanse codes which indicate poor data quality, absence of required data items (strike prices or expiration dates), and obvious reporting mistakes (e.g. transaction date after the expiration date). These issues also raise doubts about how to classify CEOs for whom we do not observe (usable) exercise information, particularly since we know from the *Execucomp* snapshots that most of these CEOs have options. We consider two possibilities: (1) we include only CEOs for whom we observe at least

one *Thomson* option exercise (*Longholder\_Thomson*) and (2) we include all *Execucomp* CEOs (*Longholder\_Thomson\_Fill*). The two variables differ only in the comparison group; the set of CEOs classified as overconfident is identical.

The exact steps we follow to identify overconfidence under the *Longholder\_Thomson* measures are as follows:

To begin, we download all Table 2 transactions for firms in our *Execucomp* sample, requiring the role code to equal “CEO.” We then apply the following filters:

1. We keep only observations for which *Thomson* cleanse codes indicate a reasonable degree of data accuracy (“R,” “H,” “C,” “L,” or “I”).
2. We drop observations which are amendments of prior records to avoid double-counting transactions (*amend* = “A”).
3. We require the acquisition/disposition flag to indicate that the record represents disposal of securities (*acqdisp* = “D”).
4. We keep only derivative codes which indicate the securities in question are call options (“OPTNS,” “ISO,” “CALL,” “NONQ,” “EMPO,” “DIRO,” “DIREO,” “EMPLO,” “NON Q,” “NONQU,” “SAR,” “OPTIO,” “EMP.,” “EMPL”).
5. We drop observations with missing strike prices or exercise dates.
6. We drop observations with implausible values of the strike price (*xprice* < 0.1 or *xprice* > 2000).
7. We keep only records with transaction codes indicating option exercises (*trancode* = “M,” “X,” “H,” or “F”)

Next, we merge the resulting data with monthly stock price data from *CRSP*. We identify all option exercises which meet two “*Longholder*” criteria: (1) the exercise occurs within 365 calendar days of option expiration and (2) the option was at least 40% in the money 12 months prior to the month of expiration (using the *CRSP* end-of-the-month stock price). We then merge the *Thomson* data to our *Execucomp* sample, retaining an option exercise observation only if the insider name in the *Thomson* data matches the CEO name in *Execucomp*. Finally, we set the variable *Longholder\_Thomson* or *Longholder\_Thomson\_Fill* equal to 1 if we observe at least one option exercise meeting the two *Longholder* criteria during the CEO’s tenure in our *Execucomp* panel. The two measures differ only in the control groups (i.e. the CEO-years for which the variable is set to 0). For *Longholder\_Thomson*, we include a CEO in the control group only if we observe at least one option exercise by the CEO in the *Thomson* data, but never an exercise that meets the two *Longholder* criteria. For *Longholder\_Thomson\_Fill*, we include all *Execucomp* CEOs for whom we never observe an option exercise meeting the two *Longholder* criteria.

In Table AI, we present summary statistics of the extended sample of firm-years (Panel I). Under the columns denoted (II), (III), and (IV) we present summary statistics of overconfident CEO-years under each of the overconfidence measures described above. The most pronounced differences are in firm size: *Longholder\_Exec* CEOs operate firms with more assets, though the difference also reflects the later sample years. They also have the highest kinks. Insert Table AI here.

In Table AII, we provide additional information on the four overconfidence measures, including the pairwise correlations between the measures and with lags of firm performance. This table supplements the discussion in Section VI of the main text. Insert Table AII here.

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## Notes

<sup>1</sup>Formally, we assume  $\frac{\partial}{\partial c} \hat{E}[\tilde{R} - \tau 1_{\{R>I\}}(\tilde{R} - I)] = 0$  and  $\frac{\partial}{\partial c} \hat{A} = 0$ .

<sup>2</sup>Propositions 1 and 2 of Malmendier and Tate (2004) derive these results formally in a parallel setup for external investment projects (mergers).

<sup>3</sup>In principle, the data allows one to track new grants over time and attempt to match changes in aggregate option holdings back to their original annual grant “package” using, e.g., a first-in first-out allocation rule. This approach is noisy and reduces the usable sample period to a few years. Instead, we construct an alternative measure using *Thomson* transaction-level data which contains explicit information on the expiration dates and strike prices of exercised (and expiring) options.

**Table AI. Summary Statistics (Execucomp Sample)**

**Panel A. Financing Deficit Variables**

Net financing deficit is cash dividends plus net investment plus change in working capital minus cash flow after interest and taxes. Net investment is capital expenditures plus increase in investments plus acquisitions plus other uses of funds minus sale of property, plants, and equipment minus sale of investment. Change in working capital is change in operating working capital plus change in cash and cash equivalents plus change in current debt. Cash flow after interest and taxes is income before extraordinary items plus depreciation and amortization plus extraordinary items and discontinued operations plus deferred taxes plus equity in net loss (earnings) plus other funds from operations plus gain (loss) from sales of property, plants, and equipment and other investments. Net debt issues are long term debt issuance minus long term debt reduction. Net equity issues are sales of common stock minus stock repurchases. Profitability is operating income before depreciation, normalized by assets at the beginning of the year. Tangibility is property, plants, and equipment, normalized by assets at the beginning of the year. Q is the market value of assets over the book value of assets, where market value of assets is the book value of assets plus market equity minus book equity.  $\Delta$  denotes one-year changes.

Variable	Full Sample (I)			Longholder_Exec Sample (II)			Longholder_CJRS Sample (III)			Longholder_Thomson(_Fill) Sample (IV)		
	Number of Firms = 2,166			Number of Firms = 270			Number of Firms = 1,359			Number of Firms = 763		
	Num. Firm-Years = 13,948 (w/ Net Equity Issues) = 13,556			Num. Firm-Years = 377 (w/ Net Equity Issues) = 367			Num. Firm-Years = 7,151 (w/ Net Equity Issues) = 6,952			Num. Firm-Years = 5,097 (w/ Net Equity Issues) = 4,932		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Assets (\$m)	5507.56	1112.16	22779.22	12870.27	2053.48	57899.51	4665.88	1108.21	15685.05	6879	1516.50	28433.19
Net Financing Deficit (\$m)	8.44	0.01	1260.86	109.20	0.55	3162.61	4.69	1.72	945.82	7	-0.24	1591.74
Cash Dividends (\$m)	93.40	2.11	527.63	237.92	6.68	1042.14	77.03	0.00	414.01	120	5.80	514.52
Net Investment (\$m)	431.65	78.00	2038.34	1224.21	142.70	5352.03	428.15	93.47	1551.85	564	114.21	2370.11
Change in Working Capital (\$m)	59.76	12.71	869.69	6.50	22.39	1092.09	54.89	15.90	757.65	75	16.36	758.64
Cash Flow after Interest and Taxes (\$m)	576.36	119.00	1951.71	1359.42	258.14	4002.86	555.39	128.86	1806.95	753	177.20	2201.42
Net Financing Deficit/Assets <sub>t-1</sub>	0.04	0.00	0.27	0.03	0.00	0.25	0.06	0.00	0.32	0.03	0.00	0.22
Net Debt Issues/Assets <sub>t-1</sub>	0.03	0.00	0.18	0.06	0.00	0.21	0.04	0.00	0.20	0.04	0.00	0.18
Net Equity Issues/Assets <sub>t-1</sub>	0.01	0.00	0.19	-0.03	-0.01	0.12	0.01	0.00	0.24	0.00	0.00	0.12
Profitability	0.16	0.16	0.15	0.17	0.17	0.12	0.18	0.18	0.16	0.18	0.17	0.12
$\Delta$ Profitability	-0.01	0.00	0.15	-0.01	0.00	0.07	-0.01	0.00	0.13	0.00	0.00	0.12
Tangibility	0.34	0.27	0.27	0.29	0.18	0.29	0.34	0.25	0.29	0.35	0.27	0.28
$\Delta$ Tangibility	-0.01	0.00	0.16	0.00	0.00	0.13	-0.01	0.00	0.18	-0.01	0.00	0.16
Q	2.12	1.61	1.90	2.17	1.88	1.21	2.43	1.85	2.24	2.20	1.73	1.57
$\Delta$ Q	-0.12	-0.01	2.16	-0.03	-0.03	0.64	-0.11	0.00	2.27	-0.06	0.00	1.37
ln(Sales)	7.12	7.05	1.63	7.71	7.50	1.64	7.08	7.02	1.59	7.44	7.36	1.57
$\Delta$ ln(Sales)	0.10	0.09	0.27	0.10	0.11	0.23	0.14	0.12	0.27	0.12	0.10	0.22

**Distribution across Fama French 12 Industry Groups**

	(I)	(II)	(III)	(IV)		(I)	(II)	(III)	(IV)
Consumer Nondurables	0.09	0.06	0.07	0.09	Telecommunication	0.03	0.02	0.03	0.02
Consumer Durables	0.04	0.02	0.03	0.04	Utilities	n.a.	n.a.	n.a.	n.a.
Manufacturing	0.13	0.07	0.10	0.12	Shops	0.15	0.16	0.14	0.16
Energy	0.05	0.09	0.06	0.07	Health	0.10	0.14	0.13	0.11
Chemicals and Allied Products	0.05	0.02	0.03	0.05	Money	n.a.	n.a.	n.a.	n.a.
Business Equipment	0.20	0.20	0.24	0.17	Other	0.17	0.21	0.17	0.17

The Fama-French Industry Groups are defined on French's website ([http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)).

**Table AI (cont.)****Panel B. Kink Variables**

Kink is the amount of interest at the point where the marginal benefit function becomes downward sloping, as a proportion of actual interest expense. ECOST is the standard deviation of the first difference in taxable earnings divided by assets, the quotient times the sum of advertising, research, and development expenses divided by sales. CYCLICAL is the standard deviation of operating earnings divided by mean assets first calculated for each firm, then averaged across firms within two-digit SIC codes. Return on assets is income before extraordinary items plus interest expense plus depreciation, divided by assets. Z-score is 3.3 times the difference of operating income before depreciation and depreciation plus sales plus 1.4 times retained earnings plus 1.2 times working capital (balance sheet), the quantity divided by assets. Quick ratio is the sum of cash and short-term investments and total receivables divided by total current liabilities. Current ratio is total current assets divided by total current liabilities. Q-ratio is preferred stock plus market value of common equity plus net short-term liabilities, the quantity divided by assets. R&D to sales and Advertising to sales are set to 0 when the numerator is missing. Computer Industry are all firms with SIC code 357, Semiconductor Industry all firms with SIC code 367, Chemicals and Allied Products comprises SIC codes 280-289, Aircraft and Guided Space Vehicles SIC codes 372 and 376, and Other Sensitive Industries SIC codes 340-400, excluding 357, 367, 372, and 376. Vested options (as a % of shares outstanding) are multiplied by 10 so that the means of vested options and stock ownership are the same order of magnitude.

Variable	(I)			(II)			(III)			(IV)		
	Number of Firms = 1,485			Number of Firms = 194			Number of Firms = 914			Number of Firms = 613		
	Num. Firm-Years = 8,730			Num. Firm-Years = 278			Num. Firm-Years = 4,413			Num. Firm-Years = 3,599		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Kink	4.23	3	3.44	5.28	5	3.55	4.56	4	3.43	4.48	4	3.35
I(No dividend)	0.37	0	0.48	0.44	0	0.50	0.45	0	0.50	0.34	0	0.47
I(Negative owners' equity)	0.02	0	0.15	0.01	0	0.08	0.02	0	0.13	0.01	0	0.08
I(NOL carryforward)	0.33	0	0.47	0.47	0	0.50	0.32	0	0.47	0.31	0	0.46
ECOST	3.58	0.45	10.15	3.97	0.35	10.65	4.33	0.59	11.18	3.22	0.44	9.07
CYCLICAL	0.09	0.10	0.03	0.10	0.10	0.03	0.09	0.10	0.02	0.09	0.10	0.03
Return on assets	0.11	0.12	0.10	0.12	0.12	0.08	0.12	0.13	0.09	0.12	0.12	0.07
ln(sales)	7.39	7.32	1.50	7.77	7.55	1.53	7.36	7.30	1.48	7.66	7.56	1.44
Z-score	2.09	2.13	1.39	2.14	2.09	1.19	2.15	2.21	1.37	2.27	2.22	1.14
Quick ratio	1.44	1.04	1.44	1.48	1.07	1.42	1.56	1.12	1.59	1.42	1.03	1.46
Current ratio	2.22	1.80	1.62	2.22	1.70	1.61	2.31	1.87	1.73	2.18	1.78	1.64
PPE-to-assets	0.32	0.27	0.21	0.26	0.19	0.23	0.30	0.24	0.21	0.31	0.26	0.21
Q-ratio	1.46	1.12	1.24	1.64	1.34	1.10	1.72	1.31	1.37	1.62	1.24	1.28
R&D-to-sales	0.04	0	0.12	0.06	0	0.15	0.05	0.00	0.13	0.04	0	0.10
Advertising-to-sales	0.01	0	0.03	0.01	0	0.03	0.01	0	0.02	0.01	0	0.02
Computer Industry	0.02	0	0.15	0.01	0	0.12	0.03	0	0.16	0.02	0	0.13
Semiconductor Industry	0.04	0	0.20	0.06	0	0.23	0.06	0	0.24	0.05	0	0.21
Chemicals and Allied Products Industry	0.10	0	0.30	0.09	0	0.29	0.10	0	0.30	0.12	0	0.32
Aircraft and Guided Space Vehicles Industry	0.01	0	0.11	0.01	0	0.10	0.01	0	0.11	0.01	0	0.11
Other Sensitive Industries	0.22	0	0.41	0.21	0	0.40	0.23	0	0.42	0.21	0	0.41

**Panel C. CEO Variables**

CEO Vested Options are the CEO's holdings of options that are exercisable within 6 months of the beginning of the year (as a % of shares outstanding), multiplied by 10 so that the means of vested options and CEO Stock Ownership are the same order of magnitude. Depression Baby is an indicator variable for CEOs born in the 1920s. Military Experience indicates CEOs with prior military service.

Variable	(I)			(II)			(III)			(IV)		
	Number of CEOs = 3,466			Number of CEOs = 270			Number of CEOs = 1,579			Number of CEOs = 869		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Age	56.12	56	7.63	56.75	56	6.73	56.03	56	7.40	55.92	56	6.93
Tenure	9.13	7	7.81	11.28	9	7.95	10.27	8	7.84	10.05	8	7.63
CEO Stock Ownership	0.03	0.00	0.07	0.02	0.00	0.06	0.03	0.01	0.06	0.02	0.00	0.05
CEO Vested Options	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Depression Baby	0.10	0	0.30	n.a.	n.a.	n.a.	0.09	0	0.29	0.09	0	0.29
Military Experience	0.04	0	0.18	0.01	0	0.09	0.03	0	0.17	0.02	0	0.14

**Table AII. Alternative Longholder Measures (Execucomp Sample)**

The sample consists of S&P 1500 companies covered by *Compustat's Execucomp* database between 1992 and 2007, excluding financial companies (SIC 6000-6999) and regulated utilities (SIC 4900-4999). Longholder\_Exec is a binary variable where 1 signifies that the CEO at some point during his tenure held an option package until the last year before expiration, provided that the package was at least 40% in the money entering its last year. Longholder\_Thomson is a binary indicator defined as Longholder\_Exec, but using *Thomson Financial* data to identify option exercises which occur in the final year of the option's duration. Longholder\_Thomson is 0 for CEOs for whom we observe at least one option exercise in the *Thomson* database during the sample period. Longholder\_Thomson\_Fill is defined as Longholder\_Thomson, but includes all CEOs who do not satisfy the Longholder criteria in the control group. Longholder\_CJRS is a binary indicator set to one if the CEO at least twice during his tenure in the sample was holding options with average moneyness greater than 67% at the end of a fiscal year, starting in the first year the CEO displays the behavior. Returns<sub>x</sub> are the natural logarithm of 1 plus stock returns (excluding dividends) from year x-1 to x.

**Panel A. Summary Statistics**

	<i>N</i>	% Over- confident	% Not Over- confident
Longholder_Exec	3,566	22.18	77.82
Longholder_CJRS	19,108	49.45	50.55
Longholder_Thomson	12,970	53.56	46.44
Longholder_Thomson_Fill	21,549	32.24	67.76

**Panel B. Pairwise Correlations**

	Longholder_Exec	Longholder_CJRS	Longholder_Thomson	Longholder_Thomson_Fill	Returns <sub>t-1</sub>	Returns <sub>t-2</sub>	Returns <sub>t-3</sub>	Returns <sub>t-4</sub>	Returns <sub>t-5</sub>
Longholder_Exec	1								
Longholder_CJRS	0.2208 (0.00; 3314)	1 (- ; 19108)							
Longholder_Thomson	0.4375 (0.00; 2290)	0.1671 (0.00; 12398)	1 (- ; 12970)						
Longholder_Thomson_Fill	0.4840 (0.00; 3566)	0.2678 (0.00; 19108)	1 (- ; 12970)	1 (- ; 21549)					
Returns <sub>t-1</sub>	0.0498 (0.00; 3526)	0.1517 (0.00; 18980)	0.0314 (0.00; 12870)	0.0723 (0.00; 21298)	1 (- ; 28944)				
Returns <sub>t-2</sub>	0.0202 (0.23; 3495)	0.1684 (0.00; 18706)	0.0167 (0.06; 12719)	0.0581 (0.00; 20939)	-0.0227 (0.00; 27801)	1 (- ; 27848)			
Returns <sub>t-3</sub>	0.0379 (0.03; 3454)	0.1629 (0.00; 18285)	0.0169 (0.06; 12484)	0.0523 (0.00; 20429)	-0.0538 (0.00; 26644)	-0.0498 (0.00; 26691)	1 (- ; 26470)		
Returns <sub>t-4</sub>	0.0145 (0.40; 3420)	0.1303 (0.00; 17760)	0.021 (0.02; 12175)	0.0508 (0.00; 19809)	-0.0613 (0.00; 25484)	-0.0622 (0.00; 25520)	-0.0488 (0.00; 25568)	1 (- ; 25624)	
Returns <sub>t-5</sub>	0.0103 (0.55; 3385)	0.0897 (0.00; 17172)	0.0345 (0.00; 11799)	0.0518 (0.00; 19129)	0.004 (0.54; 24305)	-0.0744 (0.00; 24326)	-0.0716 (0.00; 24360)	-0.0561 (0.00; 24413)	1 (- ; 24478)

*p*-values and number of observations in parentheses