CEO Overconfidence and Corporate Investment*

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Abstract

We argue that managerial overconfidence can account for corporate investment distortions. Overconfident managers overestimate the returns to their investment projects and view external funds as unduly costly. Thus, they overinvest when they have abundant internal funds, but curtail investment when they require external financing. We test the overconfidence hypothesis, using panel data on personal portfolio and corporate investment decisions of Forbes 500 CEOs. We classify CEOs as overconfident if they persistently fail to reduce their personal exposure to company-specific risk. We find that investment of overconfident CEOs is significantly more responsive to cash flow, particularly in equity-dependent firms.

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In this paper, we argue that personal characteristics of CEOs in large corporations lead to distortions in corporate investment policies. In particular, we study the investment decisions of CEOs who overestimate the future returns of their companies, measured by a failure to divest company-specific risk on their personal accounts. We find that overconfident CEOs have a heightened sensitivity of corporate investment to cash flow, particularly among equity-dependent firms.

The two traditional explanations for investment distortions are the misalignment of managerial and shareholders interests (Jensen and Meckling (1976); Jensen (1986)) and asymmetric information between corporate insiders and the capital market (Myers and Majluf (1984)). Both cause investment to be sensitive to the amount of cash in the firm. Under the agency view, managers overinvest to reap private benefits such as "perks," large empires, and entrenchment. Since the external capital market limits the extent to which managers can pursue self-interested investment, an influx of cash flow enables the manager to invest more and increases investment distortions. Under asymmetric information, the managers themselves (who act in the interest of shareholders) restrict external financing in order to avoid diluting the (undervalued) shares of their company. In this case, cash flow increases investment, but reduces the distortion. The empirical literature, starting with Fazzari, Hubbard, and Petersen (1988), confirms the existence and robustness of investment-cash flow sensitivity after controlling for investment opportunities. While most of the literature relates investment-cash flow sensitivity to imperfections in the capital market, this interpretation remains controversial (Kaplan and

Zingales (1997), (2000); Fazzari, Hubbard, and Petersen, (2000)).

We propose an alternative explanation for investment-cash flow sensitivity and suboptimal investment behavior. Rather than focusing on firm-level characteristics, we relate corporate investment decisions to personal characteristics of the top decision-maker inside the firm. Building on Roll (1986) and Heaton (2002), we argue that one important link between investment levels and cash flow is the tension between the beliefs of the CEO and the market about the value of the firm. Overconfident CEOs systematically overestimate the return to their investment projects. If they have sufficient internal funds for investment and are not disciplined by the capital market or corporate governance mechanisms, they overinvest relative to the first-best. If they do not have sufficient internal funds, however, they are reluctant to issue new equity because they perceive the stock of their company to be undervalued by the market. As a result, they curb their investment. Additional cash flow provides an opportunity to invest closer to their desired level.

Our overconfidence story builds upon a prominent stylized fact from the social psychology literature, the "better-than-average" effect. When individuals assess their relative skill, they tend to overstate their acumen relative to the average (Larwood and Whittaker (1977); Svenson (1981); Alicke (1985)). This effect extends to economic decision-making in experiments (Camerer and Lovallo (1999)). It also affects the attribution of causality. Because individuals expect their behavior to produce success, they are more likely to attribute good outcomes to their actions, but bad outcomes to (bad) luck (Miller and Ross (1975)). Executives appear to be particularly prone to display overconfidence, both in terms of the better-than-average effect and in terms of "narrow confidence intervals" (Larwood and Whittaker (1977); Kidd

(1970); Moore (1977)).[1] This finding is attributed to three main factors, each of which trigger overconfidence: the illusion of control, a high degree of commitment to good outcomes, and abstract reference points that make it hard to compare performance across individuals (Weinstein (1980); Alicke et al. (1995)). All three factors are pertinent in the context of corporate investment. A CEO who hand-picks an investment project is likely to believe he can control its outcome and to underestimate the likelihood of failure (March and Shapira (1987); Langer (1975)). The typical CEO is also highly committed to good company performance since his personal wealth and the value of his human capital fluctuate with the company's stock price. Finally, assessing relative managerial skill or, specifically, the ability to pick profitable investment projects is difficult – even ex post – due to other factors that influence overall firm performance.

Heaton (2002) first showed that common distortions in corporate investment may be the result of managers overestimating the returns to their investment. We expand on Heaton's insight in two ways. First, we model how the pre-existing capital structure affects the role of overconfidence. Second, we empirically test the predictions of the model.

To construct measures of overconfidence, we exploit the overexposure of typical CEOs to the idiosyncratic risk of their firms. CEOs receive large grants of stock and options as compensation. They cannot trade their options or hedge the risk by short-selling company stock, and the value of their human capital is intimately linked to the firm's performance. Because of this under-diversification, risk-averse CEOs should exercise their options early given a sufficiently high stock price (Lambert, Larcker, and Verrecchia (1991); Meulbroek (2001); Hall and Murphy (2000), (2002)). We take two main approaches to translate this logic into overconfidence

measures. First, we identify a benchmark for the minimum percentage in-the-money at which CEOs should exercise their options for a given year immediately following the vesting period. If a CEO persistently exercises options later than suggested by the benchmark, we infer that he is overconfident in his ability to keep the company's stock price rising and that he wants to profit from expected price increases by holding the options. Second, we look at the end of the option's duration. If a CEO is optimistic enough about his firm's future performance that he holds options all the way to expiration (typically ten years), we classify him as overconfident. Finally, since underdiversified CEOs should also avoid acquiring additional equity, we classify CEOs who habitually increase their holdings of company stock as overconfident.

We apply these measures to a panel data set on the options and stock holdings of CEOs of 477 large U.S. companies between 1980 and 1994. As a first test of the classifications, we find that CEOs who excessively hold company stock options do not earn significant abnormal returns over the S&P 500 on average. This result helps to rule out alternative explanations of "late exercise" based on inside information. We also explicitly address other potential explanations of our overconfidence measures. In the second step of the analysis, we show that investment-cash flow sensitivity is significantly higher for "late exercisers" or "stock purchasers" than for their peers. As predicted by the model, overconfident CEOs invest more when they have more cash at hand. Further, the sensitivity of investment to cash flow is strongest for CEOs of equity-dependent firms, for whom perceived financing constraints are most binding.

We provide complementary evidence that CEO characteristics other than overconfidence have explanatory power for corporate decision-making. CEOs with an engineering (or scientific) education or employment background display higher investment-cash flow sensitivity,

while CEOs with a financial education or employment background exhibit lower sensitivity. Furthermore, the sensitivity is higher for "depression babies" born in the 1930s and CEOs who assume multiple positions in their company (president, chairman of the board). These findings lend further support to the view that not only firm-level, but also personal characteristics are important for a better understanding of corporate decision-making.[2] However, overconfidence matters for investment-cash flow sensitivity beyond the effects of these observable CEO characteristics.

One caveat to our results is the issue of endogeneity. Observable personal characteristics such as employment background or birth cohort could be selection criteria for the CEO. Boards may even take overconfidence into account in choosing a CEO – though this seems harder to identify ex ante. We are able to alleviate some endogeneity concerns with additional controls. We show that our results are not driven by industry effects, firm effects (where possible), or tangible firm characteristics like size and degree of financial constraint. Most importantly, however, endogeneity does not affect our main conclusion. If the board chooses a CEO because of his overconfidence, it should be aware of the "dark sides" of this personality feature (such as distorted investment behavior) and take steps to explicitly address them.

The overconfidence-based explanation for investment distortions has a number of novel policy implications. Traditional theories, which link investment-cash flow sensitivity to capital market imperfections or misaligned incentives, propose timely disclosure of corporate accounts or high-powered incentives as potential remedies. Our findings suggest that these provisions may not suffice to address managerial discretion. A manager whose incentives are perfectly aligned and who does not face any informational asymmetries may still invest suboptimally if he is

overconfident. He believes that he is acting in the best interest of shareholders. Thus, refined corporate governance structures, involving a more active board of directors or constraints on the use of internal funds, may be necessary to achieve first-best investment levels.

The remainder of the paper is organized as follows. In Section I we present a simple model that develops the prediction that managerial overconfidence leads to positive investment-cash flow sensitivity. In Section II we introduce the data used in our analysis. Section III describes the construction of our overconfidence measures and discusses alternative explanations. Section IV provides evidence that overconfidence increases the sensitivity of investment to cash flow. Section V provides evidence that CEO overconfidence matters more in equity-dependent firms. Section VI assesses the robustness of the overconfidence effect to the inclusion of other observable CEO characteristics. Section VII concludes.

I. Model

We propose a simple two-period model that demonstrates the effect of managerial overconfidence on corporate investment in an efficient capital market. Since our goal is to demonstrate the distortionary power of overconfidence, we abstract from informational asymmetries and agency problems and assume that the manager maximizes current shareholder value.[3] The only friction in the model comes from the manager's inflated perception of the firm's investment opportunities.

Consider a firm with existing assets A and s shares outstanding. At time 1, cash flow C is realized. The CEO chooses the level of investment $I \in [0, \infty)$ and a means of financing. The

investment generates a (weakly positive) stochastic future return, realized at time 2. We denote the expected return to investment I as $R(I)$, with $R' > 0$ and $R'' < 0$ for all I. To guarantee interior solutions, we also assume that $R'(I) > 1$ for some I. The interest rate is normalized to zero. An overconfident CEO overestimates future returns by percentage Δ. Hence, for all levels of investment I, the CEO perceives the expected return to be $R(I) \cdot (1 + \Delta)$, with $\Delta = 0$ in the benchmark case of a rational CEO.

To finance I, the CEO can either use internal funds or raise external finance (debt or equity). We consider the choice among cash, risk-free debt, and equity. In this setting, equity is the only financial instrument for which the CEO's overestimation of future returns results in disagreement about the appropriate price.[4] We assume that the firm has an exogenous capacity for riskless debt D, capacity which is determined by the collateral value of the existing assets and, thus, is strictly smaller than the going-concern value ($A > D$). This condition ensures repayment in all states of the world and arises endogenously if there is a positive probability of investment failure (i.e., zero returns) for all I. The maximization problem of the CEO is thus

$$\max_{I,s',c,d} \ \frac{s}{s+s'} \left[A + C + R(I)(1+\Delta) - c - d\right] \tag{1}$$

$$\text{s.t. } \frac{s'}{s+s'} \left(A + C + R(I) - c - d\right) = I - c - d \tag{2}$$

$$c \leq C, \quad d \leq D, \quad c + d \leq I \tag{3}$$

$$c \geq 0, \quad d \geq 0, \quad I \geq 0, \tag{4}$$

where c is the amount of cash financing, d is the amount of debt financing, and s' is the number

of new shares. New shareholders demand an equity stake equal in value to the amount of capital they provide to the firm, $I - c - d$. Let (I^*, c^*, d^*) be the solution to the CEO's maximization problem (1)-(4). Further, let $\hat{I}$ be the level of investment that satisfies $R'(\hat{I}) = \frac{1}{1+\Delta}$ and I_{FB} be the (first-best) level of investment that satisfies $R'(I_{FB}) = 1$. Then, the following lemma characterizes the efficiency of the CEO's investment decision.

LEMMA 1. *(i) If the CEO is rational* ($\Delta = 0$)*,* $I^* = I_{FB}$ *for all* C, D*. (ii) If the CEO is overconfident* ($\Delta > 0$)*,* $I^* = \hat{I} > I_{FB}$ *for all* C, D *such that* $C + D \geq \hat{I}$*, and* $\hat{I} > I^* > I_{FB}$ *for all* C, D *such that* $C + D < \hat{I}$*.*

Proof. See Appendix.

Not surprisingly, the rational CEO invests at the first-best level regardless of the availability of internal funds. The overconfident CEO, on the other hand, overinvests. Perceived financing costs, however, mitigate overinvestment if the CEO is cash constrained, implying sensitivity to cash flow as summarized in the following proposition.

PROPOSITION 1 *(i) If the CEO is rational* ($\Delta = 0$)*,* I^* *is independent of internal cash flow* C *for all* C, D*. (ii) If the CEO is overconfident* ($\Delta > 0$)*,* I^* *is independent of* C *for all* C, D *such that* $C + D \geq \hat{I}$ *and is strictly increasing in* C *for all* C, D *such that* $C + D < \hat{I}$*.*

Proof. See Appendix.

An overconfident CEO believes (incorrectly) that the market is understating the present value of investment returns and that issuing shares will dilute the claims of current shareholders. Thus, he is unwilling to issue shares to finance his desired investment level, and generates

investment-cash flow sensitivity when internal resources are scarce. Proposition 1 also illuminates the importance of a firm's debt capacity. The higher is D, the more likely are cash and debt financing to be sufficient for any desired level of investment, i.e. $C + D \geq \hat{I}$. Thus, we expect to observe investment-cash flow sensitivity more often in equity-dependent firms (with overconfident CEOs) than in firms with untapped debt capacity.

While the overinvestment result depends on the specification of overconfidence, the finding of investment-cash flow sensitivity does not. For instance, suppose that the CEO is also overconfident about the value of existing assets, A. Some of these assets could be his own prior investments so that he also overestimates future cash flows generated by A. We can capture this overestimation as an upward bias in the valuation of A, which may be smaller or larger than the overestimation of the return flow R. The CEO then maximizes $\frac{s}{s+s'}[A\,(1+\Delta_A) + R(I)(1+\Delta_R) + C - c - d]$. In this setting, the overconfident CEO displays investment-cash flow sensitivity, both for $\Delta_A > \Delta_R$ and for $\Delta_A < \Delta_R$. However, the CEO underinvests when $\Delta_A > \Delta_R$ and overinvests when $\Delta_A < \Delta_R$.

Assuming that other factors which influence investment cash-flow sensitivity do not vary systematically with overconfidence, we have the following two empirically testable predictions:

PREDICTION 1. The investment of overconfident CEOs is more sensitive to cash flow than the investment of CEOs who are not overconfident.

PREDICTION 2. The investment-cash flow sensitivity of overconfident CEOs is more pronounced in equity-dependent firms.

Whether investment-cash flow sensitivity increases in overconfidence depends on the specifi-

cation of the return function and, more generally, of the overconfidence model.[5] Therefore, we will not attempt to construct a continuous measure of overconfidence; rather, we compare the investment behavior of "overconfident" versus "nonoverconfident" CEOs. Even taking this approach, however, measurement error might weaken or hide the difference between investment-cash flow sensitivity in the overconfident and nonoverconfident groups if the relation is not monotonic. Therefore, the success of the empirical analysis depends on the precision of our measure of overconfidence.

In the following sections, we test these two predictions. The empirical analysis consists of two steps. The first step is the construction of an empirical overconfidence measure. The second step is the analysis of the relation between overconfidence and the sensitivity of investment to cash flow (Prediction 1) and the change in this relation as equity-dependence increases (Prediction 2).

II. Data

We analyze a sample of 477 large publicly traded U.S. firms from the years 1980 to 1994. To be included in the sample, a firm must appear at least four times on one of the lists of the largest U.S. companies compiled by Forbes magazine in the period from 1984 to 1994.[6]

The core of the data set is described in detail in Hall and Liebman (1998) and Yermack (1995). Here, we simply highlight some of the more important features of the data for our purposes. The virtue of this data set is that it provides us with detailed information on the stock ownership and set of option packages – including exercise price, remaining duration, and

number of underlying shares – for the CEO of each company, year-by-year. From this data we obtain a fairly detailed picture of the CEO's portfolio rebalancing over his tenure. What we cannot deduce is the exact stock price at which the exercise of a particular option package occurred in a given year. Thus, whenever this information is required, we check the robustness of our results to three different assumptions on the CEO's ability to time the market in the short run: First, that exercise occurs at the maximum price during the fiscal year; second, that it occurs at the median price; and, third, that it occurs at the mean price.

In order to examine the relation between a CEO's transactions on his personal account and on corporate accounts, we supplement the data set with various items from the COMPUSTAT database. We measure investment as capital expenditures (item 128), cash flow as earnings before extraordinary items (item 18) plus depreciation (item 14), and capital as property, plants, and equipment (item 8). We normalize investment and cash flow with beginning-of-the-year capital. Given that our sample is not limited to manufacturing firms (though it mainly consists of large, nonfinancial firms), we check the robustness of our results to normalization by assets (item 6). We measure Q as the ratio of market value of assets to book value of assets. Market value of assets is defined as total assets (item6) plus market equity minus book equity. Market equity is defined as common shares outstanding (item 25) times fiscal-year closing price (item 199). Book equity is calculated as stockholders' equity (item 216) [or the first available of common equity (item 60) plus preferred stock par value (item 130) or total assets (item 6) minus total liabilities (item 181)] minus preferred stock liquidating value (item 10) [or the first available of redemption value (item 56) or par value (item 130)] plus balance sheet deferred taxes and investment tax credit (item 35) when available minus post retirement assets (item

336) when available. Book value of assets is total assets (item 6).[7] The data contain a few severe outliers, for example, observations of capital-normalized cash flow that are more than 50 standard deviations away from the mean. To ensure that these outliers do not contaminate our results, we trim cash flow at the 1% level.[8]

In addition, we supplement the data with personal information about the CEOs' employment histories and educational backgrounds, using *Dun and Bradstreet* and *Who's Who in Finance and Industry*. We classify CEOs into three groups based on their field of study: CEOs with finance education (undergraduate or graduate degrees in accounting, finance, business, and economics), CEOs with technical education (degrees in engineering or the natural sciences), and CEOs with other degrees (law, literature, etc.)[9] We also classify CEOs into three groups based on their employment experience: CEOs with a career in finance if they previously worked in a financial institution, or if they previously worked as a CFO, treasurer, accountant, or other finance-related professional; CEOs with a technical career if they are individual patent-holders, or if they previously worked as an engineer or other technically oriented professional; and, CEOs with a general management career. Finally, we use CRSP to gather stock prices for the companies in our sample. The left columns of Table I ("Full Sample") present the summary statistics of the data.[10]

[INSERT TABLE I HERE]

III. Overconfidence Measures

A. Definitions

We construct three measures of overconfidence, or proxies for Δ, based on the personal portfolio decisions of CEOs: *Holder 67*, *Longholder*, and *Net Buyer*. The first two measures, *Holder 67* and *Longholder*, use the timing of option exercises to identify overconfidence. The third measure, *Net Buyer*, uses the habitual acquisition of company stock. Our measures exploit the underdiversification of CEOs. CEO compensation contracts regularly contain large quantities of stock and option grants. To maximize the incentive effects of these holdings, the options cannot be traded and the sale of stock may be restricted. Further, firms prohibit CEOs from perfectly hedging against the risk by short-selling company stock. Most importantly, CEOs' human capital is invested in their firms, so that a bad outcome in the firm will not only negatively impact their personal portfolios, but will also reduce their outside employment options. All of these effects leave CEOs highly exposed to the idiosyncratic risk of their company.

Unlike perfectly hedged outside investors, then, CEOs must trade off the option value of holding stock options against the costs of underdiversification. Though the optimal schedule for exercise depends on their individual wealth, degree of risk aversion, and diversification (Hall and Murphy (2002)), it is generally true that risk aversion and underdiversification predict early exercise of executive options. Similarly, underdiversified CEOs, in order to divest themselves of idiosyncratic risk, should minimize their holdings of company stock. Overconfidence, however,

may lead CEOs to overestimate the future returns of their investment projects. Therefore, they believe that the stock prices of their companies will continue to rise under their leadership more than they objectively should expect. As a result, overconfidence induces them to postpone option exercise or even to buy additional company stock in order to benefit personally from the expected future gains.

These arguments may not hold for CEOs who display overoptimism about exogenous variables or overestimate the precision of their beliefs. Overoptimism about the general economic environment need not induce investment in the CEOs' own companies. Miscalibration reduces the expected volatility of the stock and thus the value of holding options. The key aspects of overconfidence for our results are overestimation of skill and self-attribution by the CEO.

Holder 67. For our first measure, we consider the status of each individual option package in our sample at the end of the vesting period. To maintain comparability across packages with vesting periods of different duration, we examine the first year in which all of the packages in the sample are at least partially exercisable, year five. We then compute the percentage in-the-money for each package. Risk aversion and underdiversification predict that CEOs should exercise options immediately after the vesting period if the amount in-the-money is beyond a rational benchmark. We use the Hall and Murphy (2002) framework as a theoretical guide in choosing a reasonable benchmark for the percentage in-the-money at or above which CEOs should exercise newly vested options. We also follow their calibrations to proxy for (unobserved) CEO wealth, diversification, and risk aversion. We apply the resulting threshold for early exercise to the full sample of CEOs (rather than attempting to calibrate individually)

and check the robustness of our results to a wide range of reasonable parameter values.

To begin, we take 67% in-the-money during the fifth year as our threshold. If an option is more than 67% in-the-money at some point in year five, the CEO should have exercised at least some portion of the package during or before the fifth year. This threshold corresponds to a risk aversion of three in a constant relative risk-aversion (CRRA) utility specification and to a percentage of wealth in company equity equal to 66. We then construct *Holder 67* as follows. We consider the subsample of CEOs who at least twice during the sample period had options that were valued above the threshold during the fifth year. We then identify the first instance (if any) at which the CEO failed to exercise such an option during or before the fifth year. From this point in time onward, we classify the CEO as overconfident if he subsequently exhibits the same behavior at least one more time during his tenure as CEO. As we are interested in a "permanent" rather than "transitory" overconfidence effect, our measure targets CEOs who "habitually" exercise options late. We repeat this exercise starting at 50% in-the-money and incrementing by five up to 150% in-the-money to verify the robustness of our results to variations in the parameters (e.g., 100% corresponds to $\rho = 3$; 50% of wealth in stock).

Whenever we use these *Holder* measures in an estimation, we restrict the sample to CEOs who at least twice during the sample period had options that were valued above the threshold during the fifth year. This restriction guarantees that every CEO in the subsample had the opportunity to be classified as overconfident and, thus, limits the degree of unobserved overconfidence in the control group. It also guarantees that we are not overproportionally identifying CEOs as overconfident when the stock of their firm is doing well. On the other

hand, our restriction considerably limits the number of observations; for *Holder 67*, it declines from 3,728 to 1,058.

Longholder. To construct our second measure, *Longholder*, we focus on the expiration date of option packages rather than the end of the vesting period. We classify a CEO as overconfident (for all of his years in the sample) if he ever holds an option until the last year of its duration. As the typical option in the sample has 10 years' duration and is fully vested (at the latest) by year five, the CEO chooses to hold, rather than exercise, the option for at least five years. Thus, again, our measure targets habitual failure to diversify, or a personality, rather than time-varying, overconfidence effect. Further, over 85% of options that are held until their final year are in-the-money and the median percentage in-the-money for such options is 253%. Thus, the CEO could have profitably exercised these options before their last year. Indeed, failure to exercise these options prior to expiration is difficult to reconcile with any reasonable calibration of the Hall and Murphy framework. Therefore, the *Longholder* measure alleviates the dependence on calibrated thresholds for rational exercise. It also enables us to circumvent the sample restriction (and potential loss of power) of the *Holder 67* measures. It is thus best suited for tests in which we must reduce or split the sample (e.g., Prediction 2).

Net Buyer. To construct our third measure, *Net Buyer*, we exploit the tendency of some CEOs to purchase additional company stock despite their already high exposure to company risk. Specifically, we consider the subsample of CEOs who keep their position as CEO for at least 10 of the 15 years in our sample. We identify CEOs as overconfident if they were net buyers of company equity during their first five years in our sample,[11] that is, if they

bought stock on net in more years than they sold on net during their first five sample years.[12] Whenever we use this measure in an estimation, we exclude the first five years of the CEOs' tenures. Thus, we use disjoint subsamples of CEO years to establish overconfidence and to measure its potential effects on investment. This approach ameliorates endogeneity concerns, but at the cost of (again) reducing sample size substantially – here to 842.

B. Discussion

In the middle and right columns of Table I, we show firm and CEO summary statistics for subsamples of firm-years determined by overconfidence sample restrictions and measured overconfidence. For brevity, we use only *Holder 67* in these comparisons. Thus, all firm-years included in either subsample are from firms with CEOs who meet the selection criterion of having at least two options that exceeded the 67% threshold in year five. The patterns are similar for the other overconfidence measures.[13]

Note that of the 113 CEOs who meet the selection criterion, 58 display overconfidence in their personal portfolio decisions. By comparison, 85 of 661 CEOs are overconfident using the *Longholder* measure and 97 of 158 using *Net Buyer*. Thus, the measure ensuring the largest sample size, *Longholder*, is also the most conservative measure of overconfidence. There are no significant differences in observable firm or CEO characteristics across the overconfident and control samples. In particular, the distribution of firms across Fama-French industry groups is virtually identical in the overall sample, the subsample satisfying the selection criterion, and the overconfident subsample. Thus, our overconfidence measure appears orthogonal to firm

characteristics, at least as measured at the industry level.

In Table II, we present the pairwise correlations among the three overconfidence measures and CEO and firm characteristics. We consider the overconfidence measures two at a time due to differences in the subsamples on which we apply them. Panel A presents the correlations for *Longholder* and *Holder 67* on the *Holder 67* subsample; Panel B presents the correlations for *Longholder* and *Net Buyer* on the *Net Buyer* subsample; and, Panel C presents the correlations for *Net Buyer* and *Holder 67* on the intersection of the *Net Buyer* and *Holder 67* subsamples. The correlation between *Longholder* and *Holder 67* is strong and highly significant (0.2472). The correlation between *Net Buyer* and *Holder 67* is also positive, though weaker (0.0628). There is only a small positive correlation between *Net Buyer* and *Longholder*. Overall, these relations suggest that our measures are capturing the same effect. We find few reliable correlations between our overconfidence measures and firm or CEO characteristics. The relations often reverse for different overconfidence measures or for the same measure on different subsamples of data, suggesting that overconfidence is not proxying for firm characteristics or observable CEO characteristics.

[INSERT TABLE II HERE]

Of particular interest are the relations among stock ownership, vested options, and our overconfidence measures. Mechanistically, an overconfident CEO who delays option exercise or purchases additional company stock will increase his holdings. However, other factors such as firm size, firm age, corporate governance, and tenure, are substantially more important in determining the level of ownership. Overall, then, it is not surprising that there is no consistent

correlation between stock or option ownership and the overconfidence measures. Further, the board typically grants stock and options to confer incentives on the CEO. However, traditional agency theory suggests that the incentive effect of stock and options will reduce investment-cash flow sensitivity – the opposite prediction of our overconfidence model. Thus, simple measures of stock and option ownership are not adequate to capture CEO overconfidence, particularly in this context.

Before turning to the effects of overconfidence on investment, we briefly consider some alternative explanations of the measures.

1. *Inside information.* A CEO may decide not to decrease exposure to company risk because of private information about future stock prices that makes holding options or buying stock attractive. Inside information also predicts investment-cash flow sensitivity. Since the information has not been incorporated into the market price, the firm's stock is undervalued and investment may be sensitive to cash flow for the usual Myers-Majluf reasons.

One of the key distinctions between overconfidence and information is persistence. Positive information is most naturally viewed as a transitory, rather than fixed effect. Information with enough precision to justify increasing exposure to company risk is likely to be short term, and it is unlikely that the same CEO would repeatedly receive positive draws. Our overconfidence measures, on the other hand, target a habitual tendency to hold too much company risk (or a fixed overconfidence effect). *Holder 67* requires that a CEO fail to exercise options that are beyond the threshold at least twice. *Longholder* requires that a CEO fail to exercise options for at least five years. *Net Buyer* requires that the factor leading the CEO to purchase additional

company stock still affects investment decisions in a disjoint future time period.

Still, *Holder 67* places no restriction on how long the CEO must hold the option beyond the fifth year and, thus, could potentially capture short-term delays in option exercise. To distinguish the two stories for this measure, we analyze the exercise behavior of CEOs over time. Under the inside information hypothesis, we would expect a CEO to sometimes hold his options (when he has positive inside information) and to sometimes exercise them early (when he has negative inside information). To test this prediction, we run a random effects probit regression of the probability that a CEO holds an option that is at least 67% in-the-money in the fifth year on the number of times that the CEO has held such an option in the past.[14] The sample consists of the 759 firm-years in which a CEO had options beyond the 67% threshold in the fifth year after the grant date. The dependent variable is equal to one whenever the CEO did not exercise any portion of those options prior to that year. Panel A of Table III presents the regression results. In Column 1, the coefficient of "past late exercises" is positive (0.2493) and highly significant ($z = 4.40$). This implies that the typical CEO, rather than varying his exercise behavior over time, either persistently holds options beyond the 67% threshold or persistently exercises early. The results are robust to the inclusion of Q (Column 2) and the firm's earnings-price ratio (Column 3) as controls. Consistent with Jenter (2002), high values of Q – perhaps, in this context, a proxy for market overvaluation – appear to decrease the probability of late exercise. The earnings-price ratio effect, on the other hand, appears to go the wrong direction for an overvaluation story (though it is statistically insignificant). Panel B of Table III shows the percentage of CEOs who hold an option that is 67% in-the-money divided into categories based on the number of past late exercises. Overall, the results

suggest that the number of times a CEO has held a 67%, in-the-money option in the past is considerably more important in determining the CEO's future exercise behavior than any information about current or future stock price performance – an indication of a personal fixed effect on option exercise decisions.

[INSERT TABLE III HERE]

The second key distinction between overconfidence and information is performance. If positive information is the true reason for not diversifying the personal portfolio, then CEOs who exhibit this behavior should earn positive abnormal returns over a strategy of diversification. We calculate the distribution of returns among all CEOs who had options beyond the 67% threshold, but did not exercise. We compare those returns to the (hypothetical) returns from exercising the options during the fifth year and investing the proceeds in the S&P 500. As we do not know the exact price at which CEOs exercised their options, we calculate the returns under three alternative assumptions. First, we assume that CEOs are able to perfectly time the market in the short run and exercise at the maximum price during the fiscal year of their actual and hypothetical exercise. Then, as alternatives, we consider exercise at the mean or median price during the year. Table IV shows that on average CEOs do not beat the market by holding options beyond the threshold. The return differentials are small with huge standard deviations under any assumption about exercise behavior. Similarly, the average CEO does not consistently beat the market by holding options: The average CEO who holds beyond the 67% threshold beats the S&P 500 only 45.86% of the time. The results are similar for the *Longholder* measure. We find that CEOs whose options were at least 40% in-the-money in year

nine (i.e., past the relevant Hall and Murphy threshold for that year) and who did not exercise would have been better off on average had they exercised and invested in the S&P 500 (though the mean is not significant). This result also holds when we consider the alternative strategies of exercising in the eighth, seventh, sixth, or fifth years with appropriate adjustments to the threshold (Malmendier and Tate (2003)). Thus, there is no evidence that positive information, on average, motivates CEOs who hold options beyond the theoretically motivated thresholds.

[INSERT TABLE IV HERE]

2. *Signalling.* Another reason why CEOs may want to hold company risk is to convey a (potentially) costly signal to the capital market that their firm's prospects are better than the prospects of similar firms. However, the most natural version of the signalling story would not predict heightened investment cash flow sensitivity. Signalling should alleviate informational asymmetries and, thus, eliminate investment-cash flow sensitivity among the firms in which CEOs hold their options. Thus, the tests of our investment predictions themselves will help to dispel this alternative explanation.

Moreover, the usefulness of option exercises as a signalling device is doubtful. Financial services firms and the financial press, while following stock purchases and sales of insiders closely, generally discount option exercises as signals of future stock prices. They point to vesting and expiration times as the main determinants of exercise.[15] Our only stock-based proxy for overconfidence, *Net Buyer*, measures overconfidence and investment-cash flow sensitivity for two disjoint time periods to specifically eliminate the influence of signalling.

The same arguments address the hypothesis that CEOs use their insider trades opportunistically to raise the capital market valuation of their firms.

3. *Risk tolerance.* Alternatively, one might want to interpret our measures of overconfidence as measures of risk attitude. A CEO may hold his options beyond the threshold simply because he is less risk averse and, therefore, less affected by underdiversification. If anything, however, lower risk aversion should predict lower investment-cash flow sensitivity since less risk averse managers should be more willing to lever up the firm. Thus, once again, the tests of the empirical predictions of our model will provide evidence against this story. Moreover, while higher risk tolerance induces option holders to exercise their options later, it does not imply that the CEO should habitually buy additional stock of his company. Indeed, to explain the *Net Buyer* measure, CEOs would need to be risk seeking on average.

4. *Tax reasons.* An option holder may postpone exercise to delay the payment of taxes on his profits. Personal income tax deferral, however, would not predict higher sensitivity of investment to cash flow among holders, nor does it apply to additional stock purchases.

5. *Procrastination.* Finally, CEOs might hold options until expiration if they are "inertial" in the sense of O'Donoghue and Rabin (2001): Inertia on their personal account may carry over to the corporate account of the firm in a reluctance to conduct equity issues, or more generally, to a preference for the "quiet life" (Bertrand and Mullainathan, (2003)). We find, however, that more than 68% of the CEOs classified as overconfident under the *Longholder* measure conduct other transactions on their personal portfolios in the two years prior to the year their "longheld" option expires. We also find in Malmendier and Tate (2003) that *Longholder* CEOs

are significantly more likely to conduct acquisitions than their peers and, thus, do not appear to procrastinate on the corporate account. Finally, an inertial CEO should not habitually purchase company equity and, so, should not be classified as overconfident under the *Net Buyer* measure.[16]

We take further steps to distinguish overconfidence from alternative explanations (particularly information) in the context of the investment regressions that follow.

IV. Test 1: Overconfidence and Investment

A. Empirical Specification

To test the model's prediction that the sensitivity of investment to cash flow increases in overconfidence (Prediction 1), we use the following general regression specification:

$$I_{it} = \beta_1 + \beta_2 Q_{it-1} + \beta_3 C_{it} + X'_{it} B_4 + \beta_5 \Delta_{it} + \beta_6 C_{it} \cdot Q_{it-1} + C_{it} \cdot X'_{it} B_7 + \beta_8 C_{it} \cdot \Delta_{it} + \varepsilon_{it}, \quad (5)$$

where C is cash flow, Q is market value of assets over book value of assets, X is the set of additional controls used in the regression, and Δ is the overconfidence measure. Note that X usually includes corporate governance, stock ownership (as a percentage of total shares outstanding), and total number of vested options (normalized by total number of shares outstanding).[17] Our measure of corporate governance is the number of outside directors who are currently CEOs in other companies.[18] We also include year- and firm-fixed effects as well as (year)*(cash flow) interactions. Where relevant, we include interactions of industry dummies and cash flow. We

use Fama and French's specification of twelve industry groups.[19] The null hypothesis is that β_8, the coefficient on the interaction of cash flow and overconfidence, is equal to zero.

One alternative to controlling for industry effects on investment-cash flow sensitivity would be to remove all cross-sectional variation by including firm-fixed effects interacted with cash flow in the analysis. Because our measures require a long tenure within the firm in order to identify a CEO as overconfident, identifying the effect only from time-series variation within the firm is typically not feasible. That is, there are an insufficient number of cases of overconfident and nonoverconfident CEOs in the same firm to draw a robust inference from any estimations. The lack of identifiable cases points to a potentially severe sample selection bias from including fixed effects in panel regressions and identifying solely out of somewhat anomalous firms with multiple short-tenured CEOs. Nevertheless, where there is enough within-firm variation in CEO overconfidence to interact firm-fixed effects with cash flow, we report the results.

In order to account for serial correlation and heteroskedasticity, we estimate (5) in two different ways. First, we run an OLS regression so that our results can be compared with the earlier investment to cash flow sensitivity literature. Then we recompute the standard errors by clustering the observations within each firm. This process treats the time series of observations within the firm as a single observation, effectively eliminating any serial correlation.

B. Holder 67

First we estimate (5) using *Holder 67* and its variants as our overconfidence measures. We run a set of three baseline regressions to demonstrate the effects of Q and cash flow on

investment: First with no additional controls, then including firm-fixed effects, and finally including firm-fixed effects as well as controls for CEO stock ownership, CEO option holdings, firm size, corporate governance and their interactions with cash flow. The results are presented in Table V for the 67%, threshold. The first two regressions confirm the stylized facts of the investment-cash flow sensitivity literature, namely, cash flow has a large amount of explanatory power beyond Q for investment. Among the control variables, we find that CEOs who own a higher percentage of their company – both in company stock and in options – display a smaller investment to cash flow sensitivity. Thus, high ownership may indeed mitigate agency problems, especially among a subsample of successful firms with high stock price appreciation. We also find that Q has more impact on investment for higher levels of cash flow (although this effect is not consistently significant). If current cash flow measures the success of past investment decisions, this result suggests that more successful companies are more responsive to investment opportunities in determining the level of their investment. Corporate governance, measured by outside CEOs on the board, slightly increases investment-cash flow sensitivity. This effect, however, appears to be linked to the subsample of relatively successful firms in these regressions. In Table VII, for example, we find a weak negative effect of corporate governance on investment-cash flow sensitivity for the entire sample of firms. Finally, larger firms have significantly less sensitivity of investment to cash flow than smaller firms. One interpretation of this result is that size captures the effects traditionally attributed to financing constraints in the investment-cash flow sensitivity literature.

[INSERT TABLE V HERE]

Next, given a baseline for comparison, we estimate Equation (5) using our benchmarked holder measure (*Holder 67*) as a proxy for Δ. Columns (4) to (7) in Table V present the results. The coefficient on the interaction of the holder indicator with cash flow is positive (0.2339 in the OLS specification with controls) and highly significant. The result is robust to clustering the standard errors by firm and including industry effects interacted with cash flow. As predicted by our model, CEOs who demonstrate a higher level of overconfidence than their peers in their personal portfolio decisions also exhibit a higher sensitivity of corporate investment to cash flow. Figure 1 presents the regression results, varying the threshold for rational exercise between 50% and 150% (along with the sample restriction). The results are the same. We also examine the effect of holding options that are between zero and 50% in-the-money and find an insignificant negative effect on investment-cash flow sensitivity. Thus, as predicted, increased investment-cash flow sensitivity comes only from holding highly in-the-money options.

[INSERT FIGURE 1 HERE]

To further distinguish the overconfidence effect on investment decisions from insider trading, we split *Holder 67* into late exercisers who lose money on at least one of the options they hold beyond the threshold and late exercisers who always profit. If information contaminates our *Holder 67* measure, then much of the effect should be isolated in the winner portion of the split (*Hold and Win 67*). Thus, we test whether the investment effects we have attributed to overconfidence are present among the loser subgroup (*Hold and Lose 67*), given their demonstrated lack of favorable insider knowledge.

First, we diagnose whether our (other) overconfidence measures are more associated with the loser subgroup (who are most likely to be overconfident) or the winner subgroup (who may have positive private information). We find that the correlation between *Longholder* and *Hold and Lose 67* is 0.2699, while the correlation between *Longholder* and *Hold and Win 67* is −0.0138. Similarly, the correlation between the *Net Buyer* variable and *Hold and Lose 67* is 0.1263, and the correlation between *Net Buyer* and *Hold and Win 67* is −0.1402.[20] Thus, our overconfidence measures are most associated with the CEOs who appear to be overconfident rather than well-informed.

Next, we repeat the regressions of Table V, splitting *Holder 67* into losers and winners. If the investment-cash flow sensitivity were driven by (highly persistent) inside information, then we should not be able to replicate the results for the losers. Table VI shows the estimates of Equation (5). We find that the estimated coefficient of *Hold and Lose 67* interacted with cash flow is positive, significant, and similar to the coefficient on *Holder 67* in Table V (the coefficient on *Hold and Lose 67* is 0.2366 in the OLS-with-controls specification). We also find a positive effect of *Hold and Win 67* on investment-cash flow sensitivity, which may indeed reflect positive inside information. The key result, then, is that the effect of *Holder 67* remains when we remove the effect of these CEOs from the estimate. Finally, as there is only a small number of CEOs (10) in the winner subgroup, we test the robustness of the result to weaker assumptions. We find that the results are virtually identical if we instead classify CEOs as winners if they more often outperform the S&P 500 when they hold beyond the threshold than underperform. Overall, then, inside information does not appear to drive our results.

[INSERT TABLE VI HERE]

C. Longholder

Table VII gives the results of estimating Equation (5) using the *Longholder* variable as our proxy for Δ.[21] As in Table V, Q appears to positively impact the sensitivity of investment to cash flow. Also, as before, equity ownership and firm size are negatively associated with investment-cash flow sensitivity. Vested options now positively impact investment-cash flow sensitivity. This positive correlation may indicate that CEOs with high ownership in vested options are more reluctant to dilute existing shares.[22] It could also arise if the cumulative effect of overconfidence in option exercise decisions outweighs the impact of new grants and provisions of the compensation contract in determining the level of vested options. Most importantly, *Longholder* CEOs have higher sensitivity of investment to cash flow. The effect is robust to controlling for differential sensitivities among the twelve Fama-French industries. Further, there is enough within-firm variation in *Longholder* to identify the *Longholder* effect on investment-cash flow sensitivity including firm-fixed effects interacted with cash flow. This specification eliminates any alternative explanation of our results that relies on fixed cross-sectional differences across firms with and without overconfident CEOs. Although these estimates are not robust to clustering the observations by firm, they are robust to alternative methods of controlling for serial correlation. The coefficients in Prais-Winsten regressions assuming a common first-order autoregressive structure on the errors across panels are 0.2385 with a t-statistic of 2.73, 0.2043 with a t-statistic of 2.80, and 0.1324 with a t-statistic of 2.76 without industry-or firm-fixed effects interacted with cash flow, with industry effects interacted

with cash flow, and with firm-fixed effects interacted with cash flow, respectively. All estimates are significant at the 1% level. Again, we conclude that an overconfident CEO will increase investment more when cash flow increases than his less confident peers.

[INSERT TABLE VII HERE]

D. Net Buyer

Table VII also presents the results from estimating Equation (5) using *Net Buyer* to capture overconfidence. CEOs are classified as overconfident based on their stock purchase decisions during their first five years in the sample. Equation (5) is estimated using only the remaining years of the CEOs' tenure. Most of the control variables in these regressions behave as in our prior estimations. The effect of Q interacted with cash flow is now negative and marginally significant. Though this result is difficult to interpret, it is not relevant for our results (see Column 4). The most important finding is that being a *Net Buyer* increases the sensitivity of investment to cash flow. The result is robust to the inclusion of industry effects on cash flow sensitivity. Though the result without industry interactions is not quite significant in the cluster specification (p-value = 0.118), the estimate controlling for industry effects on cash flow sensitivities is significant (p-value = 0.057).

As described in Section III, identifying overconfidence and measuring its effect on investment-cash flow sensitivities in disjoint time periods allow us to distinguish managerial overconfidence from other explanations (like positive information or signalling motives) that might cause simultaneous failure to diversify and cash flow sensitivity. To further check the robustness of

the results, we reestimate the regression with a one year gap between the two sample periods. The results are similar.

Overall, overconfidence increases the sensitivity of investment to cash flow under any measure.

V. Test 2: Overconfidence and Financial Constraints

In Section I, we show that overconfidence should matter most for firms that are equity-dependent (Prediction 2). If a firm has a sufficient amount of cash or untapped debt capacity to finance all of the CEO's desired investment projects, then cash flow may not affect the level of investment. If a firm must instead access the equity market for additional finance, overconfidence should have an impact on the sensitivity of investment to cash flow.

We take several approaches to test this prediction. First, we construct the Kaplan-Zingales index of financial constraint – used by Lamont, Polk, and Saá-Requejo (2001), Malmendier and Tate (2003), and Baker, Stein, and Wurgler (2003) – for our sample of firms. Kaplan and Zingales (1997) generate direct measures of financing constraints, using annual reports and even information obtained directly from company executives, to classify their sample of firms as either constrained or unconstrained. They then estimate an ordered logit of this classification on five accounting ratios meant to quantify these financial constraints: cash flow to total capital, Q, debt to total capital, dividends to total capital, and cash holdings to capital. We apply the estimates of this ordered logit regression to our sample and construct an index

of financial constraints (or equity dependence) as follows:

$$KZ_{it} = -1.001909 * \frac{CF_{it}}{K_{it-1}} + 0.2826389 * Q_{it} + 3.139193 * Leverage_{it} \\ -39.3678 * \frac{Dividend_{it}}{K_{it-1}} - 1.314759 * \frac{C_{it}}{K_{it-1}}. \quad (6)$$

Higher values of the linear combination of the five ratios imply a higher degree of financial constraint.[23] We separate our sample into quintiles based on the lagged value of the Kaplan-Zingales index and estimate Equation (5) separately on each quintile. We use *Longholder* as the proxy for overconfidence, since the sample restrictions necessary to use *Holder 67* or *Net Buyer* would severely limit the number of observations in each of the five subsamples. We find, as predicted, that the effect of overconfidence on the sensitivity of investment to cash flow is significant only for the top quintile of the Kaplan-Zingales index (Table VIII). This effect is strong (the coefficient estimate is 0.4990) and highly statistically significant ($t = 3.52$), where standard errors are clustered by firm. Though we cannot include the interaction of firm effects with cash flow in these regressions since some quintiles would be left with too few identifiable observations, the results are robust to the inclusion of industry effects on cash flow sensitivity.

[INSERT TABLE VIII HERE]

As a further robustness check on the results, we apply several other measures of equity dependence as substitutes for the Kaplan-Zingales index. We consider the following measures: firm age (defined as the number of years since Compustat first reported a nonmissing market value of equity for the firm), firm size, dividend payment (common plus preferred), and S&P

long-term debt ratings. As above, we split the sample into quintiles based on the value of each of our alternative measures at the end of the prior fiscal year. In the case of credit ratings, data unavailability leaves us with roughly 60% fewer observations. So, we instead split the sample into firms with ratings of BBB or lower and firms with ratings of A, AA, or AAA. In all cases, the strongest positive effect of overconfidence on investment-cash flow sensitivity is among the most equity-dependent firms: the quintile of the youngest firms, the smallest firms, the firms that pay the fewest dividends, and the sample of firms with debt ratings of BBB or lower. In two cases, firm size and credit ratings, this effect is not statistically significant; however, the coefficients are remarkably stable across the alternative measures (ranging from 0.28 to 0.36).[24]

Since the mechanism by which overconfidence increases the sensitivity of investment to cash flow is perceived undervaluation and reluctance to issue equity, we also consider the differences in financing decisions between overconfident and nonoverconfident CEOs. Using the financing deficit as defined by Frank and Goyal (2003), we find that overconfident CEOs are more likely than other CEOs to raise debt (rather than equity) to cover financing needs.[25]

Thus, both predictions of our simple model of overconfidence are confirmed in the data.

VI. Other Personal Characteristics

In this section we examine the relation between overconfidence and other observable executive characteristics: educational and employment background, birth cohort, and accumulation of titles within the company. We analyze their effects on investment-cash flow sensitivity and

ask whether CEO overconfidence affects investment decisions independently. First, we estimate Equation (5) including each of these characteristics (in lieu of a proxy for Δ) and industry effects interacted with cash flow. As Columns (1)-(4) of Table IX show, CEOs with technical education have more investment-cash flow sensitivity than CEOs with general education while CEOs with financial education have less. The results are similar replacing educational background with employment background (untabulated). CEOs who belong to the Great Depression birth cohort also have more investment-cash flow sensitivity. Donaldson (1990) provides a nice description of the psychology underlying this effect[26]:

> "... the reader should bear in mind the organizational context of the time [at General Mills in the late 1960s/mid 1970s]. The corporate leaders of this period were young adults in the 1930s whose early business and personal lives were profoundly affected by the collapse of the capital markets during the Great Depression. This led them to be deeply skeptical of the public capital markets as a reliable source of personal or corporate funding, to avoid financial risk wherever possible, and to have an instinctive affinity for a strategy of self-sufficiency" (p. 125).

In addition, CEOs who have accumulated additional titles (President and Chairman of the Board) display heightened sensitivity of investment to cash flow. Finally, we include all of the characteristics and *Longholder* as a proxy for overconfidence (Column 6). *Longholder* still strongly predicts higher investment-cash flow sensitivity. The 1930s cohort effect and finance education effect also remain significant. We conclude that more conventional "style" effects, rooted in the CEO's background, may be important for determining investment policy.[27] How-

ever, overconfidence is distinct from these observable CEO characteristics.

[INSERT TABLE IX HERE]

VII. Conclusion

The main goal of this paper is to establish the relation between managerial overconfidence and corporate investment decisions. Our analysis consists of three main steps. First, we derive, in a simple model of the corporate investment decision, the prediction that the sensitivity of investment to cash flow is strongest in the presence of overconfidence. We then construct three measures of overconfidence, using data on personal portfolio decisions of the CEO: (1) Does the CEO hold his options beyond a theoretically calibrated benchmark for exercise? (2) Does the CEO hold his options even until the last year before expiration? (3) Does the CEO habitually buy stock of his company during the first five sample years? Whenever the answer to one of these questions is yes, we classify a CEO as overconfident. Additional tests on the persistence of such behavior and on the CEO's gains and losses from option exercise strengthen the interpretation of these measures as proxies for overconfidence.

We then regress investment on cash flow, the overconfidence measure, and the interaction of overconfidence and cash flow. We find a strong positive relation between the sensitivity of investment to cash flow and executive overconfidence. The coefficients of the interaction term of overconfidence and cash flow are highly significant for all of our measures. We also find that overconfidence matters more in firms that are equity dependent, as predicted by the overconfidence model.

These results have important implications for contracting practices and organizational design. Specifically, standard incentives such as stock- and option-based compensation are unlikely to mitigate the detrimental effects of managerial overconfidence. As a result, the board of directors may need to employ alternative disciplinary measures, such as debt overhang, which can suffice to constrain overconfident CEOs. In addition, the results confirm the need for independent and vigilant directors.

Appendix

Proof of Lemma 1. Solving Equation (2) for s' yields $s' = s\frac{I-c-d}{A+C+R(I)-I}$. Substituting into the objective function, we can rewrite the maximization problem as follows[28]:

$$\max_{I,c,d} \; A + C + R(I)(1+\Delta) - (I-c-d)\cdot\frac{A+C+R(I)(1+\Delta)-c-d}{A+C+R(I)-c-d} - (c+d) \tag{A1}$$

$$\text{s.t. } c \le C, \quad d \le D, \quad c+d \le I \tag{A2}$$

$$c \ge 0, \quad d \ge 0, \quad I \ge 0. \tag{A3}$$

Our assumptions on $R(\cdot)$ ensure $I^* > 0$. For simplicity, we ignore the nonnegativity constraints $c \ge 0$ and $d \ge 0$ and show instead that the optimal solution to the unconstrained problem satisfies them. Let λ, μ, and ν be the Lagrange multipliers on the constraints $c \le C$, $d \le D$, and $c + d \le I$, respectively. Then, the following conditions determine the optimal investment and financing plan:

$$R'(I^*)(1+\Delta) - \frac{A+C+R(I^*)(1+\Delta)-c^*-d^*}{A+C+R(I^*)-c^*-d^*} \tag{A4}$$
$$-(I^*-c^*-d^*)\cdot\frac{(A+C+R(I^*)-c^*-d^*)R'(I^*)(1+\Delta)-R'(I^*)(A+C+R(I^*)(1+\Delta)-c^*-d^*)}{(A+C+R(I^*)-c^*-d^*)^2}+\nu = 0$$

$$\frac{A+C+R(I^*)(1+\Delta)-c^*-d^*}{A+C+R(I^*)-c^*-d^*} - \frac{\Delta R(I^*)(I^*-c^*-d^*)}{(A+C+R(I^*)-c^*-d^*)^2} - 1 - \lambda - \nu = 0 \tag{A5}$$

$$\frac{A+C+R(I^*)(1+\Delta)-c^*-d^*}{A+C+R(I^*)-c^*-d^*} - \frac{\Delta R(I^*)(I^*-c^*-d^*)}{(A+C+R(I^*)-c^*-d^*)^2} - 1 - \mu - \nu = 0 \tag{A6}$$

$$\lambda(c^*-C) = 0, \quad \mu(d^*-D) = 0, \quad \nu(c^*+d^*-I^*) = 0 \tag{A7}$$

$$\lambda \ge 0, \quad \mu \ge 0, \quad \nu \ge 0.$$

(i) Suppose $\Delta = 0$. Then conditions (A4)-(A6) simplify to

$$R'(I^*) - 1 + \nu = 0 \tag{A8}$$
$$-\lambda - \nu = 0 \tag{A9}$$
$$-\mu - \nu = 0. \tag{A10}$$

From (A9) and (A10), we must have $\lambda = \mu = -\nu$. But, since the multipliers must be nonnegative, we conclude that $\lambda = \mu = \nu = 0$. Thus, from (A8), $R'(I^*) = 1$ and $I^* = I_{FB}$. Further, all financing plans (c^*, d^*) satisfying (A2) and (A3) at I^* are optimal.

(ii) Suppose $\Delta > 0$. We consider separately the cases $\nu = 0$ and $\nu > 0$.

If $\nu = 0$, the constraint $c + d \le I$ does not bind at I^*. Thus, this case includes all optimal plans in which the CEO issues shares ($s' > 0$). From conditions (A5) and (A6),

$$\lambda = \mu = \frac{(A+C+R(I^*)-c^*-d^*)^2 + \Delta R(I^*)(A+C+R(I^*)-I^*)}{(A+C+R(I^*)-c^*-d^*)^2} - 1. \tag{A11}$$

Then, since $A + R(I^*) > I^* - C$, $\lambda = \mu > 0$. Thus, $c^* = C$ and $d^* = D$ from (A7), and (A3)

is satisfied.[29] From condition (A4),

$$R'(I^*) = \frac{1}{1+\Delta\frac{A+C-c^*-d^*}{A+R(I^*)+C-c^*-d^*}\frac{A+C+R(I^*)-I^*}{A+R(I^*)(1+\Delta)+C-c^*-d^*}}$$

and, substituting $c^* = C$ and $d^* = D$,

$$R'(I^*) = \frac{1}{1+\Delta\frac{A-D}{A+R(I^*)-D}\frac{A+C+R(I^*)-I^*}{A+R(I^*)(1+\Delta)-D}}. \tag{A12}$$

Notice that $c^* = C$, $d^* = D$, and $c^* + d^* \leq I^*$ imply $C + D \leq I^*$. With $R(I^*) \geq 0$, $\Delta \geq 0$, $C + D \leq I^*$, $A > D$, and $A + R(I^*) > I^* - C$, we have $\frac{1}{1+\Delta} < R'(I^*) < 1$. Thus, as $R'' < 0$, $I^* < \hat{I}$ and, by implication, $C + D < \hat{I}$.

Now suppose $\nu > 0$. Then, $c^* + d^* = I^*$ and the optimal financing plan does not include equity ($s' = 0$). Then, using (A5) and (A6),

$$\lambda = \mu = \frac{A + C + R(I^*)(1 + \Delta) - c^* - d^*}{A + C + R(I^*) - c^* - d^*} - 1 - \nu. \tag{A13}$$

Solving for ν and substituting in (A4) gives

$$R'(I^*)(1 + \Delta) - 1 - \lambda = 0. \tag{A14}$$

First, consider $\lambda = \mu = 0$. Then, $R'(I^*) = \frac{1}{1+\Delta}$, which implies $I^* = \hat{I} > I_{FB}$. Further, as $c^* \leq C$ and $d^* \leq D$, we have $C + D \geq \hat{I}$. All financing plans (c^*, d^*) satisfying $0 \leq c^* \leq C$, $0 \leq d^* \leq D$, and $c^* + d^* = I^*$ are optimal.

Next, consider $\lambda = \mu > 0$. Then, from (A7), $c^* = C$ and $d^* = D$ and (A3) is satisfied. Further, $R'(I^*) = \frac{1+\lambda}{1+\Delta} > \frac{1}{1+\Delta} = R'(\hat{I})$. Thus, as $R'' < 0$, $I^* < \hat{I}$ and, by implication, $C + D < \hat{I}$. Finally, using $\nu > 0$, (A13), and (A14), $1 + \frac{\Delta R(I^*)}{A+R(I^*)-D} > R'(I^*)(1 + \Delta)$, implying $R'(I^*) < 1$ and $I_{FB} < I^*$. Q.E.D.

Proof of Proposition 1.

(i) For $\Delta = 0$, $R'(I^*) = 1$ implies that I^* is independent of C.

(ii) For $\Delta > 0$ and $\nu = 0$, (A12) gives

$$\frac{dI^*}{dC} = -\frac{\Delta R'(I^*)(A-D)}{R''(I^*)[(A+R(I^*)-D)(A+R(I^*)(1+\Delta)-D)+\Delta(A-D)(A+C+R(I^*)-I^*)]+2R'(I^*)(R'(I^*)-1)(1+\Delta)(A+R(I^*)-D)}. \tag{A15}$$

Then, $A > D$, $A + R(I^*) > I^* - C$, and $R'(I^*) < 1$ imply $\frac{dI^*}{dC} > 0$. Further, $C + D < \hat{I}$.

For $\Delta > 0$ and $\nu > 0$, $I^* = \hat{I}$ and is thus independent of C over the subset $C + D \geq \hat{I}$. For $C + D < \hat{I}$, we have instead $I^* = C + D$ and thus $\frac{dI^*}{dC} = 1 > 0$. **Q.E.D.**

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Notes

[1]Upward bias in the assessment of future outcomes is sometimes referred to as "overoptimism" rather than "overconfidence." We follow the literature on self-serving attribution and choose the label "overconfidence" in order to distinguish the overestimation of one's own abilities (such as IQ or managerial skills) and outcomes relating to one's own personal situation from the general overestimation of exogenous outcomes (such as the growth of the U.S. economy).

[2]See also Bertrand and Schoar (2003) on the impact of managerial style on firm policy.

[3]A manager who is not self-interested does not necessarily act in the interest of current shareholders since efficient investment implies maximizing the total value of the firm (see Hart (1993), (2001)). To conform with the previous literature, we assume that the manager maximizes current shareholder value. Moreover, in the case of overconfident managers, it is not clear whether value maximization leads to more efficient outcomes than the maximization of current shareholder value since managers and shareholders will not agree on the value-maximizing course of action even without managerial self-interest.

[4]The investment-cash flow sensitivity result replicates in any setting with at least one financial security that is not risk-free and thus induces disagreement about its price.

[5]See Kaplan-Zingales (1997) for a similarly posed theoretical problem.

[6]Note that this criterion limits the number of IPOs in our sample (and, thus, the relevance of the more stringent restrictions on insider trading associated with such firms, such as lockup periods).

[7]Definitions of Q and its components are as in Fama and French (2002).

[8]The results are similar if we instead winsorize cash flow at 1 %.

[9]The few CEOs with degrees belonging to more than one group are classified in multiple categories.

[10]We lose 130 (financial) firms when we merge in the accounting data necessary to construct cash flow, investment, and Q due to missing data. Additionally, our treatment of cash flow and the requirement that options and stock holdings data be present for a firm-year to be included in the regressions brings the total number of firms to 337.

[11]We exclude CEOs for whom data on stock purchases is not present for more than one of these five years.

[12]Note that some of the increase in shareholdings may arise due to new stock grants. This component is unlikely to be the driving factor behind our classification, however. Indeed, we find that there are no restricted stock grants in the CEO-years we use to construct this measure.

[13]See Malmendier and Tate (2003) for a similar split of summary statistics using the *Longholder* measure.

[14]The results are the same if we look only at CEOs who had an option to reach the 67 % threshold at least twice.

[15]Financial advisory firms that track insider trades often report only the purchases and sales of stocks, not the exercise of options (see, for instance, the websites of Investar and Quicken; see also EDGAR). Other websites make it explicit that option exercise should be understood as "noise" with respect to insider knowledge; see, for instance, http://www.winninginvesting.com/insider.htm ("The employees consider the options part of their salary....") or http://invest-faq.com/articles/trade-insider.html ("same-day exercise of a stock option and selling the resulting stock ... rarely means very much."); similarly, see the weekly column "Insider Trading Spotlight" in the *Wall Street Journal*, and the weekly coverage of insider-trading information in the *Financial Times*.

[16]This conclusion is somewhat clouded by the possibility that new grants contaminate the *Net Buyer* measure.

[17]Stock ownership and vested options, like Q, are taken at the beginning of the fiscal year. Also, we multiply vested options by 10 in the regressions so that its mean is comparable to the mean of stock ownership.

[18]Among others, Brickley, Coles, and Terry (1994) suggest that the number of outside executives are an improvement on previous measures of corporate governance; see also Byrd and Hickman (1992). An alternative measure available in our data set is board size. Employing an indicator of efficient board size (fewer than 12 members) as a measure of governance gives similar results.

[19]See French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) for definitions. The results are typically robust to larger numbers of industry classifications with the results on the largest samples (e.g., the personal characteristic results in Section VI) robust to even the full set of 48 Fama and French groups.

[20]The correlations between the *loser* and *winner* variables and *Longholder* are calculated using the *Holder 67* sample restriction; the correlations between the *loser* and *winner* variables and *Net Buyer* are calculated using the intersection of the *Holder 67* and *Net Buyer* sample restrictions. All correlations except *Longholder* and *winner* are statistically significant at the 1 % level.

[21]Because of space considerations, Table VII does not display the benchmark regressions of investment on only cash flow and Q, including and excluding fixed effects. However, the results of those regressions are similar to the results in Table V for the *Holder 67* subsample.

[22]See Hadlock (1998).

[23]To construct the index, we use the definition of Q as in Kaplan and Zingales (1997). The ratios composed from COMPUSTAT data items are: cash flow to capital = (item 18 + item 14) / item 8 ; Q = [item 6 + (item24 * item 25) - item 60 - item 74] / item 6 ; debt to capital (leverage) = (item 9 + item 34) / (item 9 + item 34 + item 216) ; dividends to capital = item21 + item 19) / item 8 ; cash to capital = item 1 / item 8. Item 8,

capital, is always taken at the beginning of the year.

[24]Table available upon request.

[25]Tables are available upon request.

[26]We thank the referee for suggesting this quotation.

[27]See also Bertrand and Schoar (2003).

[28]Notice that we need $A + R(I^*) > I^* - C$ for this problem to be well defined. $A + R(I^*) = I^* - C$ implies that the CEO cannot raise funds from the equity markets (and thus $I^* = c^* + d^*$). Thus, cash flow sensitivity arises if and only if internal funds are insufficient to cover desired investment ($C + D < \hat{I}$).

[29]Notice that all cash and debt capacity is exhausted before the CEO will issue equity.

Table I

Summary Statistics

The sample with "Holder67 Sample Restriction" contains all CEO-years of CEOs who had options more than 67% in-the-money in the fifth year at least two times during their sample tenure. The "Holder67 Sample" contains all CEO-years after the CEO fails to exercise a five-year-old option that is at least 67% in-the-money, provided that he subsequently does it again at least once.

Panel A. Firm Data Summary Statistics

	Full Sample						Holder67 Sample Restriction						Holder67 Sample					
	Number of Firms = 337						Number of Firms = 113						Number of Firms = 58					
Variable	Obs.	Mean	Median	SD	Min.	Max.	Obs.	Mean	Median	SD	Min.	Max.	Obs.	Mean	Median	SD	Min.	Max.
Assets ($M)	3742	5,652	2,286	12,759	14	198,599	1058	5,584	2,161	12,978	20.3	180,237	305	6,802	2,532	18,782	197	180,237
Capital ($M)	3740	2,448	989	5,599	4	128,063	1058	1,831	846	3,616	4	42,027	305	2,306	924	5,049	48.6	42,027
Investment ($M)	3742	382	151	949	0	17,810	1058	370	159	878	0	11,712	305	477	182	1,190	0	11,712
Investment normalized by lagged capital	3742	0.23	0.18	0.25	0	5.72	1058	0.25	0.21	0.23	0	5.72	305	0.23	0.21	0.12	0	0.94
Investment normalized by lagged assets	3742	0.09	0.07	0.08	0	1.64	1058	0.10	0.08	0.07	0	0.07	305	0.09	0.08	0.06	0	0.42
Cash flow ($M)	3742	453	191	985	-618	15,726	1058	490	203	1,005	-117	11,713	305	616	249	1,317	-60	11,713
Cash flow normalized by lagged capital	3742	0.35	0.25	0.35	-0.24	2.55	1058	0.42	0.32	0.35	-0.11	2.46	305	0.40	0.31	0.33	-0.09	2.46
Cash flow normalized by lagged assets	3742	0.11	0.10	0.07	-0.16	0.65	1058	0.13	0.12	0.07	-0.06	0.59	305	0.12	0.12	0.07	-0.06	0.49
Q (beginning of the fiscal year)	3742	1.44	1.14	0.92	0.51	12.26	1058	1.58	1.31	0.90	0.66	10.71	305	1.62	1.39	0.75	0.83	6.49
Earnings/Price Ratio	3648	0.05	0.06	0.15	-7	1	1030	0.06	0.06	0.06	-0.94	0.35	304	0.05	0.05	0.04	-0.22	0.15
ROA	3742	0.06	0.05	0.06	-0.21	0.55	1058	0.08	0.07	0.07	-0.19	0.55	305	0.07	0.06	0.06	-0.19	0.32
Corporate governance (Outside CEOs)	3742	1.77	1	1.59	0	9	1058	1.74	1	1.58	0	8	305	1.85	1	1.73	0	8

Distribution across Fama French 12 Industry Groups (3728 observations)				*(1056 observations)*				*(305 observations)*			
Consumer Nondurables	0.11	Telecommunication	0.04	Cons. ND	0.14	Telecomm.	0.02	Cons. ND	0.10	Telecomm.	0.02
Consumer Durables	0.04	Utilities	0.17	Cons. D	0.05	Utilities	0.03	Cons. D	0.05	Utilities	0.00
Manufacturing	0.13	Shops	0.11	Manuf.	0.11	Shops	0.12	Manuf.	0.10	Shops	0.12
Energy	0.03	Health	0.05	Energy	0.01	Health	0.09	Energy	0.02	Health	0.10
Chemicals and Allied Products	0.06	Money	0.06	Chemicals	0.12	Money	0.05	Chemicals	0.15	Money	0.05
Business Equipment	0.07	Other	0.26	Bus. Equip.	0.12	Other	0.26	Bus. Equip.	0.16	Other	0.25

(http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

Panel B. CEO Data Summary Statistics

	Full Sample						Holder 67 Sample Restriction						Holder 67 Sample					
	Number of CEOs = 697						Number of CEOs = 113						Number of CEOs = 58					
Variable	Obs.	Mean	Median	SD	Min.	Max.	Obs.	Mean	Median	SD	Min.	Max.	Obs.	Mean	Median	SD	Min.	Max.
Age	3741	57.57	58	6.77	33	84	1058	58.02	58	6.12	41	82	305	60.78	61	5.88	44	82
Years as CEO	3716	8.53	6	7.44	1	45	1058	10.81	9	7.24	1	39	297	13.72	12	5.91	6	35
CEO & President & Chairman (dummy)	3742	0.38	0	0.49	0	1	1058	0.37	0	0.48	0	1	305	0.40	0	0.49	0	1
Founder (dummy)	3186	0.17	0	0.37	0	1	944	0.17	0	0.38	0	1	279	0.17	0	0.38	0	1
Stock ownership (%)	3742	0.023	0.0012	0.07	0	0.951	1058	0.017	0.002	0.05	0	0.38	305	0.009	0.003	0.02	0	0.22
Vested options (% of shares outst.)	3742	0.002	0.0005	0.01	0	0.463	1058	0.004	0.001	0.01	0	0.11	305	0.005	0.002	0.01	0	0.07
"Depression baby" (born in 1930s) (dummy)	3741	0.37	0	0.48	0	1	1058	0.42	0	0.49	0	1	305	0.37	0	0.48	0	1
Finance career (dummy)	2014	0.23	0	0.42	0	1	693	0.21	0	0.41	0	1	187	0.15	0	0.36	0	1
Technical career (dummy)	2014	0.19	0	0.39	0	1	693	0.18	0	0.38	0	1	187	0.17	0	0.38	0	1
Finance education (dummy)	2218	0.33	0	0.47	0	1	786	0.38	0	0.49	0	1	215	0.45	0	0.50	0	1
MBA (dummy)	2218	0.27	0	0.44	0	1	786	0.33	0	0.47	0	1	215	0.36	0	0.48	0	1
Technical education (dummy)	2218	0.56	1	0.50	0	1	786	0.52	1	0.50	0	1	215	0.48	0	0.50	0	1

Table II

Correlations

Sample A: CEOs with options more than 67% in-the-money in the fifth year at least two times.
Sample B: CEOs with at least 10 years in the data and no more than one missing observation of ownership in the first five years. Data from the first five years of each CEO's tenure excluded.
Sample C: CEOs with options more than 67% in-the-money in the fifth year at least two times and with at least 10 years in the data and no more than one missing observation of ownership in the first five years. Data from the first five years of each CEO's tenure excluded.

Overconfidence and Firm Characteristics

	Holder 67			Longholder			Net Buyer			Size			Q			CF/k			Stock Ownersh.			Vested Options			Corp. Gov.		
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.
Holder 67	1.00	n/a	1.00																								
Longholder	***0.25***	n/a	n/a	1.00	1.00	n/a																					
Net Buyer	n/a	n/a	**0.06**	n/a	**0.01**	n/a	n/a	1.00	1.00																		
Size	*0.15*	n/a	0.06	*-0.17*	*-0.11*	n/a	n/a	*0.25*	*0.32*	1.00	1.00	1.00															
Q	0.03	n/a	-0.04	*0.10*	*0.11*	n/a	n/a	*-0.11*	*-0.10*	*-0.25*	*-0.34*	*-0.28*	1.00	1.00	1.00												
CF/k	-0.03	n/a	-0.04	*0.11*	*0.15*	n/a	n/a	*-0.16*	*-0.08*	*-0.20*	*-0.10*	*-0.12*	*0.44*	*0.40*	*0.44*	1.00	1.00	1.00									
Stock ownership	*-0.10*	n/a	*-0.18*	*-0.07*	*-0.19*	n/a	n/a	*-0.20*	*-0.18*	*-0.20*	*-0.12*	*-0.13*	-0.01	-0.01	*-0.09*	*0.06*	*0.11*	0.00	1.00	1.00	1.00						
Vested options	*0.10*	n/a	0.06	*0.17*	*0.30*	n/a	n/a	*-0.11*	*-0.15*	*-0.31*	*-0.26*	*-0.37*	*0.18*	*0.18*	*0.20*	*0.25*	*0.27*	*0.34*	*0.10*	*-0.07*	0.01	1.00	1.00	1.00			
Corporate governance	0.04	n/a	0.02	0.02	0.04	n/a	n/a	*0.06*	0.01	*0.33*	*0.29*	*0.35*	*-0.08*	*-0.15*	*-0.09*	*-0.08*	*-0.09*	-0.01	*-0.14*	*-0.23*	*-0.15*	*-0.16*	*-0.14*	*-0.18*	1.00	1.00	1.00

Overconfidence and CEO Characteristics

	Holder 67			Longholder			Net Buyer			Depression Baby			CEO/Pres/Chm.			Finance Career			Techn. Career			Tenure		
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.
"Depression baby"	*-0.06*	n/a	*-0.15*	-0.03	*-0.07*	n/a	n/a	0.04	0.04	1.00	1.00	1.00												
CEO & President & Chairman	0.04	n/a	0.05	-0.04	*-0.06*	n/a	n/a	*0.13*	0.07	-0.01	-0.02	*-0.10*	1.00	1.00	1.00									
Finance career	*-0.09*	n/a	*-0.16*	*-0.10*	*-0.13*	n/a	n/a	*0.08*	*0.29*	-0.05	0.06	-0.03	*-0.14*	*-0.12*	*-0.19*	1.00	1.00	1.00						
Technical career	-0.01	n/a	0.02	*-0.12*	-0.05	n/a	n/a	*-0.25*	*-0.26*	*0.10*	0.07	*0.15*	*0.07*	0.01	0.04	*-0.15*	*-0.15*	-0.07	1.00	1.00	1.00			
Tenure	*0.25*	n/a	-0.05	0.02	*-0.06*	n/a	n/a	*-0.21*	*-0.18*	*-0.18*	*-0.35*	*-0.28*	0.01	-0.01	-0.03	*-0.14*	*-0.12*	*-0.13*	*0.14*	0.07	*0.22*	1.00	1.00	1.00

Coefficients in italics are significant at 10%.

Table III
Persistence of Exercising Behavior

In Panel A, the dependent variable is a dummy variable taking the value one if the CEO fails to exercise a five-year-old option that reaches at least 67% in-the-money in the current period. Past late exercises is the number of times that the CEO has exercised such options late in the past. Q is the market value of assets over the book value of assets at the beginning of the year. Earnings/Price ratio is the minimal earnings to price ratio during the fiscal year. Panel B presents statistics on late exercises of stock options partitioned by the number of past late exercises by the CEO in question.

Panel A. Random Effects Probit Regression

Sample: Observations with 67%-in-the-money options (in year five)

	(1)	(2)	(3)	(4)
Past late exercises	0.2493	0.2569	0.2571	0.266
	(4.40)***	(4.57)***	(4.61)***	(4.80)***
Q		-0.1519		-0.1514
		(1.79)*		(1.81)*
Earnings/price ratio			-0.709	-0.8128
			(0.77)	(0.89)
Observations	759	742	731	728
Number of CEOs	278	273	272	271

Absolute value of z statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Panel B. Percent of "Late Exercisers" Partitioned by Number of Past Late Exercises

Sample: Observations with 67%-in-the-money options (in year five)

Past Late Exercises	% Who Exercise Late	Number of CEOs
0	0.32	487
1	0.64	128
2	0.73	67
3	0.94	32
4	0.79	28
> 4	0.74	23

Table IV

Distribution of Returns of "Late Exercisers" (67%, fifth year)

The table presents data on the returns of late exercising CEOs (Holders 67) by percentiles. The first column presents the percentage in-the-money at the maximum price during the fifth fiscal year from grant date for each option package that is held beyond the 67% threshold. The second, third, and fourth columns present the returns (in %) relative to exercising the options during year five and investing instead in the S&P500, assuming exercise at the maximum, mean, and median stock prices during the fiscal year, respectively. We also present the last percentile for which the return is negative under each price assumption. All returns are annualized.

Sample: CEOs who have option packages at least 67% in-the-money in the fifth year after the option grant and who have not exercised the options before the fifth year.

Percentage in-the-money in year 5		Return (in %) relative to exercising during year 5 and investing in S&P500					
		Exercise at fiscal-year maximum price		Exercise at fiscal-year mean price		Exercise at fiscal-year median price	
Percentile	% in the money	Percentile	Return	Percentile	Return	Percentile	Return
10th	161.89	10th	-16.56	10th	-16.48	10th	-16.45
20th	213.71	20th	-10.32	20th	-10.51	20th	-11.65
30th	280.97	30th	-6.40	30th	-5.89	30th	-7.39
40th	366.88	40th	-2.79	40th	-2.50	40th	-2.56
		46th	-0.66	46th	-0.38	49th	-0.05
50th	435.88	50th	1.02	50th	1.64	50th	0.30
60th	616.83	60th	5.72	60th	6.94	60th	5.59
70th	905.43	70th	10.86	70th	10.96	70th	11.62
80th	1,395.22	80th	19.16	80th	17.32	80th	16.05
90th	2,326.39	90th	28.27	90th	25.27	90th	25.07
Mean	1,275.90		3.60		4.85		3.57
Standard Deviation	3,336.66		20.23		20.96		21.15
Observations	182		182		182		182
CEOs	86		86		86		86

Table V

Regression of Investment on Cash Flow and Exercise Behavior

The dependent variable in the regressions is Investment, defined as firm capital expenditures and normalized by capital at the beginning of the year. Cash flow is earnings before extraordinary items plus depreciation and is normalized by capital at the beginning of the year. Q is the market value of assets over the book value of assets at the beginning of the year. Stock ownership is the fraction of company stock owned by the CEO and his immediate family at the beginning of the year. Vested options are the CEO's holdings of options that are exercisable within six months of the beginning of the year, as a fraction of common shares outstanding. Vested options are multiplied by 10 so that the mean is comparable to stock ownership. Size is the natural logarithm of assets at the beginning of the year. Corporate governance is the number of outside directors who currently serve as CEOs of other companies.

Holder 67 is a dummy variable equal to one for all CEO-years after the CEO holds a five-year-old option that is more than 67% in-the-money, provided that he subsequently does it again at least once. Industries are defined as the twelve Fama-French industry groups. In Columns 6 and 7, standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

Sample: CEOs with options more than 67% in-themoney in the fifth year at least two times.

	Baseline Regressions			Late Exercise of 67%,-in-the-money Options (in year 5)			
	no fixed effects, no controls	fixed effects, no controls	fixed effects, controls	over-confidence with fixed effects, no controls	over-confidence with fixed effects, controls	standard errors clustered by firm	industry - CF interactions, clustered by firm
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.2052	0.6419	1.6579	0.6729	1.7044	1.7044	1.2911
	(9.73)***	(7.19)***	(9.85)***	(7.56)***	(10.20)***	(2.99)***	(3.22)***
Q	0.0250	0.0635	-0.0049	0.0656	-0.0088	-0.0088	-0.0112
	(3.04)***	(6.54)***	(0.24)	(6.79)***	(0.44)	(0.18)	(0.35)
Stock ownership (%)			-0.1077		-0.1834	-0.1834	0.1892
			(0.19)		(0.33)	(0.26)	(0.34)
Vested options			0.1946		0.1398	0.1398	0.1989
			(1.61)		(1.17)	(1.04)	(1.55)
Size			0.0466		0.0543	0.0543	0.0429
			(2.45)**		(2.88)***	(1.47)	(1.44)
Corporate governance			-0.0042		-0.0071	-0.0071	-0.0131
			(0.54)		(0.92)	(0.75)	(1.40)
(Q)*(Cash flow)			0.0521		0.0648	0.0648	0.0645
			(2.64)***		(3.28)***	(0.83)	(1.28)
(Stock ownership)*(Cash flow)			-0.5749		-0.6897	-0.6897	-1.1138
			(1.38)		(1.67)*	(0.45)	(0.97)
(Vested options)*(Cash flow)			-0.4612		-0.2981	-0.2981	-0.5015
			(4.15)***		(2.62)***	(1.32)	(2.62)***
(Size)*(Cash flow)			-0.1713		-0.1754	-0.1754	-0.1433
			(8.47)***		(8.77)***	(2.31)**	(2.64)***
(Corporate governance)*(Cash flow)			0.0363		0.0441	0.0441	0.0597
			(2.16)**		(2.65)***	(1.69)*	(2.61)**
Holder 67				-0.0351	-0.0495	-0.0495	-0.0362
				(1.35)	(1.96)*	(1.67)*	(1.27)
(Holder 67)*(Cash flow)				0.1648	0.2339	0.2339	0.1718
				(3.39)***	(4.70)***	(2.59)**	(2.20)**
Year fixed effects	no	yes	yes	yes	yes	yes	yes
Firm fixed effects	no	yes	yes	yes	yes	yes	yes
(Year fixed effects)*(Cash flow)	no	yes	yes	yes	yes	yes	yes
(Industry fixed effects)*(Cash flow)	no	no	no	no	no	no	yes
Observations	1058	1058	1058	1058	1058	1058	1056
Adjusted R-squared	0.13	0.56	0.61	0.56	0.62	0.62	0.67

Constant included. Absolute value of t statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1

Holder Regression for Different % in the Money

Figure 1 presents the results of reestimating the regression specified in Column 6 of Table V using different percentages in-the-money as thresholds for rational exercise in the classification of CEOs as overconfident. More specifically, *Holder 67* is replaced in the regression by Holder "x", where Holder "x" is a dummy variable equal to one for all CEO-years after the CEO holds a five-year-old option that is more than "x"% in-the-money, provided that he subsequently does it again at least once. In addition, the sample is restricted in each regression to the subsample of CEOs who at least twice had options that reached at least "x"% in the money after five years. The number of CEOs meeting this restriction for each "x" is presented below along with the subset of those CEOs who are classified as overconfident using the Holder "x" measure. Coefficients on Holder "x" interacted with cash flow are significant at the 5% level for all x except x = 50, 80, and 85, which are significant at 1%, where standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

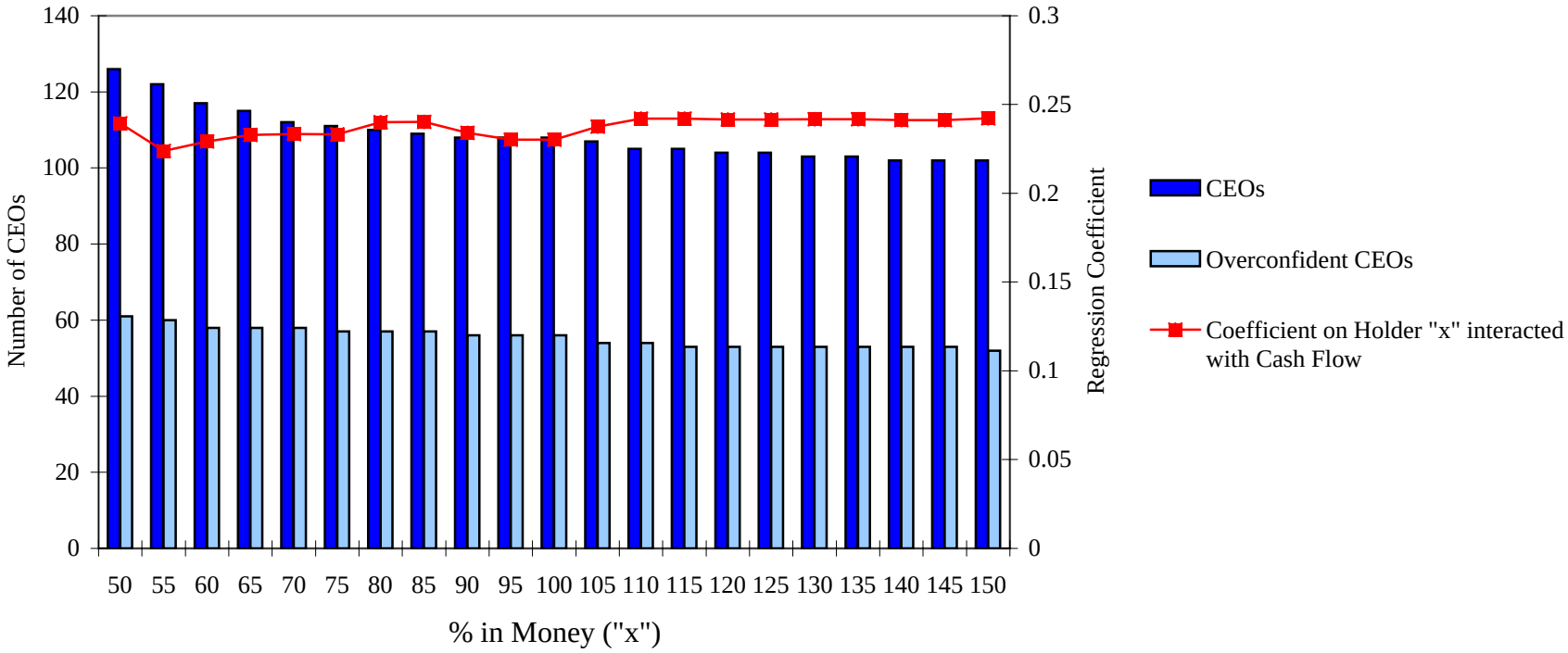

Table VI

Regression of Investment on Cash Flow and Exercise Behavior

The dependent variable in the regressions is Investment, defined as firm capital expenditures and normalized by capital at the beginning of the fiscal year. Cash flow is earnings before extraordinary items plus depreciation and is normalized by capital at the beginning of the year. Q is the market value of assets over the book value of assets at the beginning of the year. Stock ownership is the fraction of company stock owned by the CEO and his immediate family at the beginning of the year. Vested options are the CEO's holdings of options that are exercisable within 6 months of the beginning of the year, as a fraction of common shares outstanding. Vested options are multiplied by 10 so that the mean is comparable to stock ownership. Size is the natural logarithm of assets at the beginning of the fiscal year. Corporate governance is the number of outside directors who currently serve as CEOs of other companies.

Hold and Win 67 is a dummy variable equal to one for all CEO-years after the CEO holds a five-year-old option that is more than 67% in-the-money, provided that he subsequently does it again at least once and that he earns excess returns by holding the options (relative to exercising in the fifth year and investing the proceeds in the S&P 500) each time. Hold and Lose 67 is a dummy variable equal to one for all CEO-years after the CEO holds a five-year-old option that is more than 67% in-the-money, provided that he subsequently does it again at least once and that he loses money by holding such an option (relative to exercising in the fifth year and investing the proceeds in the S&P 500) at least once. Returns are calculated using the maximum stock price during the fiscal year. Industries are defined as the twelve Fama-French industry groups. In Columns 6 and 7, standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

Sample: CEOs with options more than 67% in-the-money in the fifth year at least two times.

	Baseline Regressions			Late Exercise of 67%,-in-the-Money Options (in year 5) with Losses			
	no fixed effects, no controls	fixed effects, no controls	fixed effects, controls	over-confidence with fixed effects, no controls	over-confidence with fixed effects, controls	standard errors clustered by firm	industry - CF interactions, clustered by firm
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.2096	0.6576	1.7235	0.681	1.7368	1.7368	1.3526
	(9.58)***	(7.14)***	(9.83)***	(7.42)***	(9.95)***	(2.90)***	(3.21)***
Q	0.0271	0.0668	-0.0057	0.0716	-0.007	-0.007	-0.0055
	(3.14)***	(6.29)***	(0.26)	(6.74)***	(0.32)	(0.14)	(0.16)
Stock ownership (%)			-0.2164		-0.2233	-0.2233	-0.09
			(0.31)		(0.33)	(0.33)	(0.14)
Vested options			0.1802		0.1311	0.1311	0.2108
			(1.46)		(1.07)	(0.94)	(1.54)
Size			0.0535		0.0587	0.0587	0.0504
			(2.71)***		(2.99)***	(1.52)	(1.63)
Corporate governance			-0.0042		-0.0072	-0.0072	-0.0124
			(0.52)		(0.90)	(0.75)	(1.36)
(Q)*(Cash flow)			0.0527		0.0647	0.0647	0.072
			(2.53)**		(3.10)***	(0.82)	(1.41)
(Stock ownership)*(Cash flow)			-0.7401		-0.8257	-0.8257	-1.196
			(1.71)*		(1.92)*	(0.55)	(1.09)
(Vested options)*(Cash flow)			-0.4438		-0.2907	-0.2907	-0.5406
			(3.87)***		(2.46)**	(1.25)	(2.57)**
(Size)*(Cash flow)			-0.1761		-0.1768	-0.1768	-0.1575
			(8.42)***		(8.46)***	(2.27)**	(2.72)***
(Corporate governance)*(Cash flow)			0.0383		0.0467	0.0467	0.0561
			(2.18)**		(2.67)***	(1.72)*	(2.64)***
Hold and Win 67				-0.1359	-0.0679	-0.0679	-0.0621
				(2.49)**	(1.31)	(0.81)	(0.64)
(Hold and Win 67)*(Cash flow)				0.3254	0.2869	0.2869	0.1855
				(3.82)***	(3.45)***	(1.96)*	(1.24)
Hold and Lose 67				-0.0289	-0.0622	-0.0622	-0.0498
				(0.94)	(2.09)**	(1.76)*	(1.61)
(Hold and Lose 67)*(Cash flow)				0.1417	0.2366	0.2366	0.1699
				(2.22)**	(3.71)***	(2.33)**	(1.91)*
Year fixed effects	no	yes	yes	yes	yes	yes	yes
Firm fixed effects	no	yes	yes	yes	yes	yes	yes
(Year fixed effects)*(Cash flow)	no	yes	yes	yes	yes	yes	yes
(Industry fixed effects)*(Cash flow)	no	no	no	no	no	no	yes
Observations	1016	1016	1016	1016	1016	1016	1014
Adjusted R-squared	0.13	0.55	0.61	0.56	0.62	0.62	0.68

Constant included. Absolute value of t statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table VII

Regression of Investment on Cash Flow and Longholder or Net Buyer

The dependent variable in the regressions is Investment, defined as firm capital expenditures and normalized by capital at the beginning of the year. Cash flow is earnings before extraordinary items plus depreciation and is normalized by capital at the beginning of the year. Q is the market value of assets over the book value of assets at the beginning of the year. Stock ownership is the fraction of company stock owned by the CEO and his immediate family at the beginning of the year. Vested options are the CEO's holdings of options that are exercisable within 6 months of the beginning of the year, as a fraction of common shares outstanding. Vested options are multiplied by 10 so that the mean is comparable to stock ownership. Size is the natural logarithm of assets at the beginning of the year. Corporate governance is the number of outside directors who currently serve as CEOs of other companies.

Longholder is a dummy variable equal to one if the CEO ever held an option until the last year prior to expiration. Net Buyer is a dummy variable equal to one if the CEO was a net buyer of stock more years than he was a net seller in his first five years in the sample. Columns 5 - 8 includes only CEOs with at least 10 years in the sample and excludes their first five years. Industries are defined as the twelve Fama-French industry groups. Standard errors in columns 3, 4, 7, and 8 are robust to heteroskedasticity and arbitrary within-firm serial correlation.

	Longholder Regressions				Net Buyer Regressions			
	fixed effects, controls	over-confidence with fixed effects, controls	standard errors clustered by firm	firm - CF interactions, clustered by firm	fixed effects, controls	over-confidence with fixed effects, controls	standard errors clustered by firm	industry - CF interactions, clustered by firm
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash flow	0.7249	0.656	0.656	1.1063	1.6262	1.555	1.555	1.382
	(8.33)***	(7.50)***	(2.53)**	(2.59)**	(7.24)***	(6.99)***	(4.19)***	(2.46)**
Q	0.0814	0.0851	0.0851	0.1009	0.0752	0.0770	0.0770	0.0677
	(7.53)***	(7.89)***	(1.99)**	(1.45)	(3.45)***	(3.57)***	(3.23)***	(2.96)***
Stock ownership (%)	0.1936	0.196	0.196	0.1138	0.3543	-0.0964	-0.0964	-0.1138
	(2.37)**	(2.41)**	(1.01)	(0.54)	(0.91)	(0.24)	(0.24)	(0.27)
Vested options	-0.0231	0.003	0.003	0.0098	0.1104	0.0639	0.0639	0.0934
	(0.24)	(0.03)	(0.01)	(0.07)	(0.72)	(0.42)	(0.43)	(0.64)
Size	-0.0465	-0.0494	-0.0494	-0.0213	-0.0860	-0.0790	-0.0790	-0.0827
	(4.81)***	(5.12)***	(2.34)**	(0.53)	(3.36)***	(3.12)***	(1.48)	(1.53)
Corporate governance	0.0012	0.0023	0.0023	0.0058	0.0025	0.0071	0.0071	-0.0025
	(0.31)	(0.59)	(0.43)	(1.22)	(0.26)	(0.74)	(0.42)	(0.16)
(Q)*(Cash flow)	-0.0062	-0.0099	-0.0099	-0.0234	-0.0555	-0.0721	-0.0721	-0.0502
	(0.63)	(1.02)	(0.23)	(0.04)	(2.44)**	(3.17)***	(1.80)*	(1.53)
(Stock ownership)*(Cash flow)	0.0186	0.002	0.002	0.2694	-0.8325	0.3991	0.3991	0.5724
	(0.12)	(0.01)	(0.00)	(1.91)*	(1.25)	(0.56)	(0.34)	(0.44)
(Vested options)*(Cash flow)	0.3198	0.2847	0.2847	-0.0427	-0.1131	-0.0012	-0.0012	0.0221
	(4.46)***	(3.97)***	(1.19)	(0.61)	(0.85)	(0.01)	(0.01)	(0.11)
(Size)*(Cash flow)	-0.0595	-0.053	-0.053	-0.0202	-0.1517	-0.1653	-0.1653	-0.1123
	(5.67)***	(5.04)***	(1.55)	(1.18)	(5.49)***	(6.02)***	(3.43)***	(2.31)**
(Corporate governance)*(Cash flow)	-0.0074	-0.0096	-0.0096	-0.0242	0.022	0.0006	0.0006	0.0337
	(0.82)	(1.07)	(0.49)	(0.34)	(0.92)	(0.03)	(0.01)	(0.55)
Longholder		-0.0504	-0.0504	-0.0306				
		(2.65)***	(1.00)	(1.05)				
(Longholder)*(Cash flow)		0.1778	0.1778	0.1126				
		(5.51)***	(1.33)	(1.32)				
Net Buyer						1.0615	1.0615	0.1053
						(2.83)***	(1.84)*	(0.11)
(Net Buyer)*(Cash flow)						0.4226	0.4226	0.449
						(4.33)***	(1.57)	(1.92)*
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
(Year fixed effects)*(Cash flow)	yes	yes	yes	yes	yes	yes	yes	yes
(Industry fixed effects)*(Cash flow)	no	no	no	no	no	no	no	yes
(Firm fixed effects)*(Cash flow)	no	no	no	yes	no	no	no	no
Observations	3742	3742	3742	3742	842	842	842	842
Adjusted R-squared	0.54	0.54	0.54	0.63	0.53	0.54	0.54	0.56

Constant Included. Absolute value of t statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table VIII

Regression of Investment on Cash Flow and Overconfidence by Equity Dependence

The dependent variable in the regressions is Investment, defined as firm capital expenditures and normalized by capital at the beginning of the year. Cash flow is earnings before extraordinary items plus depreciation and is normalized by capital at the beginning of the year. Q is the market value of assets over the book value of assets and is taken at the beginning of the year. Stock ownership is the fraction of company stock owned by the CEO and his immediate family at the beginning of the year. Vested options are the CEO's holdings of options that are exercisable within 6 months of the beginning of the year, as a fraction of common shares outstanding. Vested options are multiplied by 10 so that the mean is comparable to stock ownership. Size is the natural logarithm of assets at the beginning of the year. Corporate governance is the number of outside directors who currently serve as CEOs of other companies. Longholder is a dummy variable equal to one if the CEO ever held an option until the last year prior to expiration.

Firms are classified according to quintiles of the Kaplan-Zingales index, where the highest quintile contains the most constrained subsample. All standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

	OLS with Fixed Effects				
	Most Constrained	---------->			Least Constrained
	(1)	(2)	(3)	(4)	(5)
Cash flow	1.1538	0.1763	0.8952	0.5259	0.6969
	(2.21)**	(0.34)	(2.08)**	(1.01)	(2.50)**
Q	0.1844	0.0598	0.0700	0.0124	-0.0346
	(4.48)***	(1.41)	(1.99)**	(0.43)	(0.41)
Stock ownership (%)	-0.4103	0.5790	0.0266	-0.1723	0.3433
	(1.60)	(2.02)**	(0.15)	(1.16)	(0.79)
Vested options	0.1414	-0.3270	0.2748	0.2150	0.7829
	(0.59)	(1.02)	(1.43)	(0.53)	(1.09)
Size	-0.0428	-0.0175	-0.0223	-0.0664	-0.0425
	(1.04)	(0.73)	(0.94)	(1.54)	(0.81)
Corporate governance	0.0022	-0.0044	0.0034	-0.0073	0.0122
	(0.21)	(0.64)	(0.57)	(0.51)	(0.52)
(Q)*(Cash flow)	-0.1685	0.0364	-0.0420	0.0371	0.0420
	(2.12)**	(0.30)	(0.53)	(1.00)	(0.64)
(Stock ownership)*(Cash flow)	-0.3707	-1.2622	-1.0177	0.5432	0.0685
	(0.69)	(1.48)	(1.32)	(0.92)	(0.10)
(Vested options)*(Cash flow)	-0.4152	1.3804	0.0486	-0.1765	-0.6750
	(1.18)	(2.31)**	(0.08)	(0.55)	(1.22)
(Size)*(Cash flow)	-0.0446	-0.0144	-0.0482	0.0258	-0.0413
	(0.69)	(0.23)	(1.05)	(0.47)	(0.98)
(Corporate governance)*(Cash flow)	-0.0439	0.0954	-0.0318	0.0237	-0.0273
	(0.91)	(2.26)**	(1.24)	(0.57)	(0.80)
Longholder	-0.0832	0.0831	-0.0196	-0.0219	-0.1404
	(1.72)*	(1.74)*	(0.68)	(0.43)	(1.10)
(Longholder)*(Cash flow)	0.4990	-0.1449	0.0680	0.0025	0.2453
	(3.52)***	(1.10)	(0.67)	(0.02)	(1.28)
Year fixed effects	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes
(Year fixed effects)*(Cash flow)	yes	yes	yes	yes	yes
Observations	728	728	729	728	728
Adjusted R-squared	0.75	0.82	0.91	0.78	0.56

Constant included. Absolute value of t statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table IX

Regression of Investment on Personal Characteristics and Longholder

The dependent variable in the regressions is Investment, defined as firm capital expenditures and normalized by capital at the beginning of the year. Cash flow (CF) is earnings before extraordinary items plus depreciation and is normalized by capital at the beginning of the year. Q is the market value of assets over the book value of assets at the beginning of the year. Titles is a dummy variable equal to one for all CEO-years if the CEO is also president and chairman of the board. Tenure is the number of years the CEO has held that position. "Depression baby" is a dummy variable equal to one if the CEO was born in the 1930s. Finance Education is a dummy variable equal to one if the CEO had "financial education." Financial education includes undergraduate and graduate degrees in accounting, finance, business (incl. MBA), and economics. Technical Education is a dummy variable equal to one if the CEO had "technical education." Technical education includes undergraduate and graduate degrees in engineering, physics, operations research, chemistry, mathematics, biology, pharmacy, and other applied sciences.

Longholder is a dummy variable equal to one if the CEO ever held an option until the last year prior to expiration. Industries are defined as the twelve Fama-French industry groups. All standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

	OLS with Fixed Effects				
	Titles	Cohort 1930s	Employment Background	All Personal Characteristics	All Personal Characteristics and Longholder
	(1)	(2)	(3)	(4)	(5)
Cash Flow	0.9414	1.0181	0.9946	0.8087	0.7106
	(3.08)***	(2.78)***	(2.87)***	(2.94)***	(2.63)***
Q	0.0751	0.078	0.0868	0.0769	0.0819
	(1.04)	(1.08)	(1.25)	(1.05)	(1.13)
Titles	-0.0239			-0.0208	-0.0199
	(0.97)			(0.86)	(0.83)
(Titles)*(CF)	0.1342			0.1234	0.1222
	(1.38)			(1.30)	(1.30)
Tenure	-0.0013	-0.0021		-0.0018	-0.0013
	(0.88)	(1.20)		(1.18)	(0.93)
(Tenure)*(CF)	0.0032	0.0044		0.0043	0.0026
	(0.70)	(0.89)		(0.92)	(0.60)
"Depression baby"		-0.0415		-0.0527	-0.0432
		(1.33)		(1.88)*	(1.69)*
("Depression baby")*(CF)		0.1138		0.1427	0.1255
		(1.32)		(2.00)**	(1.85)*
Finance Education			0.04	0.051	0.0513
			(1.62)	(2.26)**	(2.32)**
(Finance Education)*(CF)			-0.123	-0.1458	-0.1482
			(1.80)*	(2.34)**	(2.40)**
Technical Education			-0.0475	-0.0486	-0.0503
			(1.78)*	(1.96)*	(2.07)**
(Technical Education)*(CF)			0.0894	0.1022	0.1117
			(1.21)	(1.44)	(1.59)
Longholder					-0.0642
					(1.65)
(Longholder)*(CF)					0.2196
					(1.97)*
Observations	2201	2201	2201	2201	2201
Adjusted R-squared	0.56	0.55	0.55	0.56	0.56

Constant included. Absolute value of t statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Controls for Corporate governance, Stock ownership, Vested options, Size and interactions of these variables and of Q with Cash Flow are included. Fixed effects for Year and Firm and the interactions of (Year)*(CF) and (Industry)*(CF) are also included.