CEO Overconfidence and Corporate Investment*

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Abstract

We argue that overconfidence and other personal characteristics of chief executive officers can account for widespread and persistent investment distortions. Overconfident CEOs overestimate the quality of their investment projects and view external finance as unduly costly. Thus, they invest more when they have internal funds at their disposal. We test the overconfidence hypothesis, using panel data on personal portfolio and corporate investment decisions of CEOs in Forbes 500 companies. We classify CEOs as overconfident if they persistently fail to reduce their exposure to company-specific risk on their personal portfolio. We find that investment of overconfident CEOs is significantly more responsive to cash flow, particularly in equity-dependent firms. In addition, other personal characteristics (education, employment background, cohort) strongly affect the correlation between investment and cash flow.

The analysis of corporate investment decisions has been the focus of much of the finance literature of the last forty years.[1] Two main explanations for distortions in investment policies have emerged. Jensen and Meckling (1976) point to the misalignment of managerial incentives and shareholder interests. According to this view, managers overinvest to reap private benefits such as "perks," large empires, and entrenchment.[2] Myers and Majluf (1984), instead, propose asymmetric information between corporate insiders and the capital market as an explanation for investment distortions. Informational asymmetries cause good firms to be undervalued by the capital market, and bias managers towards debt financing and underinvestment.[3]

In contrast to the world of Modigliani and Miller (1958), both agency problems and asymmetric information imply that investment depends on capital structure. According to both theories the level of investment should be sensitive to the level of cash flow in the firm. Under the agency view, investment increases in internal funds because the external capital market limits the extent to which managers can pursue self-interested investment. Thus, an influx of cash flow induces 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 current shares. In this case, cash flow increases investment, but reduces the distortion.

A large volume of empirical literature, spawned by Fazzari, Hubbard and Petersen's 1988 paper, confirms the existence and robustness of investment-cash flow sensitivity after controlling for investment opportunities.[4] Most of this literature relates investment-cash flow sensitivity to imperfections in the capital market.[5] In addition, the sensitivity of investment to cash flow appears to be more pronounced when managers have a large ownership stake in the firm–

consistent with the asymmetric information story, but not the agency story (in its simplest form).[6] Kaplan and Zingales (1997, 2000), however, call this interpretation of investment-cash flow sensitivity into question. They construct more direct measures of financing constraints and show, using the same sample of firms as Fazzari et al., that financially constrained firms actually display a lower sensitivity of investment to cash flow than unconstrained firms.[7]

In this paper, we propose an alternative explanation for investment-cash flow sensitivity and non-optimal 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. We argue that one important link between investment levels and cash flow is the tension between the overconfidence of the CEO and market valuation. 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, even in the absence of asymmetric information and agency problems. 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 when internal resources are scarce. Additional cash flow provides an opportunity to invest closer to the desired level. Thus, the investment of overconfident managers responds to the amount of cash flow available inside the firm.

Heaton (2002) first showed that the assumption of overconfidence provides a unifying framework for the costs and benefits of financial slack, which typically conflict in models of managerial moral hazard and asymmetric information. We expand on Heaton's insight in two ways. First, we model the impact of overconfidence on the sensitivity of the level of investment to capital

structure. Then, we empirically test the predictions of the model. We show that the level of investment depends on cash flow if managers display overconfidence about the quality of their investment projects.

We analyze a sample of 477 firms from Forbes 500 lists for the years 1980 to 1994 to test this prediction empirically.[8] The most important feature of this data set for our purpose is the time-series information it contains on the option and stock holdings of the CEOs. We use the CEOs' decisions to either hold company-specific risk or diversify to construct several measures of overconfidence. By matching the CEO observations with firm-level data from CRSP and COMPUSTAT, we can relate the behavior of CEOs on their private accounts to decisions on their firms' corporate accounts and test whether overconfident CEOs exhibit higher investment cash flow sensitivity.

Our measures of overconfidence build upon previous literature in corporate finance on the optimal timing of option exercises for underdiversified, risk-averse executives (Carpenter, 1998; Hall and Murphy, 2002).[9] Unlike outside investors, CEOs cannot trade their options or hedge the risk by short-selling stock of the company. In addition, their human capital and reputation are intimately linked to the firm's performance. Thus, CEOs are likely to be overexposed to their firms' idiosyncratic risk and, in most cases, should not hold options on company stock until expiration. Though the optimal schedule for early exercise depends on individual factors such as wealth, degree of risk-aversion and diversification, any risk-averse CEO should exercise his options early given a sufficiently high stock price.

The previous literature provides us with a benchmark for the minimum percentage in the money

at which a CEO should exercise his options, for a given year after the vesting period. Our first measure of overconfidence compares the benchmark predictions to the actual exercise behavior of a CEO. If a CEO persistently exercises options later than suggested by the benchmark, we infer that this CEO is overconfident about his ability to keep the company's stock price rising and wants to profit from expected stock increases by holding the options. We find that among those CEOs who hold their options the average CEO does not earn significant abnormal returns over the S&P 500. This result is consistent with the overconfidence hypothesis and in conflict with alternative explanations of "late exercise" based on inside information.

In the second step of the analysis, we show that investment-cash flow sensitivity is significantly higher for "late exercisers" than for "rational exercisers." As predicted by the model, overconfident CEOs invest more when they have more cash at hand. Further, this result is strongest for CEOs of equity dependent firms, for whom perceived financing constraints are most binding.

Other measures of overconfidence based on late option exercise and habitual stock purchases confirm these results. CEOs who, despite their underdiversification, do not reduce their exposure to company-specific risk display consistently higher investment-cash flow sensitivity.

We also provide complementary evidence that CEO characteristics other than overconfidence have explanatory power for corporate decision-making. Using additional data on the personal, educational and employment background of CEOs, which we collected from *Dun and Bradstreet* and *Who's Who in Finance and Industry*, we show that CEOs with an engineering (or scientific) education or employment background display higher investment-cash flow sensitivity, while CEOs with an MBA or a financial employment background exhibit lower sensitivity.

Furthermore, the sensitivity is higher for CEOs born in the 1930s and CEOs who assume multiple positions in their company (president, chairman of the board). These findings *I*end further support to the view that not only firm-level, but also personal characteristics are important for a better understanding of investment-cash flow sensitivity.[10]

One possible caveat to these results is the issue of endogeneity. Personal characteristics like employment background or birth cohort are observable by the board and may be a selection criterion for the choice of CEO. Further, boards may take overconfidence into account in choosing a CEO, even though overconfidence is much harder for the board to identify ex ante since the majority of CEOs in our sample did not have prior experience as CEOs.

We are able to alleviate some endogeneity concerns with additional controls. We show that our results are not driven by industry effects 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. While these provisions are undoubtedly crucial to overcome certain distortions in managerial decision-making, our findings suggest that they 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. At the same time, his overconfidence leads him to believe that he is acting in the best interest of the shareholders. In this case, refined corporate governance structures, involving for instance a more active board of directors or constraints on capital structure and the use of internal funds, may be more appropriate for alleviating the deviation from first-best levels of investment.

Overall, our results suggest that measurable personal characteristics of chief executives are an important key to a better understanding of corporate decision-making. Overconfidence, in particular, seems to predict investment behavior in situations of managerial discretion. These findings have important implications for CEO selection and organizational design.

Related Literature

A large psychology literature suggests that people exhibit overconfidence in individual decision-making. One well-established stylized fact is the "better than average" effect: when people compare their skills to the skills of their peers, they tend to overstate their acumen relative to the average (Larwood and Whittaker, 1977; Svenson, 1981; Alicke, 1985). Overconfidence, in the form of the "better than average effect," 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.[11] This self-serving attribution of outcomes, in turn, reinforces individual overconfidence.

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 US economy).

Experimental studies have found that executives are 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). The psychology literature suggests three main reasons for this finding. First, individuals are more overconfident about outcomes that they believe are under their control (Weinstein, 1980). A CEO who has selected an investment project is likely to feel the illusion of control over its outcome and to underestimate the likelihood of a bad outcome (March and Shapira 1987; Langer, 1975). Second, individuals are especially overconfident about outcomes to which they are highly committed (Weinstein, 1980). The typical CEO compensation contract ties his or her personal wealth to the company's stock price and, hence, to the outcomes of corporate investment decisions. This commitment is heightened since the reputational capital of CEOs is also sensitive to their firms' performance. Third, overconfidence is likely to be strongest when it is difficult to compare performance across individuals and when the reference point is abstract (Alicke, Klotz, Breitenbecher, Yurak, et al., 1995). For a CEO who brings a portfolio of projects to the capital market, the relevant benchmark is the average portfolio of projects among all publicly traded companies–a benchmark about which the CEO is unlikely to have concrete information.

Given the psychological evidence, overconfidence has received surprisingly little attention in the corporate finance literature.[12] There are a few notable exceptions. Roll (1986) advanced the idea that in corporate takeovers the overconfidence of individual decision-makers often

results in bidding firms paying too much for their targets.[13] Goel and Thakor (2002) point out that overconfidence can be value-increasing, when it takes the form of misperception of risk. Put in the context of corporate investment, a risk averse manager is likely to invest too conservatively in the eyes of fully diversified shareholders, whereas an overconfident manager will be willing to assume greater risks.[14] Goel and Thakor's point, that overconfidence may not always be detrimental to firm performance, provides an important caution against equating overconfidence and value-reduction. Similarly, their strong conviction in the success of their projects might make overconfident CEOs quite adept at motivating the workers around them. Their "cheerleading" may in fact be an asset to the corporation, as long as there is an effective board or a rational capital market to prevent them from financing negative net present value projects.[15] The negative effects of overconfidence, however, will manifest themselves when the CEOs' actions are less constrained, such as determining the uses of free cash flow.

Empirical evidence for overconfidence in the economics literature is provided by Camerer and Lovallo (1999). They present an experiment in which players must choose whether to enter a competitive market in which their winnings will be determined in part by performance on a short quiz. They find that subjects enter the market too often and display overconfidence about their future performance. Our paper is among the first to take the experimental results to the field and to provide evidence of overconfidence in real economic data.[16]

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 our empirical

strategy, provides evidence that overconfidence can explain the sensitivity of investment to cash flow and discusses alternative explanations of our findings. Section IV provides evidence that CEO overconfidence matters more in equity-dependent firms. In Section V, we present broader evidence on the impact of personal characteristics on the sensitivity of investment to cash flow. Section VI concludes and provides some broad directions for future research.

I Theory

A Setting

We propose a simple model that demonstrates the effect of managerial overconfidence on corporate investment in an efficient capital market. Our goal is to demonstrate the distortionary power of overconfidence apart from the informational asymmetries that lead to financing constraints, and hence sensitivity of investment to cash flow, in traditional models. Similarly, we abstract from any agency problem between the owners and the management of the firm and assume that the manager maximizes shareholder value.[17] The only friction in our model comes from the manager's inflated perception of the firm's investment opportunities.

We analyze a simple two-period model. Consider a firm with existing assets A and s shares outstanding. At time 1, cash flow C is realized and the CEO decides how much to invest. The CEO has access to a set of investment opportunities represented by the return function $R(\cdot)$. Investment I leads to returns $R(I)$ at time 2. For simplicity, we assume $R(\cdot)$ to be deterministic rather than stochastic.[18] We make the usual assumptions on the slope and curvature of R,

namely $R' > 0$ and $R'' < 0$, where R is defined on $[0; \infty)$. The interest rate is normalized to be zero. If the CEO is overconfident, he may perceive the quality of his (potential) investment projects as "better than average" and bias $R(\cdot)$ upwards.

We also assume that the firm has limited debt capacity.[19] Thus, a firm with low cash flow must eventually either issue equity or restrict its investment. We first analyze the investment and financing decisions of CEOs who have exhausted their debt capacity and must choose between equity and internal funds to finance their investment. We will then consider the implications of untapped debt capacity.

B Investment Decision of a Rational CEO

At time 1 the CEO chooses the level of investment $I \in [0, \infty)$ and a means of financing. Suppose first that the CEO has sufficient internal funds to finance all desired investment projects. Then, he maximizes $A + C + R(I) - I$ and invests at the first best level I^*, where $R'(I^*) = 1$. This condition defines a unique, interior solution for the optimal level of investment I^* as long as $R'(I) > 1$ for some I; else the unique solution is $I^* = 0$.

Suppose, instead, that the CEO cannot finance all desired investment internally. Then, whenever the constraint of limited debt capacity is binding, the CEO must finance $I - C$ by issuing new equity s'. Without loss of generality, assume that the CEO first expends the full amount of internal funds and raises the remaining financing for investment by issuing new equity. New shareholders demand an equity stake equal in value to the amount of capital they provide to

the firm. The CEO maximizes shareholder value subject to the financing constraint, or

$$\max_{I} \ \frac{s}{s+s'}(A + R(I))$$

$$\text{s.t. } \frac{s'}{s+s'}(A + R(I)) = I - C$$

This problem has the first-order condition $R'(I) = 1$. Not surprisingly, the rational CEO invests at the first-best level, independent of the availability of internal funds (as long as $R'(I) > 1$ for some I; and else $I^* = 0$). More generally, since the capital market is frictionless, a CEO who correctly perceives $R(\cdot)$ is indifferent between financing investment out of C or issuing new shares, and the optimal level of investment is not sensitive to cash flow.

C Investment Decision of an Overconfident CEO

An overconfident CEO perceives a wedge between external and internal finance. Consider the case of a CEO who overestimates the returns to his projects by percentage Δ. That is, for all levels of investment I he perceives the future return to be equal to $\widehat{R}(I) = R(I) \cdot (1 + \Delta)$.

As above, we consider first the decision of a CEO with sufficiently high cash flow to finance all desired investment. Here, the CEO maximizes $A + C + R(I) \cdot (1 + \Delta) - I$, so the desired level of investment, which we denote $\widehat{I}$, solves $R'(\widehat{I})(1 + \Delta) = 1$. $\widehat{I}$ exceeds the first best and, given sufficient cash flow, an overconfident CEO will overinvest relative to the first best.

Now, suppose that the CEO cannot finance all desired investment internally, i.e. $C < \widehat{I}$. As before, we assume that the market assesses the value of the firm's projects correctly. So,

the overconfident CEO faces the same financing constraint as the rational CEO. To the overconfident CEO, however, the market is understating the present value of the returns to his investment projects. As a consequence of this misperception, the CEO always invests all of C before issuing new equity. To find the optimal level of investment, he solves the following program:

$$\begin{aligned} &\max_I \ \frac{s}{s+s'}\left[A+R(I)(1+\Delta)\right] \\ &\text{s.t. } \frac{s'}{s+s'}\left(A+R(I)\right) = I-C \end{aligned} \tag{1}$$

The first-order condition of this program is:

$$R'(I) = \frac{1}{1+\Delta\frac{A}{A+R(I)}\frac{A+R(I)-[I-C]}{A+(1+\Delta)R(I)}}$$

In order for the CEO to access the equity market at all, we must have $A+R(I) > I-C$. Thus, the right hand side of the first-order condition is smaller than 1, but bigger than $\frac{1}{1+\Delta}$.[20] The overconfident CEO still overinvests relative to the first best. However, the perceived cost of external finance curtails investment below the desired level, $\widehat{I}$.

Since we cannot empirically identify the first-best level of investment, our real concern is the direction of the dependence of investment on cash flow.

Proposition 1 *In a frictionless capital market, the level of investment I is sensitive to the amount of cash flow C, if and only if the CEO is overconfident ($\Delta > 0$). Further, investment is strictly increasing in C for $C \in [0, \widehat{I})$.*

PROOF OF PROPOSITION 1. Denote the solution to (1) as I^*. As shown in Section B, if $\Delta = 0$, I^* does not depend on C. If $\Delta > 0$, then for $\widehat{I} > C$, the program (1) reduces to $\max_I (1 + \frac{R(I)}{A+R(I)}\Delta)(A + R(I) - I + C)$. If I^* interior, we can apply the implicit-function theorem and find

$$\frac{dI}{dC} = -\frac{\frac{AR'(I)}{(A+R(I))^2}}{\frac{-2A(R'(I))^2(A+R(I)+C-I)+(A+R(I))AR''(I)(C-I)}{(A+R(I))^3} + R''(I) + \frac{R''(I)}{\Delta}} \tag{2}$$

The denominator of this expression is the second derivative of the objective function; thus, it is negative at an interior maximum. Then, $\frac{dI}{dC} > 0$. If I^* not interior ($I^* = 0$), $\frac{dI}{dC} = 0$. Suppose now that $\widehat{I} \leq C$; then $I^* = \widehat{I}$ and $\frac{dI}{dC} = 0$. Hence the optimal investment level I^* depends on C iff $\Delta > 0$, and I^* strictly increases in C over $C \in [0, \widehat{I})$ for $\Delta > 0$. **Q.E.D.**

Note that while the investment-cash flow sensitivity result does not depend on the specification of overconfidence, the overinvestment result is less robust. For instance, the CEO may also be overconfident about the value of assets in place, A, especially if those represent past hand-picked investment projects. Generalizing the objective function accordingly to

$$\frac{s}{s+s'}\left[A\left(1+\Delta_A\right) + R(I)(1+\Delta_R)\right],$$

we still find that the overconfident CEO displays investment-cash flow sensitivity, both for $\Delta_A > \Delta_R$ and for $\Delta_A < \Delta_R$. However, the CEO would underinvest when $\Delta_A > \Delta_R$ and overinvest when $\Delta_A < \Delta_R$.[21]

To summarize, whenever the overconfident CEO has to rely on equity financing, he reduces his level of investment. Cash flow allows him to mitigate the effect of perceived distortions in the capital market on his investment behavior and to raise investment closer to his desired level.

Positive investment-cash flow sensitivity thus distinguishes an overconfident from a non-overconfident CEO.

It is noteworthy that the distinction between different degrees of overconfidence is less straightforward. Whether investment-cash flow sensitivity increases in overconfidence depends on the specification of the return function and, more generally, of the overconfidence model.[22] Therefore, we will not attempt to construct a continuous measure of overconfidence but rather compare the investment behavior of "overconfident" versus "non-overconfident" CEOs. Even taking this approach, however, measurement error might weaken or hide the difference between investment-cash flow sensitivity in the overconfident and non-overconfident groups if the relationship is not monotonic. Therefore, the success of the empirical analysis depends on the precision of our measure of overconfidence. As long as $\frac{dI}{dC}$ is continuous in Δ, Proposition (1) implies that it will be increasing in some neighborhood around $\Delta = 0$. We must be sure that our criteria for overconfidence require a high enough level of overconfidence that, even with measurement error, all overconfident CEOs do not fall into the area of $\Delta = 0$. Similarly, we might want to restrict the comparison group of non-overconfident CEOs to those clearly in close neighborhood of $\Delta = 0$. Finding a positive and significant empirical relationship between our overconfidence measure and investment-cash flow sensitivity, however, might already allay our concern about this possible theoretical ambiguity.

Thus far, investment-cash flow sensitivity is purely the result of perceived distortions in the equity market. The introduction of debt into the model generates additional empirical predictions. When the firm has not exhausted its debt capacity, it will seek outside financing not only

on the equity market, but also on the debt market. Debt-financing, however, will often seem cheaper to the overconfident CEO than equity-financing. Unlike new shareholders, lenders do not participate in the (perceived) upside of the CEO's project. The CEO is thus likely to perceive debt as less undervalued than equity. In fact, for safe debt, true and perceived default risk coincide and the CEO agrees with creditors on the value of the debt. More generally, an overconfident CEO with untapped debt capacity may be happy to finance investment with debt, even if he is not willing to issue equity. As a result, he, like an overconfident CEO with unlimited cash, may fail to exhibit sensitivity of investment to cash flow.

Thus, we have two predictions about the relation between investment-cash flow sensitivity and overconfidence.

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.

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 relationship between overconfidence and the sensitivity of investment to cash flow (Prediction 1) and the change in this relationship as equity-dependence increases (Prediction 2).

After we introduce our data set in Section II, we propose three measures of overconfidence

(Section III) . These measures use the theoretical prediction that underdiversified, risk-averse executives should exercise stock options early if they are sufficiently in the money, and that they should not increase their equity holdings. At the end of the paper, we consider broader measures of personal characteristics, analyze their impact on investment-cash flow sensitivity, and consider their relationship with our overconfidence measures.

II Data

We analyze a sample of 477 large publicly-traded United States 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 largest US companies compiled by Forbes magazine in the period from 1984 to 1994.[23]

The core of the data set is described in detail in Hall and Liebman (1998). Here, we will 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 in each 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 relationship between a CEO's transactions on his personal account and his transactions on corporate accounts, we supplement Hall and Liebman's data set with various items from the COMPUSTAT database. Following Kaplan and Zingales (1997), 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 total assets (item 6) minus total liabilities (item 181) minus preferred stock (item 10) plus deferred taxes (item 35) plus convertible debt (item 79). When preferred stock is missing, we replace it with the redemption value of preferred stock. Book value of assets is total assets (item 6).[24] The untreated data set contains a few severe outliers, e.g. 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.[25]

In addition, we collect personal information about the CEOs in our sample. Specifically, we supplement the data set with the CEOs' employment histories and educational backgrounds using *Dun and Bradstreet* and *Who's Who in Finance and Industry.* We broadly classify a CEO's professional background as "technical," "financial," and "general management," as

defined in the Appendix and Tables XI-XIII. Finally, we use CRSP to gather stock prices as well as 2 and 4 digit SIC codes for the companies in our sample.

The appendix defines the variables used in the regression analysis and Table I presents the summary statistics of the data, divided into firm-specific and CEO-specific variables.[26]

III 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, we use the following general regression specification:

$$I_{it} = \beta_1 + \beta_2 Q_{it-1} + \beta_3 C_{it} + X'_{it} B_4 + \beta_5 \Delta_{it} + \beta_6 C_{it} \cdot Q_{it-1} + C_{it} \cdot X'_{it} B_7 + \beta_8 C_{it} \cdot \Delta_{it} + \varepsilon_{it} \quad (3)$$

where C stands for 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. 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).[27] We include the level of stock and option holdings at the beginning of the fiscal year to control for the incentive effects of equity-based compensation. Our measure of corporate governance is the number of outside directors who are currently CEOs in other companies.[28] 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 five industry groups.[29] The null hypothesis is that β_8, the coefficient on the interaction of

cash flow and overconfidence, is equal to zero.

Note that 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 we will require a long tenure within the firm in order to be able to classify a CEO as overconfident, identifying the effect only from time series variation within the firm is not feasible for most of our measures. That is, there are an insufficient number of cases of overconfident and non-overconfident CEOs in the same firm to draw robust inference from any estimations. This choice is unlikely to bias our results, though, since an alternative explanation based on firm characteristics could generate all of our results only if the firm characteristic in question were positively correlated with each of our overconfidence measures, but were orthogonal to industry and all of the tangible firm characteristics we include as controls. At the same time, this lack of identifiable cases points to a potentially severe sample selection bias that can be induced by including fixed effects in panel regressions and identifying solely out of somewhat anomalous firms with multiple (short-tenured) CEOs.

In order to account for serial correlation and heteroskedasticity, we estimate (3) 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.[30]

We construct several measures of overconfidence, or proxies for Δ, based on personal portfolio decisions of CEOs. We consider CEOs overconfident if they fail to exercise stock options that

are highly in the money ((i.e. beyond the rational benchmark) or if they repeatedly buy stock of their own company. These measures utilize the trade-off between underdiversification and overconfidence for a risk averse CEO. CEOs of large corporations are typically highly underdiversified with respect to company risk and, as long as they are even slightly risk averse, should attempt to reduce their personal stake in the company whenever possible. In particular, underdiversified CEOs should exercise options after the vesting period if the options are sufficiently in the money, and they should reduce their position in company stock whenever possible. Overconfidence, however, may lead CEOs to postpone option exercise and to acquire additional stock. An overconfident CEO overestimates the quality and future returns of his investment projects. Therefore, he believes that the stock price of his company will continue to rise under his leadership more than he should objectively expect. As a result, overconfidence induces him to postpone option exercise or to increase his holdings of company stock in order to benefit personally from the expected future gains. Note that this is true for CEOs who are overconfident (as defined in this paper), but not necessarily for CEOs who display overoptimism about exogenous variables or overestimate the precision of their beliefs. Overoptimism may extend to the general economic environment and thus induce other types of personal investments than investment in the CEO's own company. Overcalibration reduces the expected volatility of the stock and thus the value of holding options. The key aspect of overconfidence for our results is self-attribution by the CEO.

At the same time, if the CEO's expectations about the returns of potential investments are too optimistic and not shared by the external capital market, the volume of investment will be sensitive to the availability of internal funds. Thus, we would expect overconfident CEOs

to display investment-cash flow sensitivity.

In the remainder of this section, we construct three proxies for Δ and present the respective results of the regression specified in Equation (3). We also perform supplementary tests to address alternative explanations for our estimates of β_8.

B Measure 1: "Holding Options Too Long"

Our first measure uses the timing of option exercises to identify overconfidence. Previous literature in corporate finance finds that risk-averse, underdiversified executives typically should not hold their options until expiration (Carpenter, 1998; Hall and Murphy, 2002). Black and Scholes (1973) demonstrate that an investor who can hedge his position should value options as if he were risk-neutral and, therefore, never forgo option value by exercising an option early. Unlike outside investors, however, a CEO cannot trade his options or hedge the risk by short-selling stock of his company. CEO compensation contracts regularly contain large quantities of stock and option grants in lieu of cash compensation. Moreover, to maximize the incentive effects of these holdings, the firm prohibits the CEO from perfectly hedging against the risk by selling company stock short and may limit the frequency and quantity of divestitures he may undertake in any given year. As a result, the CEO's portfolio is likely to include too much of his own company's idiosyncratic risk. Most importantly, the CEO's human capital is invested in the firm, so that a bad outcome in his firm will not only negatively impact his personal portfolio, but also reduce his outside options. So, again, a CEO is likely to be overexposed to his firm's idiosyncratic risk, and the Black-Scholes formula will not apply. A CEO instead

must trade-off the option-value of holding his stock options against the costs of underdiversification. The optimal schedule for early exercise depends on his individual wealth, degree of risk-aversion and diversification.

Applying this result, we consider the subsample of CEOs for whom an option granted at the money five years prior would be substantially in the money. By looking five years beyond the grant date, we ensure that the package (or at least a substantial portion) is beyond the vesting period. We then pose the following question: did the CEO exercise some portion of this package before or during the fifth year or is he still holding the package in its entirety? We classify CEOs who fall into the latter group as overconfident.

We use the Hall and Murphy (2002) framework as a theoretical guide in choosing a reasonable threshold for the percentage in the money at or above which a CEO should exercise his stock options. Rather than calculating the percentage in the money at which a CEO should exercise for every executive in our sample, we calculate several thresholds, applicable for a range of reasonable assumptions on risk-aversion, diversification, and wealth, which we then apply to all of the CEOs in the sample. We choose this simplification for two reasons. First, as we cannot observe each CEO's degree of risk aversion and wealth or the fraction of his total wealth invested in company equity, individual calibration would introduce a great deal of observation-specific noise into the estimation without clear benefits. Second, we employ several reasonable parameter values for risk-aversion, wealth, and diversification, which give us a range of percentages in the money. Thus, it is unlikely that the results are driven by the specific parameter values employed.

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, a CEO should have exercised at least some portion of his option package either during or before the fifth year. This threshold corresponds to a risk aversion of 3 in a CRRA utility specification and to a percentage of wealth in company equity equal to 66. We repeat this exercise starting at 50% in the money and incrementing by 5 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).[31]

We construct Measure 1 (for each value of the threshold) 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 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 as long as he subsequently exhibits the same behavior at least one more time during his tenure as CEO. This last requirement lessens the probability that CEOs will be misclassified as overconfident when in fact they had an instance of inside information or simply made a mistake. As we are mainly interested in the "permanent" rather than "transitory" overconfidence level of a CEO, our measure targets CEOs who "habitually" exercise options late.

It is important to note that our sample restriction guarantees that every CEO in the subsample had the "opportunity" to be classified as overconfident. Thus, it limits the degree of unobserved overconfidence in the group to which we compare our overconfident CEOs. It also guarantees that we are not overproportionally identifying CEOs as overconfident when the stock of their firm is doing well. Instead, only those CEOs whose company appreciated at least 67% (or x%

for each of the 21 alternative thresholds) in value over two different five year intervals remain in the sample. On the other hand, our restriction considerably limits the number of observations; it declines from 3569 to 1019.

Table II presents summary statistics for the sample of CEOs who meet this selection criterion. It also provides summary statistics for the subsample of CEOs who are classified as overconfident under our measure. Out of 108 remaining CEOs in the subsample, a substantial number, 56, display overconfidence in their personal portfolio decisions. The distribution of firms across Fama-French industry groups is virtually identical in the overall sample and the overconfident subsample. Thus, our overconfidence measure appears orthogonal to firm characteristics, at least as measured at the industry level.

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 III for the 67% threshold. The first two regressions confirm the stylized facts of the investment-cash flow sensitivity literature – namely that 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 typically not statistically significant). To the extent that current

cash flow measures the success of past investment decisions, then it is not surprising that more successful companies are more responsive to investment opportunities in determining their current level of 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 VIII, for example, we find a weak negative effect of corporate governance on investment-cash flow sensitivity for the entire sample of firms. Finally, we find that 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.

Then, given a baseline for comparison, we estimate Equation (3) using our benchmarked holder measure ("Holder 67") as a proxy for Δ. Columns (4) to (7) in Table III present the results. The coefficient on the interaction of the holder indicator with cash flow is positive (0.2237 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 I presents the regression results varying the threshold for rational exercise between 50% and 150%. The results are the same.

Alternative Explanations. While these results correspond exactly to the predictions of our model, we conduct several additional empirical tests to address potential alternative interpre-

tations.

1. *Inside information.* Another reason a CEO may hold an option that is more than 67% in the money is inside information. Namely, the CEO may have private information about future stock prices that makes holding the option more attractive. Then, as this information has not been incorporated into the market price, the firm's stock is currently undervalued and investment may be sensitive to cash flow for the usual Myers-Majluf reasons. This sensitivity, however, should only persist until the information becomes public and not for the remainder of the CEO's tenure. Nevertheless, we address this alternative interpretation of our findings more directly with some additional tests.

First, if holding options past the predicted exercise point were the result of inside information, we should see variation in exercising behavior across different instances when the same CEO faces the exercise or hold decision. That is, we would expect to observe a CEO holding his options when he has positive inside information and exercising them when he has negative inside information. To test this null hypothesis, 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 CEO has held such an option in the past.[32] The sample consists of the 759 observations in which a CEO had options beyond the 67% threshold in the fifth year after the grant date. The dependent variable is equal to 1 in any year in which the CEO did not exercise any portion of those options prior to that year. Panel A of Table IV 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 price-earnings 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 PE ratio, on the other hand, appears to have no meaningful impact on exercise probability. Panel B of Table IV 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.

Second, if asymmetric information were the true reason both for holding options past the 67% threshold and for the sensitivity of investment to cash flow, then CEOs who make positive profits from holding their options should be driving our results. We, therefore, calculate the distribution of returns among all CEOs who had options beyond the threshold and who did not exercise. We compare those to the returns from exercising the options during the fifth year and investing the proceeds in a diversified portfolio. 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. We then compare the return the CEOs obtained by holding the options to the return they would have received from exercising during the fifth year and investing the proceeds in the S&P 500. As alternatives, we consider exercise at the mean or median price during the year, and recalculate

returns. Table V shows that, in fact, CEOs do not beat the market by holding options beyond the threshold. The return differential is not positive and statistically different from zero under any assumption about exercise behavior – not even under the extreme assumption that CEOs always exercise at the maximum stock price. These results, however, do not imply that CEO insider trading is negligible. Indeed, we observe that between 51% and 54% of the return differentials are positive.

To test whether insider trading drives our results on investment-cash flow sensitivity, then, we modify our measure of overconfidence so that it only includes "late exercisers" who make losses from holding their options. That is, we classify a CEO as overconfident only if he actually loses money (by our return measure) on at least one of the options he holds beyond the threshold. For these CEOs we are confident in saying ex post that they should have exercised when the option reached the threshold, given their demonstrated lack of favorable insider knowledge.

We then repeat the regressions of Tables III with this modified overconfidence proxy. If the investment-cash flow sensitivity were driven by the small number of CEOs who held their options because of (highly persistent) inside information, then this additional restriction should weaken the coefficient on our proxy for Δ interacted with cash flow. Table VI shows the estimates of Equation (3), splitting Holder 67 into "losers" and "winners." We find that the estimated coefficient of the "loser" indicator (Hold and Lose 67) interacted with cash flow is positive, significant, and very similar to the coefficient on Holder 67 in Table III (the coefficient on Hold and Lose 67 is 0.2418 in the OLS with controls specification). We also find a positive effect of the "winner" indicator (Hold and Win 67) on investment cash flow sensitivity; however, the effect is typically smaller than the "loser" effect and is *not* robust to the inclusion of industry

effects. If the "winner" variable picks up positive inside information, then we would expect it to lead to heightened investment cash flow sensitivity in the years in which the CEO had positive information. The key result, then, is that the effect of Holder 67 remains when we remove the effect of these CEOs from the estimate.

Taking this argument a step further, we construct a modified proxy that allows us to contrast the permanence of the overconfidence effect with the transitory nature of the inside information effect. CEOs who were classified as overconfident by the original holder variable but who were really trading on inside information should only exhibit investment-cash flow sensitivity for the period in which they had such information. The truly overconfident CEOs, on the other hand, should exhibit a permanent, personality-driven sensitivity of investment to cash flow. To see these effects empirically, we look at the investment-cash flow sensitivity of CEOs classified as overconfident by the original holder measure over their entire tenures instead of from the first instance of missing the threshold onward. As in Table VI, we estimate this effect separately for the "losers" and "winners." In untabulated results, we find that the "winner" variable now has a negative impact on investment cash flow sensitivity. The "loser" variable, on the other hand, is still positively related to investment cash flow sensitivity. In addition, the two coefficients are significantly different from each other ($p = 0.0147$).

We conclude that inside information is not driving our results. This evidence will be bolstered by our additional measures of overconfidence, particularly Measure 3.

2. *Risk tolerance.* Alternatively, one might want to interpret our measure of overconfidence as a measure of risk aversion. A CEO may hold his options beyond the threshold simply because

he is less risk-averse and, therefore, less affected by underdiversification. It is hard, though, to imagine a compelling theoretical reason why a less risk averse CEO should display higher sensitivity of investment to cash flow. Thus, the strong and significant relationship between option holding behavior and sensitivity of investment to cash flow challenges the risk tolerance story by itself. 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 – an alternative measure of overconfidence we construct in Section D.

3. *Signalling.* Another interpretation of the decision to hold options is that the decision to hold conveys a signal to the capital market. Specifically, CEOs may want to hold the options as a (potentially) costly signal that their firm's prospects are better than the prospects of other firms whose CEOs have options that are 67% in the money and five years old. However, the most natural version of the signalling story would have the opposite implications of our empirical findings. Assuming no other uncontrolled differences between firms, signalling should alleviate informational asymmetries and, thus, lead to less investment-cash flow sensitivity among the firms where CEOs hold their options.

Moreover, the usefulness of option exercises as a signalling device is doubtful. Financial services firms and the financial press generally discount the credibility of option exercises as signals of future stock prices. They refer to option exercises as "noise" and advise investors to concentrate on stock purchases and sales as indicators of the private information of corporate insiders.[33] In addition, the time series behavior of the fraction of CEOs who hold options beyond the threshold does not fit the signalling interpretation. From Table VII, the fraction of CEOs who

hold an option past the 67% threshold appears to be procyclical. It peaks in 1990 and declines during the recession years of 1991 and 1992 before climbing up again at the end of the period. It is unclear why signalling would be less valuable in a depressed economy. Signalling serves to differentiate a firm from similar firms with worse future prospects, which should be – if anything – more useful in a bad economy, when finance is scarce. Finally, we point again to our later measures which will help to rule out signalling. Section D, in particular, measures overconfidence and investment-cash flow sensitivity for two disjoint time periods.

The same arguments address the hypothesis that CEOs are not actually signalling the higher quality of their firms, but instead use their insider trades opportunistically to try to raise the capital market valuation of their firms.

4. *Tax reasons.* Another consideration is taxation. An option holder may postpone the option exercise to postpone the payment of taxes on his profits. Tax deferral, however, would not explain the higher sensitivity of investment to cash flow among holders. Moreover, for the most widely granted type of stock options, NQSOs and SARs, taxes seem insufficient to explain delayed exercise. These options are taxed less favorably at exercise than at sale of the stock. The CEO has to pay ordinary income tax of up to 39.6% on the profits from exercise (stock price minus exercise price) and only capital gains tax of 20% on the profits from sale (stock price at sale minus stock price at income taxation). Therefore, whenever a CEO believes that the stock price will rise, he has an incentive to exercise his options early.

5. *Liquidity.* A final interpretation of the decision to hold an option is that the company's stock is illiquid and, as a result, the CEO would be unable to sell the shares he would obtain

should he exercise. At the same time, illiquidity would make seasoned equity offerings less attractive since the price of the new shares would have to be unduly low to induce investors to purchase them, causing investment to be sensitive to cash flow.

This story seems fairly implausible for our sample of firms, though, which is a subsample of the largest U.S. corporations. In addition, liquidity concerns should be more relevant when a stock is performing poorly than when it is consistently rising. In order to be included in any of the regressions, however, a firm had to experience at least two five year intervals between 1980 and 1994 over which its stock rose at least 67%. It is hard to imagine that the subsample of the largest U.S. firms that consistently perform well would be a subsample that would trade infrequently. Finally, the illiquidity story implies that the CEO should avoid purchasing additional equity in the company. In Section D, we target habitual stock purchases as an alternative measure of overconfidence.

Further concerns, including the exact calibration of the threshold percentages for exercise, can be addressed with the following measures.

C Measure 2: "Holding Options Forever"

So far we have considered the decision to exercise an option during the fifth year after the grant date. We have argued that CEOs who continue to hold, even though the option is sufficiently in the money, are overconfident. Our results are robust to a wide range of benchmarks (50% to 150% in the money), reflecting alternative assumptions about CEOs' risk aversion, wealth, and diversification. It is thus unlikely that mismeasurement of individual differences drives our

results.

Alternatively, we can deal with the lack of individual information by classifying CEOs as overconfident only if they display such extreme reluctance to exercise options that it is not possible to rationalize their exercise behavior with justifiable assumptions on risk aversion, wealth, and diversification. In this spirit, our second measure of overconfidence requires a CEO to hold an option all the way to expiration.

We consider the full sample of CEO-years and 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. Under Measure 1, we required a CEO to twice hold a five-year-old option that was beyond the threshold in order to be classified as overconfident. Here, this "habitual" component of the late exercise is, in a sense, built into the measure. As the typical option in the sample has 10 years duration and is fully vested (at the latest) by year 5, the CEO chooses to hold the option (rather than exercise) for at least 5 years.

Table VIII gives the results of estimating Equation (3) using this "longholder" variable as our proxy for Δ. As in Table III, Q appears to positively impact the sensitivity of investment to cash flow. Also, equity ownership and firm size, as before, are negatively associated with investment-cash flow sensitivity. Interestingly, vested options now positively impact investment cash flow sensitivity. This positive correlation might arise if a CEO with high ownership in vested options worries about diluting existing shares more than CEOs with fewer options.[34] It might also arise if the cumulative effects 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. We also now find, as expected, that corporate governance decreases the sensitivity of investment to cash flow. Most importantly, however, the coefficient of the "longholder" variable interacted with cash flow is positive and statistically significant. Although this measure is not robust to clustering the observations by firm, it is robust to alternative methods of controlling for serial correlation.[35] Overconfidence, once again, leads to an increased sensitivity of investment to cash flow.

It is noteworthy that those options that were held until the last year before expiration were not simply out of the money. In our sample we find that 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, this finding further corroborates the built-in "habitual" aspect of this measure. At the same time, this measure complements Measure 1 in that it does not explicitly select on high performance companies. Thus, we can rule out the possibility that our results capture CEO behavior specific to a sample of glamour firms.

The correlation between this holder measure (Measure 2) and the benchmarked holder measure (Measure 1) – on the subsample of Measure 1 – is positive and very high (0.2417). Moreover, the correlation between Measure 2 and the "loser" variable constructed from Measure 1 is 0.2920, while the correlation between Measure 2 and the "winner" portion of Measure 1 is -0.0247. Thus, Measure 1, its "loser" component and the longholder measure appear to proxy for the same effect, an effect different from the one identified by the "winner" portion of Measure 1.

One potential objection to this measure is that CEOs might simply hold an option until the

end of its duration if they are "inertial." That is, CEOs procrastinate the decision to exercise their options until prompted by impending expiration, in the spirit of O'Donoghue and Rabin (2001). This inertia on their personal account may carry over to the firms' corporate account in a reluctance to conduct equity issues, or generally a preference for the "quiet life" (Bertrand and Mullainathan, forthcoming). One way to address this concern is to investigate whether CEOs who are not exercising options are actively carrying out other portfolio transactions. We find that roughly 68% of the CEOs either sell shares or exercise another option that is not in its final year of duration in the two years prior to the year in question. In addition, we find in Malmendier and Tate (2003), that the CEOs classified as overconfident under Measure 2 are significantly more likely to conduct acquisitions than their peers. So, the majority of CEOs classified as overconfident under this holder measure appear not to procrastinate portfolio rebalancing, but rather to display overconfidence.

In addition, "inertia" is less pertinent for our benchmarked holder variables (Measure 1) since the vast majority of CEOs who hold beyond the relevant benchmark in the fifth year nevertheless exercise before the option reaches its final year. For example, 86% of the CEOs who hold beyond the fifth year when the option reaches 67% in the money during that year still exercise before the option reaches its final year. And, in any event, an inertial CEO would not habitually purchase company equity – the subject of our next section.

Again, we conclude that an overconfident CEO will alter investment more when cash flow changes than his less confident peers.

D Measure 3: "Habitual Buyer of Stock"

Underdiversified CEOs, in order to divest themselves of idiosyncratic risk, should not only exercise their options before expiration, but also minimize their holdings of company stock. Of course, the board of directors might prevent an executive from selling large blocks of equity. Also, an executive must be concerned about the negative signal stock sales convey to the market. If, however, a CEO habitually increases his equity position by acquiring new shares, we interpret his purchasing behavior as an indication of overconfidence.

This third measure of overconfidence also directly addresses the inside information hypothesis; that is, a CEO who increases his equity holdings must have positive private information about future stock prices. We consider equity purchases and investment decisions in two disjoint time periods. 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 then identify the CEOs who were "net buyers" of company equity during their first five years in our sample, i.e. who bought stock on net in more years than they sold on net during their first five sample years.[36] We classify these CEOs as overconfident. We then estimate equation (3) on the remainder of the CEOs' tenures. That is, we classify CEOs as overconfident based on their first five years in the sample, but then exclude those years from the regression. The rationale is that any insider information with enough precision to affect corporate decisions is likely to realize either during the first five years or quite early on in the later subsample of CEO years. Thus, a strong relationship between net buying in the first five years and sensitivity of investment to cash flow over the five or more remaining years is unlikely to be due to inside information.

The results are shown in Table IX. Most of the control variables behave as in our prior estimations. Notably, 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 the coefficient on the interaction of the net buyer variable with cash flow is positive (0.4425 in the OLS specification) and highly significant. Again, though the estimate is not robust to clustering the errors by firm ($p = 0.117$), it is robust to alternative controls for serial correlation.[37]

We also perform several additional estimations to gauge the robustness of these results. Given the strong effect of firm size on investment cash flow sensitivity, we re-run the regressions including size squared interacted with cash flow. Under this alternative specification, the net buyer variable is robust even to clustering. We also reestimate the regression with a one year gap between the two sample periods to further weaken the possibility that information contaminates our estimates. The results are similar. Thus, we are comfortable interpreting the strong relationship between habitual increases in equity holdings and sensitivity of investment to cash flow as evidence of managerial overconfidence.

A second confound to the stock-based measure of overconfidence centers on dynamic contracting issues. The board of directors might not only prevent the CEO from divesting stock, but also implicitly pressure him to increase his position in company equity, most likely in order to mitigate agency problems with respect to potential uses of funds that they cannot directly monitor. Then, a strong board should mitigate the effect of being a net buyer on the sensitivity of investment to cash flow. Indeed, when we control for the interaction of governance with the net buyer variable and with investment, we find a negative (though insignificant) coefficient.

Thus, if there are CEOs accumulating equity because they are "encouraged" by an effective board of directors, these cases are not generating our results.

We also note that the correlation between habitual stock acquisition and failing to exercise at the 67% threshold (Measure 1) is positive. On the subsample of CEOs who appear in the data for at least 10 years (eliminating the first five years we use to construct Measure 3) and for whom a five year old option was at least 67% in the money at least twice (i.e. the intersection of the sample restrictions for the two proxies), the correlation between these two variables is 0.0786. Alternatively, the correlation between the net buyer variable and the "loser" variable is 0.1495 and the correlation between the net buyer variable and the "winner" variable is -0.1007. Finally, the correlation between the net buyer variable and the "longholder" variable (Measure 2) is also positive, though fairly weak (0.0237). Again, these relationships suggest that the habitual buyer variable, Measure 1, its "loser" constituent, and Measure 2 are indeed capturing the same effect: overconfidence. And, they confirm our interpretation of the decomposition of Measure 1 into "losers" and "winners."

E Summary

Thus far we have constructed three overconfidence measures using the CEOs' personal portfolio decisions and have shown that each measure is positively correlated with investment-cash flow sensitivity.

The first set of proxies for overconfidence are based on the CEO's choice to hold a five-year-old option beyond the threshold for exercise predicted by the Hall-Murphy model. For several

different calibrations of the model (yielding 50% to 150% in the money as thresholds for exercise), we show that CEOs who hold beyond the benchmark at least twice display significantly higher sensitivity of investment to cash flow than their peers after the point at which they reveal their overconfidence. We also show that the effect is not due to CEOs who gain excess returns over the S&P500 by holding such options. Finally, we provide evidence that CEOs are not, on average, holding these options to signal future prospects or because of profitable inside information, higher risk tolerance, tax postponement, or stock illiquidity.

Second, we consider the group of CEOs who, at any point in their tenure, hold an option until the year of expiration. We find that investment is significantly more sensitive to cash flow among this group of CEOs than among their peers. This measure complements the first proxies as it does not use calibrated parameter values in a theoretical model or rely on high performance of the company's equity in the market.

Finally, we construct a measure of overconfidence based on the CEOs' stock purchases. We classify CEOs as overconfident if they were a net buyer of company stock more years than they were a net seller during the first five years they appear in our sample. Then, we examine the investment behavior of all of our CEOs, excluding their first five years in the sample. CEOs we classify as overconfident, again, have higher investment-cash flow sensitivity in this subsample. This measure casts doubt on a liquidity-based interpretation of our findings. In addition, by relating personal portfolio decisions to corporate investment decisions in disjoint time periods, it provides further evidence that signalling and inside information cannot explain our findings.

IV Test 2: Overconfidence and Financial Constraints

As developed in Section I, a second implication of our model is that overconfidence should matter more for firms that are more financially constrained (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.

To test this prediction, we construct the Kaplan-Zingales index of financial constraints, used by Lamont, Polk and Saá-Requejo (2001) and Baker, Stein, and Wurgler (forthcoming), for our sample of firms. Rather than applying the standard proxies for financial constraints (such as the lack of dividend payments or leverage), Kaplan and Zingales generate direct measures of financing constraints, using information from annual reports and even information gleaned from the company's 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. The index includes cash flow to total capital, Q, debt to total capital, dividends to total capital, and cash holdings to capital and provides an objective and comprehensive measure of a firm's equity dependence. Following the methodology in Lamont, Polk and Saá-Requejo and Baker, Stein, and Wurgler, we apply the estimates of this ordered logit regression to our sample[38] and construct an index of financial constraints (or equity dependence) as follows:

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

Higher values of the linear combination of the five ratios imply a higher degree of financial constraint.[39]

We separate our sample into quintiles based on the lagged value of the Kaplan-Zingales index and estimate equation (3) separately on each quintile. We use Measure 2, holding options forever, as a proxy for overconfidence, since the sample restrictions necessary to use the benchmarked holder (Measure 1) or stock purchase (Measure 3) variables as proxies for Δ would severely limit the number of observations in each of the five subsamples.[40] We expect to find the strongest effect of overconfidence for the subsample of firms which have the highest values of the Kaplan-Zingales index.

Using the "longholder" measure of overconfidence (Table X), 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. This effect is strong (the coefficient estimate is 0.4927) and highly statistically significant ($t = 3.44$), where standard errors are clustered by firm.

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

V Other Personal Characteristics

Though the thrust of our paper has been to show that overconfidence matters in corporate decision-making, the broader point is that personal characteristics of the leading executive rather than characteristics of the firm can explain deviations of corporate decisions from optimal levels. Thus, in this section we provide further evidence of the managerial fixed effect on the sensitivity of investment to cash flow. Though overconfidence is clearly part of this effect, it need not be the entire effect.

A Education and Employment History

We examine the effect of the educational and employment background of CEOs on their firms' sensitivity of investment to cash flow. First, we classify CEOs into three groups based on their field of study: CEOs with an MBA degree, CEOs with technical education (engineering degree or degree in the natural sciences), and CEOs with other degrees (law, literature, etc.)[41] Second, we 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 as a CFO or as treasurer or as an accountant or generally in a finance-related position; CEOs with a technical career if they are individual patent-holders or previously worked as an engineer or generally in a technically-oriented position; and CEOs with a general management career.

Table XI presents estimates of Equation (3) using dummies based on these classifications and interactions of those dummies with cash flow (in lieu of the overconfidence variable Δ and its interaction $C \cdot \Delta$). We also include industry dummies interacted with cash flow to control for

industry-specific investment patterns (e.g. the typical sensitivity of investment to cash flow in a "technical firm") and to distinguish those from personal effects (e.g. the typical investment behavior of a person with a "technical background").

The effect of a technical degree or career on the sensitivity of investment to cash flow is striking. As Tables XI shows, the estimated coefficient on the interaction of technical education with cash flow is always roughly 0.15 and is significant in all specifications. Similarly, the effect of a technical employment background is roughly 0.25. CEOs with an MBA or a finance background, on the other hand, appear to be less sensitive to cash flow in their investment decisions. The interaction of MBA and cash flow has a coefficient of roughly -0.12 in all specifications. Thus, CEOs with technical and finance backgrounds or education appear to invest differently from CEOs with a general management career or general education. In particular, technical CEOs are more sensitive to cash flow in choosing the level of investment and finance CEOs less.

One plausible explanation of these results is that CEOs with a financial background have a better understanding of capital markets than their peers. It is also possible that the type of person who pursues a finance education or works in the financial industry is less likely to be overconfident than an engineer or scientist. An engineer or scientist, on the other hand, may be intrinsically motivated to implement the latest technological innovation in his firm, without regard to financing constraints. Free cash flow provides this opportunity. While there may be many interpretations of the results, the important point is that a personal feature of the CEO proves again to have strong influence on corporate decision making.

Given that a technical background has a strong and robust positive effect on investment cash flow sensitivity, like our overconfidence proxies, we investigate the relationship between the two effects. First, we repeat the methodology of the last section, using technical background in lieu of a proxy for Δ. That is, we estimate the effect of a technical background on investment-cash flow sensitivity in each of the Kaplan-Zingales quintiles. The results are presented in Table XII. The most striking result is that technical background has a significant positive effect on investment cash flow sensitivity only among the firms in the least constrained quintile of the index. If anything, the effect appears slightly negative among the most constrained firms and the effect seems to monotonically decline as we move from the least to most constrained quintiles. This result clearly distinguishes technical background from overconfidence.[42] We also find, in Table XIII, that our overconfidence proxy (Measure 2) remains significant even in a regression that controls for technical background. And, the correlation between the two variables is -0.0484. Thus, overconfidence and technical background appear to be distinct, positive managerial fixed effects on investment cash flow sensitivity.

B Depression Baby and Title Accumulation

We also examine the effect of membership in the 1930s cohort ("depression babies") on the sensitivity of investment to cash flow. Conventional wisdom suggests that growing up during the Great Depression may explain the reluctance of some CEOs to borrow. We find, in Table XIII, that CEOs born in the 1930s do indeed exhibit higher sensitivities of investment to cash flow.[43]

Finally, we examine the effect of accumulation of titles on investment-cash flow sensitivity. In particular, we construct a variable similar to Morck, Shleifer, and Vishny's (1989) BOSS variable. This variable takes the value one if the CEO also holds the titles President and Chairman of the Board. One interpretation of this variable might be that an overconfident CEO, due to an inflated image of his own capabilities, is likely to pursue as much authority within the firm as possible. Therefore, the Titles variable may be another proxy for overconfidence. Alternatively, the Titles variable may simply be another proxy for corporate governance. The more positions a CEO occupies, the less he is disciplined by the board and the more he can pursue his preferred investment policies. The regression results for this variable are also presented in Table XIII. Here, again, the effect on investment-cash flow sensitivity is positive.

VI Conclusion

The main goal of this paper is to establish a relation between corporate decision-making and personal characteristics of the leading executive inside the corporation. We focus on the impact of managerial overconfidence on corporate investment decisions, and find that overconfidence has high explanatory power for the sensitivity of investment to cash flow. 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 option beyond a theoretically-calibrated benchmark for exercise? (2) Does the CEO hold his options even until the last year

before expiration? (3) Did 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 relationship 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.

In addition to the overconfidence effects, we find that business education or a financial employment background reduces the correlation between cash flow and investment while technical education or background, high status within the company (as measured by the accumulation of titles), and membership in the 1930-1939 birth cohort increase the sensitivity of investment to cash flow. These latter findings confirm that personal characteristics matter for corporate decision making and are identifiable empirically.

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. Variable Definitions

Variable Name	Definition
1. Dependent Variable	
Investment	Capital expenditures (Item 128), normalized by Capital or Assets
2. Variables used for Normalization	
Capital (lagged)	Property, plants, and equipment (Item 8)
Assets (lagged)	Total assets (Item 6)
3. Control Variables	
Q	(Market value of assets / Book value of assets) = (Total assets (Item6) + Market value of equity - Book value of equity) / Total assets (Item 6)
Market value of equity	Common shares outstanding (Item 25) * Fiscal year closing price (Item 199)
Book value of equity	Total assets (Item 6) - Total liabilities (Item 181) - Preferred stock (Item 10) + Deferred taxes (Item 35) + Convertible debt (Item 79); when preferred stock is missing, we replace it with the redemption value of preferred stock (Item 56).
Cash flow	Earnings before extraordinary items (Item 8) + Depreciation (Item 14), normalized by Capital or Assets
Stock ownership	Percent of common stock owned by the CEO and his immediate family at the beginning of the fiscal year, even if the CEO disclaims beneficial ownership, unless the relative in question also works for the company. Does not include stock subject to options or conversion of other securities, restricted stock for which retrictions have not lapsed, or shares for which the CEO controls investment or voting rights without deriving economic benefit.
Vested options	(Total number of CEO stock options exercisable within 60 days as of some date reported near the beginning of the fiscal year) / (Total number of shares of stock outstanding at the beginning of the fiscal year)
Corporate governance	Number of outside directors who currently serve as CEOs of other companies
Size	Natural logarithm of Assets at the beginning of the fiscal year
Industry effects	Fama-French industry groups as defined on French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)
4. Overconfidence Measures	
Holder "x"	Dummy variable equal to 1 for the CEO-years after a CEO has held a five-year-old option that was more than x % in the money, provided that he subsequently does it again at least once.
Hold and Lose "x"	Dummy variable equal to 1 for the CEO-years after a CEO has held a five-year-old option that was more than x % 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.
Hold and Win "x"	Dummy variable equal to 1 for the CEO-years after a CEO has held a five-year-old option that was more than x % in the money, provided that he subsequently does it again at least once and that he earns excess returns from holding such an option (relative to exercising in the fifth year and investing the proceeds in the S&P 500) each time.
Longholder	Dummy variable equal to 1 for all CEO-years if the CEO ever held an option until the last year prior to expiration.
Net Buyer (in first five years)	Dummy variable equal to 1 for all CEO-years in the relevant subsample (i.e. excluding the first five sample years) if the CEO was a net buyer of stock for more years than he was a net seller during his first five sample years.
5. Personal Characteristics	
Titles	Dummy variable equal to 1 if the CEO is also president and chairman of the board (in a given year).
Depression baby	Dummy variable equal to 1 if the CEO was born between 1930 and 1939.
Finance career	Dummy variable equal to 1 if the CEO had prior employment experience in a financial position. Financial positions include CFO, accountant, or employee of a financial institution.
Technical career	Dummy variable equal to 1 if the CEO had prior employment experience in a technical position. Technical positions include engineer, researcher, or natural scientist. Individual patent holders are also classified as having a technical background.
Finance education	Dummy variable equal to 1 if the CEO had "financial education." Financial education comprises undergraduate and graduate degrees in accounting, finance, business (incl. MBA), and economics.
MBA	Dummy variable equal to 1 if the CEO has an MBA degree.
Technical education	Dummy variable equal to 1 if the CEO had "technical education." Technical education comprises undergraduate and graduate degrees in engineering, physics, operations research, chemistry, mathematics, biology, pharmacy, and other applied sciences.

COMPUSTAT item numbers in parentheses.

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Notes

[1]Harris and Raviv (1991), Shleifer and Vishny (1997), Hubbard (1998), Zingales (2000), Stein (forthcoming) and Hart (forthcoming) provide excellent surveys.

[2]Berle and Means (1932), Baumol (1959), and Williamson (1964) were among the earliest to examine this conflict of interests. Jensen (1986) analyzes empire building, Shleifer and Vishny (1989) managerial entrenchment.

[3]Akerlof (1970) pioneered the adverse selection literature, showing the impact of informational asymmetry on quality. Other applications to equity and debt markets include Stiglitz and Weiss (1981); Greenwald, Stiglitz, and Weiss (1984); Myers (1984).

[4]Several papers address the measurement and endogeneity problem of investment-cash flow regressions. That is, a large cash or debt volume may indicate better marginal investment opportunities, when investment opportunities cannot be measured perfectly; see e.g. Erickson and Whited (2000, 2001). The analysis of natural experiments with exogenous cash flow shocks, however, corroborates the existence of the investment-cash flow puzzle. For an overview of the literature see Stein (forthcoming).

[5]Proxies for being financially unconstrained are, for example, high dividend payments (Fazzari, Hubbard, and Petersen 1998; Hubbard, Kashyap, and Whited, 1995); participation in the public debt market (Gilchrist and Himmelberg, 1995); business group affiliation (Hoshi, Kashyap, Scharfstein, 1991; Cho, 1996; Shin and Park, 1999). Another proxy for low cost of external finance relative to internal finance is a higher tax rate on undistributed profits (Calomiris and Hubbard, 1995).

[6]See Hadlock (1998). The results of Morck, Shleifer, and Vishny (1988) suggest that the agency explanation holds at low and at rather high levels of managerial ownership, but not for an intermediate range.

[7]Similarly, asymmetric information does not appear to be a plausible explanation for the "socialistic" allocation of internal funds from a cash wind fall within firms or the poor quality of projects financed with those funds (Lamont, 1997, and Blanchard, López-de-Silanes, and Shleifer, 1994). See also Fazzari, Hubbard, and Petersen (2000).

[8]The data was provided to us by Brian Hall and David Yermack. For details see Hall and Liebman (1998)

and Yermack (1995).

[9]Meulbroek (2001) provides a measure of the costs of equity-linked compensation, if executives are underdiversified.

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

[11]Miller and Ross (1975) provide a critical review of the abundant psychology literature on self-serving biases. Babcock and Loewenstein (1997) relate the "above average" effect to the literature on self-serving biases and analyse the effects on bargaining. Gervais and Odean (2001) apply self-serving attribution to trading behavior.

[12]The asset pricing literature has instead been particularly receptive to the notion of overconfidence among private investors and traders. Examples include Odean (1998); Daniel, Hirshleifer, and Subrahmanyam (1998) and (2001); Barber and Odean (2000); Scheinkman and Xiong (*forthcoming*).

[13]Malmendier and Tate (2003) provide empirical evidence on the impact of CEO overconfidence on merger decisions.

[14]Bernardo and Welch (2001) also develop a model in which managerial overconfidence persists in equilibrium. Overconfidence reduces the tendency to herd and facilitates the revelation of private information. Heifetz and Spiegel (2001) show under which conditions overconfident individuals end up outnumbering unbiased individuals in the evolutionary selection process. The idea that a biased objective function may confer advantages in the interaction with other (unbiased) agents goes back at least to Schelling (1960).

[15]Van den Steen (2001) models a setting in which the board of directors selects a CEO with "strong beliefs" for exactly this reason.

[16]Ariely and Wertenbroch (2002) and DellaVigna and Malmendier (2002) provide empirical evidence on overconfidence about positive personal features such as self-control.

[17]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 and 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. Indeed, the managers and shareholders will not agree on the

value-maximizing course of action even without managerial self-interest .

[18]Substituting $R(\cdot)$ with $ER(\cdot)$ does not alter our results. In fact, (persistent) overconfidence is a reasonable assumption only in the light of uncertainty about future returns.

[19]See for example Baker, Wurgler, and Stein (forthcoming.) Limited debt capacity can be endogenized in a model with bankruptcy costs (such as difficulty in accessing future financing); cf. Bolton and Scharfstein, 1990.

[20]Note, then, that the condition for an interior solution for the rational CEO (that $R'(I) > 1$ for some $I \geq 0$) is also sufficient to guarantee an interior solution here.

[21]See also Heaton (2002) for a framework in which overconfidence can lead to both underinvestment and overinvestment.

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

[23]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).

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

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

[26]We lose 111 (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 319.

[27]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.

[28]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.

[29]See French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) for de-

finitions. 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 V) robust to even the full set of 48 Fama and French groups.

[30]The disadvantage of this procedure is that it results in a substantial loss of power. In cases where our results are not significant at the 10% level when using clustered standard errors, they are robust to alternative controls for serial correlation. In particular, we run a Prais-Winsten regression with panel-corrected standard errors, assuming a first-order autoregressive error term and heteroskedasticity between different panels. We also run an OLS specification including a lag of investment as an additional control. Both approaches deliver significant results.

[31]The Hall-Murphy framework assumes that the CEO must invest any proceeds from exercise at the riskless rate, i.e. the CEO's only exposure to market returns is through company stock and options. In order to minimize the effect of the resulting upward bias in the threshold percentage, the level of risk-aversion should be chosen on the higher rather than the lower end of reasonable parameter values.

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

[33]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, Quicken; 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, the weekly column "Insider Trading Spotlight" in the *Wall Street Journal*, the weekly coverage of insider-trading information in the *Financial Times*.

[34]See Hadlock (1998).

[35]For example, the coefficient in a Prais-Winsten regression assuming a common first order autoregressive structure on the errors across panels is 0.1824 with a t-statistic of 2.19.

[36]We exclude CEOs for whom data on stock purchases is not present for more than 1 of these 5 years. Some of the increase in share-holdings for these CEOs 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.

[37]The coefficient in a Prais-Winsten regression assuming a common first order autoregressive structure on the errors across panels is 0.5073 with a t-statistic of 2.14.

[38]Our results are subject to the same important caveat as the other papers employing the KZ index. Namely, our data sample is not the Kaplan and Zingales sample; our sample does not consist entirely of manufacturing firms. Then, we cannot rule out an effect of financial constraints beyond what is captured by the index.

[39]To construct the index, we use a different definition of Q than in the rest of the paper to conform to the definition used by Kaplan and Zingales. The ratios composed from COMPUSTAT data items as follows: 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 (lagged).

[40]We also checked the robustness of our prior results to the inclusion of dummies for the five quintiles and the interaction of these dummies with cash flow. This direct control for financing constraints has no impact on any of our results.

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

[42]It also reassures us that the result on overconfidence by Kaplan-Zingales quintile was not spurious. That is, we will not find that any variable with a positive correlation to investment cash flow sensitivity is strongest among the most constrained firms.

[43]All standard errors in Table XIII are clustered by firm and all regressions include industry effects interacted with cash flow.

Table I

Summary Statistics

A. Firm Data Summary Statistics

Number of Firms = 319; Total Observations = 3569

Variable	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
Assets ($M)	3569	5,287	2,254	11,522	14	191,013
Capital ($M)	3567	2,302	990	4,290	4	110,023
Investment ($M)	3569	360	153	789	0	17,030
Investment normalized by lagged capital	3569	0.232	0.185	0.251	0.000	5.715
Investment normalized by lagged assets	3569	0.092	0.075	0.077	0.000	1.641
Cash flow ($M)	3569	426	189	850	-618	13192
Cash flow normalized by lagged capital	3569	0.336	0.248	0.326	-0.279	2.331
Cash flow normalized by lagged assets	3569	0.112	0.103	0.068	-0.157	0.654
Q (beginning of the fiscal year)	3569	1.419	1.125	0.876	0.512	11.219
Price/Earnings ratio	3514	23.59	14.83	171.93	-2137.50	5262.50
Corporate governance (Outside CEOs)	3569	1.77	1	1.58	0	9
Manufacturing (FF industry dummy)	3555	0.51	1	0.50	0	1
Utilities (FF industry dummy)	3555	0.18	0	0.38	0	1
Shops (FF industry dummy)	3555	0.14	0	0.35	0	1
Money (FF industry dummy)	3555	0.06	0	0.06	0	1
Other (FF industry dummy)	3555	0.12	0	0.32	0	1

All variables are defined in the Appendix. The Fama-French industries (FF industry dummies) are defined on French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

B. CEO Data Summary Statistics

Number of CEOs = 665; Total Observations = 3569

Variable	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
Age	3568	57.59	58	6.75	33	84
Years as CEO	3544	8.55	6	7.46	1	45
CEO & President	3569	0.56	1	0.50	0	1
CEO & Chairman	3569	0.82	1	0.39	0	1
CEO & President & Chairman	3569	0.38	0	0.49	0	1
Founder	3039	0.17	0	0.38	0	1
Stock ownership (%)	3569	0.023	0.0012	0.071	0	0.951
Vested options (% of shares outstanding)	3569	0.002	0.0004	0.011	0	0.463
"Depression baby" (born in 1930s)	3568	0.37	0	0.48	0	1
Finance career	1913	0.23	0	0.42	0	1
Technical career	1913	0.18	0	0.39	0	1
Finance education	2110	0.33	0	0.47	0	1
MBA	2110	0.27	0	0.44	0	1
Technical education	2110	0.55	1	0.50	0	1

All variables are defined in the Appendix.

Table II

CEO Data Summary Statistics

A. Sample: CEOs with options more than 67% in the money in the fifth year at least 2 times

Number of CEOs = 108; Total Observations = 1019

Variable	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
Manufacturing (FF industry dummy)	1017	0.66	1	0.47	0	1
Utilities (FF industry dummy)	1017	0.05	0	0.23	0	1
Shops (FF industry dummy)	1017	0.14	0	0.34	0	1
Money (FF industry dummy)	1017	0.05	0	0.22	0	1
Other (FF industry dummy)	1017	0.10	0	0.30	0	1
Age	1019	58.10	58	6.16	41	82
Years as CEO	997	10.86	9	7.27	1	39
CEO & President	1019	0.50	1	0.50	0	1
CEO & Chairman	1019	0.86	1	0.35	0	1
CEO & President & Chairman	1019	0.37	0	0.48	0	1
Founder	1019	0.17	0	0.38	0	1
Stock ownership (%)	1019	0.018	0.002	0.050	0	0.385
Vested options (% of shares outstanding)	1019	0.003	0.001	0.007	0	0.106
"Depression baby" (born in 1930s)	1019	0.41	0	0.49	0	1
Finance career	662	0.22	0	0.41	0	1
Technical career	662	0.17	0	0.38	0	1
Finance education	752	0.39	0	0.49	0	1
MBA	752	0.34	0	0.47	0	1
Technical education	752	0.51	1	0.50	0	1

All variables are defined in the Appendix. The Fama-French industries (FF industry dummies) are defined on French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

B. Subsample: 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.

Number of CEOs = 56; Total Observations = 293

Variable	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
Manufacturing (FF industry dummy)	293	0.71	1	0.45	0	1
Utilities (FF industry dummy)	293	0.00	0	0.00	0	0
Shops (FF industry dummy)	293	0.14	0	0.35	0	1
Money (FF industry dummy)	293	0.05	0	0.21	0	1
Other (FF industry dummy)	293	0.10	0	0.29	0	1
Age	293	60.99	61	5.84	44	82
Years as CEO	285	13.81	13	5.92	6	35
CEO & President	293	0.47	0	0.50	0	1
CEO & Chairman	293	0.92	1	0.26	0	1
CEO & President & Chairman	293	0.40	0	0.49	0	1
Founder	270	0.17	0	0.38	0	1
Stock ownership (%)	293	0.009	0.003	0.021	0	0.225
Vested options (% of shares outstanding)	293	0.005	0.002	0.007	0	0.039
"Depression baby" (born in 1930s)	293	0.37	0	0.48	0	1
Finance career	182	0.15	0	0.36	0	1
Technical career	182	0.16	0	0.37	0	1
Finance education	208	0.44	0	0.50	0	1
MBA	208	0.37	0	0.48	0	1
Technical education	208	0.48	0	0.50	0	1

All variables are defined in the Appendix. The Fama-French industries (FF industry dummies) are defined on French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

Table III

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 begining 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. Industries are defined as the five Fama-French industry groups.

Holder 67 is a dummy variable equal to 1 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. 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)			
	no fixed effects, no controls	fixed effects, no controls	fixed effects, controls	no controls	with controls	standard errors clustered by firm	industry - CF interactions, clustered errors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.2390	0.6422	2.0173	0.6674	2.0553	2.0553	2.1908
	(10.42)***	(6.81)***	(11.36)***	(7.09)***	(11.66)***	(3.42)***	(3.96)***
Q	0.0178	0.0655	0.0128	0.0664	0.0093	0.0093	0.0163
	(2.13)**	(6.62)***	(0.64)	(6.74)***	(0.47)	(0.21)	(0.44)
Stock ownership (%)			-0.0800		-0.1951	-0.1951	0.1845
			(0.14)		(0.35)	(0.29)	(0.31)
Vested options			0.0124		-0.0036	-0.0036	-0.0217
			(0.07)		(0.02)	(0.02)	(0.13)
Size			0.0337		0.0429	0.0429	0.0666
			(1.68)*		(2.15)**	(1.23)	(1.83)*
Corporate governance			-0.0036		-0.0079	-0.0079	-0.0066
			(0.45)		(1.00)	(0.79)	(0.67)
(Q)*(Cash flow)			0.0255		0.0374	0.0374	0.0198
			(1.29)		(1.88)*	(0.52)	(0.33)
(Stock ownership)*(Cash flow)			-0.8267		-0.8831	-0.8831	-1.4805
			(1.99)**		(2.14)**	(0.61)	(1.10)
(Vested options)*(Cash flow)			-0.3991		-0.2573	-0.2573	-0.2826
			(3.28)***		(2.07)**	(1.18)	(1.29)
(Size)*(Cash flow)			-0.2214		-0.2260	-0.2260	-0.2324
			(10.27)***		(10.58)***	(2.85)***	(3.22)***
(Corporate governance)*(Cash flow)			0.0382		0.0501	0.0501	0.0345
			(2.20)**		(2.87)***	(1.76)*	(1.35)
Holder 67				-0.0333	-0.0503	-0.0503	-0.0482
				(1.23)	(1.92)*	(1.56)	(1.43)
(Holder 67)*(Cash flow)				0.1562	0.2237	0.2237	0.2215
				(2.94)***	(4.11)***	(2.08)**	(1.93)*
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	1019	1019	1019	1019	1019	1019	1017
Adjusted R-squared	0.14	0.55	0.63	0.56	0.63	0.63	0.66

Constant included. Absolute value of t statistics in parentheses.

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

Figure I

Regression of Investment on Cash Flow and Exercise Behavior

Figure 1 presents the results of reestimating the regression specified in Column 6 of Table III 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 1 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 x up to 135% and at the 10% level for higher x, where standard errors are robust to heteroskedasticity and arbitrary within-firm serial correlation.

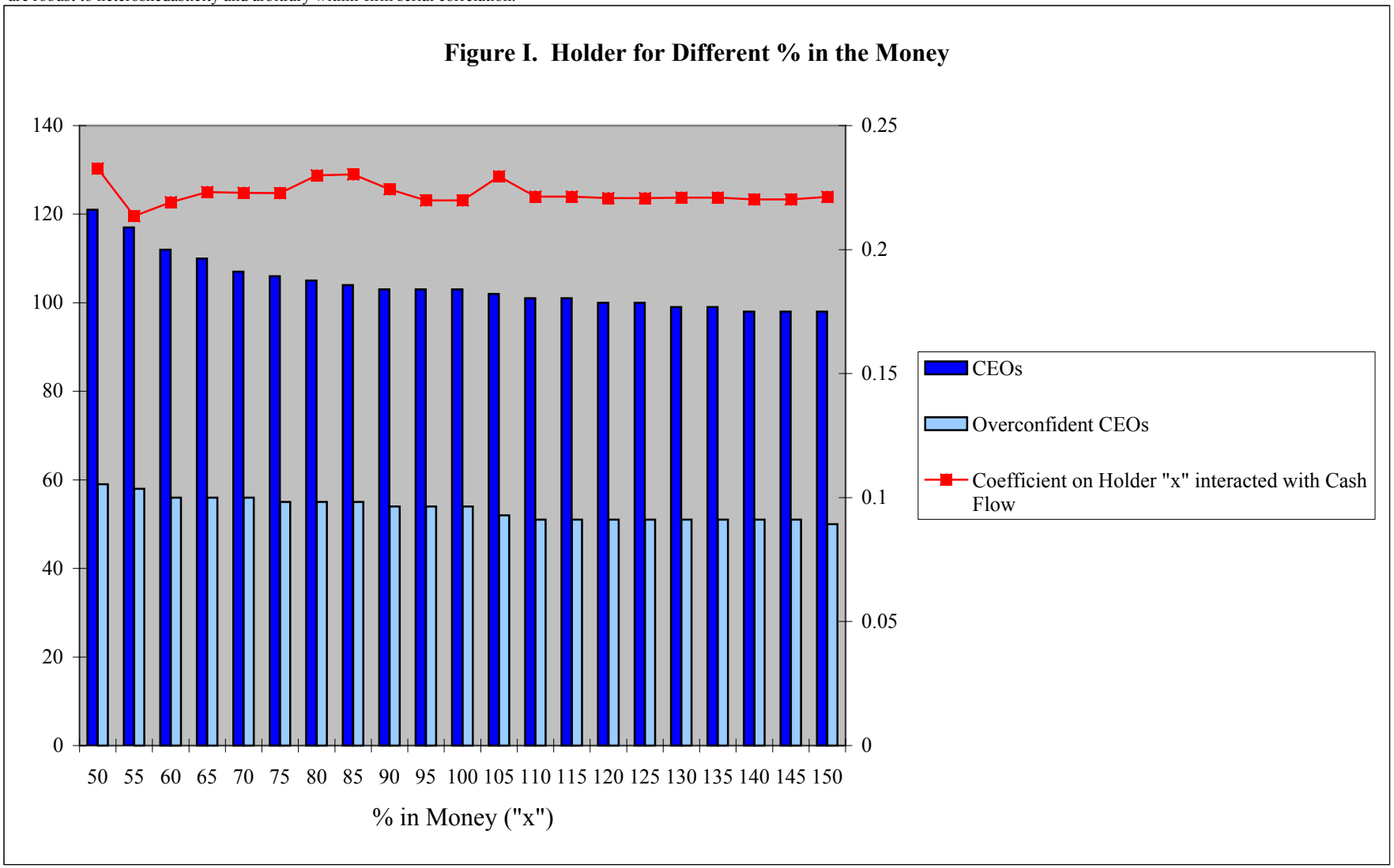

Table IV
Persistence of Exercising Behavior

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. Price/Earnings ratio is the maximal price earnings 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.

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	0.1896	0.2612	0.1982
	(4.40)***	(2.88)***	(4.70)***	(3.07)***
Q		-0.151		-0.1544
		(1.57)		(1.65)
Price/Earnings ratio			0.0011	0.0014
			(1.19)	(1.26)
Observations	759	528	730	519
Number of CEOs	278	187	272	186

Absolute value of z statistics in parentheses.

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

B. Percent of "Late Exercisers" Partitioned by Number of Last 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	0.77	15

Table V

Distribution of Returns of "Late Exercisers" (67%, 5th 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 5th year after the option grant and who have not exercised the options before the 5th 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		Exercises at fiscal-year mean price		Exercises 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 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. Corporate governance is the number of outside directors who currently serve as CEOs of other companies. Size is the natural logarithm of assets at the beginning of the fiscal year.

Hold and Win 67 is a dummy variable equal to 1 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 1 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 five Fama-French industry groups.

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	no controls	with controls	standard errors clustered by firm	industry - CF interactions, clustered errors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.239	0.6422	2.0173	0.6647	2.0745	2.0745	2.1974
	(10.42)***	(6.81)***	(11.36)***	(7.04)***	(11.64)***	(3.39)***	(3.94)***
Q	0.0178	0.0655	0.0128	0.0665	0.0092	0.0092	0.0159
	(2.13)**	(6.62)***	(0.64)	(6.73)***	(0.46)	(0.20)	(0.43)
(Q)*(Cash flow)			0.0255		0.0371	0.0371	0.02
			(1.29)		(1.87)*	(0.52)	(0.33)
Stock ownership (%)			-0.08		-0.2039	-0.2039	0.1927
			(0.14)		(0.37)	(0.30)	(0.33)
Vested options			0.0124		0.0088	0.0088	-0.0094
			(0.07)		(0.05)	(0.06)	(0.06)
Corporate governance			-0.0036		-0.0084	-0.0084	-0.0075
			(0.45)		(1.05)	(0.82)	(0.76)
Size			0.0337		0.045	0.045	0.0687
			(1.68)*		(2.23)**	(1.24)	(1.84)*
(Stock ownership)*(Cash flow)			-0.8267		-0.887	-0.887	-1.459
			(1.99)**		(2.15)**	(0.61)	(1.10)
(Vested options)*(Cash flow)			-0.3991		-0.2677	-0.2677	-0.2935
			(3.28)***		(2.14)**	(1.21)	(1.33)
(Corporate governance)*(Cash flow)			0.0382		0.0507	0.0507	0.0359
			(2.20)**		(2.91)***	(1.77)*	(1.38)
(Size)*(Cash flow)			0.0255		-0.2281	-0.2281	-0.2333
			(1.29)		(10.57)***	(2.84)***	(3.22)***
Hold and Win 67				-0.0487	-0.0293	-0.0293	-0.0268
				(1.23)	(0.78)	(0.63)	(0.50)
(Hold and Win 67)*(Cash flow)				0.1812	0.2002	0.2002	0.1842
				(2.73)***	(3.04)***	(1.79)*	(1.31)
Hold and Lose 67				-0.0226	-0.0621	-0.0621	-0.0628
				(0.70)	(2.02)**	(1.63)	(1.82)*
(Hold and Lose 67)*(Cash flow)				0.1301	0.2418	0.2418	0.2577
				(1.83)*	(3.46)***	(1.94)*	(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	1019	1019	1019	1019	1019	1019	1017
Adjusted R-squared	0.14	0.55	0.63	0.56	0.63	0.63	0.66

Constant included. Absolute value of t statistics in parentheses.

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

Table VII

Time Series of the Fraction of CEOs Holding 67% in the Money

The table presents time series data for the fraction of CEOs holding options despite the options reaching 67% in the money in year 5.

Year	Fraction of CEOs holding despite reaching 67% in the money (Holders 67)	Observations
85	0.38	63
86	0.47	75
87	0.42	95
88	0.49	75
89	0.42	90
90	0.66	80
91	0.51	74
92	0.36	74
93	0.41	71
94	0.49	69

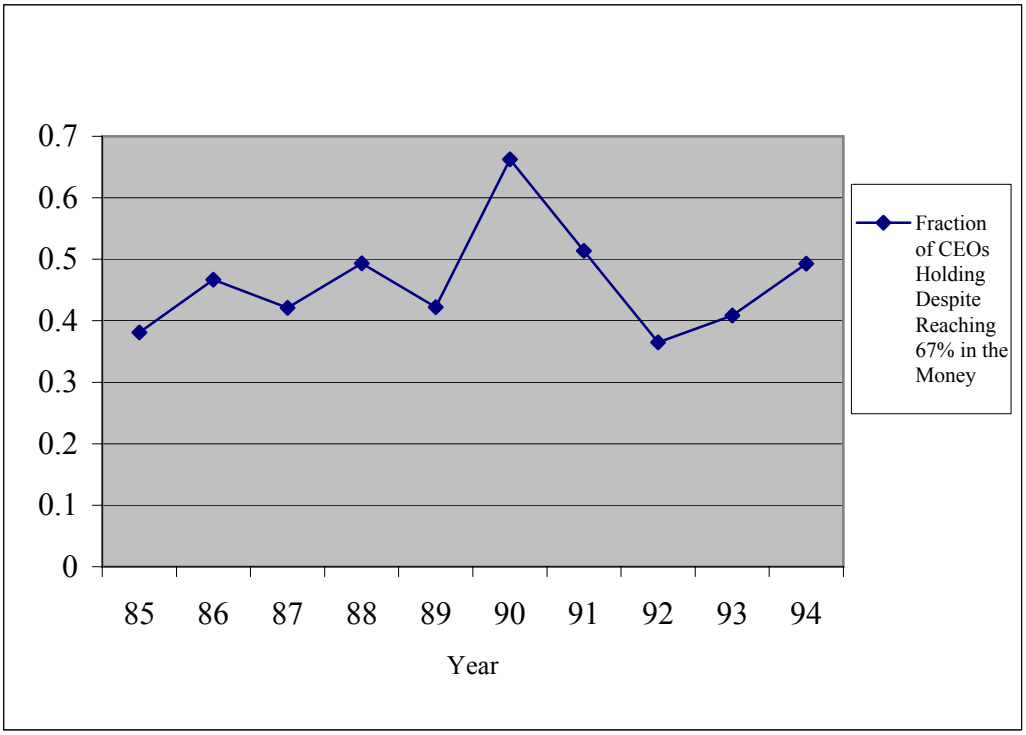

Table VIII

Regression of Investment on Cash Flow and Holding Options "Forever"

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. Industries are defined as the five Fama-French industry groups. Standard errors in columns 6 and 7 are robust to heteroskedasticity and arbitrary within-firm serial correlation.

	Baseline Regressions			Holding Options Until Last Year Before Expiration			
	no fixed effects, no controls	fixed effects, no controls	fixed effects, controls	no controls	with controls	standard errors clustered by firm	industry - CF interactions, clustered errors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.2723	0.5051	0.847	0.4367	0.7858	0.7858	0.6743
	(21.24)***	(12.21)***	(9.19)***	(10.32)***	(8.42)***	(2.47)**	(2.05)**
Q	0.053	0.099	0.0812	0.0983	0.0846	0.0846	0.0931
	(11.09)***	(15.06)***	(7.49)***	(15.05)***	(7.79)***	(2.00)**	(1.93)*
Stock ownership (%)			0.2457		0.251	0.251	0.2533
			(2.80)***		(2.86)***	(1.24)	(1.32)
Vested options			-0.0465		-0.0134	-0.0134	-0.0211
			(0.41)		(0.12)	(0.05)	(0.08)
Size			-0.0415		-0.0454	-0.0454	-0.049
			(4.08)***		(4.45)***	(2.02)**	(2.09)**
Corporate governance			0.0021		0.0029	0.0029	0.0041
			(0.51)		(0.72)	(0.52)	(0.78)
(Q)*(Cash flow)			0.0107		0.0063	0.0063	-0.0127
			(1.02)		(0.60)	(0.14)	(0.23)
(Stock ownership)*(Cash flow)			-0.2848		-0.2971	-0.2971	-0.3701
			(1.71)*		(1.79)*	(0.60)	(0.73)
(Vested options)*(Cash flow)			0.3584		0.3225	0.3225	0.3331
			(4.51)***		(4.03)***	(1.30)	(1.38)
(Size)*(Cash flow)			-0.0666		-0.0618	-0.0618	-0.0519
			(5.91)***		(5.47)***	(1.47)	(1.14)
(Corporate governance)*(Cash flow)			-0.0083		-0.0102	-0.0102	-0.0151
			(0.86)		(1.05)	(0.49)	(0.79)
Longholder				-0.0737	-0.0461	-0.0461	-0.0532
				(3.67)***	(2.34)**	(1.07)	(1.29)
(Longholder)*(Cash flow)				0.2317	0.1346	0.1346	0.155
				(6.81)***	(3.95)***	(1.18)	(1.35)
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	3569	3569	3569	3569	3569	3569	3555
Adjusted R-squared	0.22	0.51	0.55	0.51	0.55	0.55	0.55

Constant Included. Absolute value of t statistics in parentheses.

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

Table IX

Regression of Investment on Cash Flow and Stock Purchases in First Five Years

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. Net Buyer is a dummy variable equal to one for the remainder of the CEO's years in the sample if he was a net buyer of stock more years than he was a net seller in his first five years in the sample. Industries are defined as the five Fama-French industry groups.

Standard errors in columns 6 and 7 are robust to heteroskedasticity and arbitrary within-firm serial correlation.

Sample: CEOs who appear in the data for at least 10 years

	Baseline Regressions			Buying Behavior in First Five Years			
	no fixed effects, no controls	fixed effects, no controls	fixed effects, controls	no controls	with controls	standard errors clustered by firm	industry - CF interactions, clustered errors
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.1539	0.2411	1.653	0.0301	1.5614	1.5614	1.094
	(6.27)***	(2.64)***	(6.12)***	(0.31)	(5.84)***	(4.10)***	(2.04)**
Q	0.0305	0.0488	0.0745	0.0343	0.076	0.076	0.074
	(3.58)***	(3.87)***	(3.40)***	(2.71)***	(3.52)***	(3.26)***	(2.69)***
Stock ownership (%)			0.3357		-0.1032	-0.1032	0.3074
			(0.85)		(0.26)	(0.27)	(0.59)
Vested options			0.0761		0.0157	0.0157	0.0196
			(0.31)		(0.06)	(0.06)	(0.08)
Size			-0.1001		-0.0942	-0.0942	-0.1068
			(3.74)***		(3.57)***	(1.76)*	(1.94)*
Corporate governance			0.0043		0.0095	0.0095	0.0071
			(0.43)		(0.96)	(0.55)	(0.42)
(Q)*(Cash flow)			-0.0564		-0.0741	-0.0741	-0.0629
			(2.44)**		(3.21)***	(1.82)*	(1.40)
(Stock ownership)*(Cash flow)			-0.8385		0.3589	0.3589	-0.5852
			(1.22)		(0.49)	(0.30)	(0.47)
(Vested options)*(Cash flow)			-0.0669		0.042	0.042	0.1152
			(0.42)		(0.27)	(0.27)	(0.77)
(Size)*(Cash flow)			-0.1494		-0.1592	-0.1592	-0.1032
			(5.22)***		(5.62)***	(3.39)***	(1.88)*
(Corporate governance)*(Cash flow)			0.0221		-0.0013	-0.0013	0.0111
			(0.91)		(0.05)	(0.02)	(0.18)
Net Buyer				-0.8153	-0.3788	-0.3788	1.506
				(2.33)**	(0.69)	(0.42)	(1.04)
(Net Buyer)*(Cash flow)				0.4913	0.4425	0.4425	0.4267
				(5.44)***	(4.42)***	(1.58)	(1.43)
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	818	818	818	818	818	818	818
Adjusted R-squared	0.09	0.47	0.53	0.49	0.54	0.54	0.55

Constant included. Absolute value of t statistics in parentheses.

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

Table X

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 1 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	1.1362	0.1443	0.7831	0.7831	0.7052
	(1.93)*	(0.26)	(2.21)**	(1.71)*	(2.29)**
Q	0.1813	0.0549	0.0723	0.0413	-0.0466
	(4.26)***	(1.34)	(2.14)**	(1.74)*	(0.54)
Stock ownership (%)	-0.3888	0.4572	-0.0731	-0.9642	0.5606
	(1.69)*	(1.75)*	(0.41)	(1.62)	(1.41)
Vested options	0.1845	-0.348	0.9945	0.9212	0.3124
	(0.65)	(1.12)	(2.32)**	(1.24)	(0.37)
Size	-0.0461	-0.0154	-0.0002	-0.042	-0.042
	(1.06)	(0.61)	(0.01)	(1.13)	(0.84)
Corporate governance	0.0025	-0.003	0.0036	-0.0137	0.0162
	(0.23)	(0.42)	(0.68)	(1.00)	(0.67)
(Q)*(Cash flow)	-0.1873	0.0557	-0.0531	-0.0066	0.0685
	(2.35)**	(0.47)	(0.70)	(0.21)	(0.81)
(Stock ownership)*(Cash flow)	-0.3197	-0.8051	-0.3971	1.4618	-0.5946
	(0.63)	(1.03)	(0.54)	(1.36)	(0.90)
(Vested options)*(Cash flow)	-0.4351	1.0147	-1.0181	-2.2851	-0.3998
	(1.03)	(1.71)*	(1.06)	(1.59)	(0.86)
(Size)*(Cash flow)	-0.055	-0.013	-0.0408	-0.0035	-0.0391
	(0.72)	(0.19)	(0.92)	(0.07)	(0.89)
(Corporate governance)*(Cash flow)	-0.0463	0.0836	-0.029	0.0447	-0.0327
	(0.84)	(1.85)*	(1.38)	(1.08)	(0.89)
Longholde	-0.083	0.0838	-0.0247	-0.0616	-0.1337
	(1.73)*	(1.61)	(0.89)	(1.30)	(1.30)
(Longholder)*(Cash flow)	0.4927	-0.1414	0.0491	0.117	0.2113
	(3.44)***	(1.06)	(0.61)	(0.84)	(1.44)
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	700	700	701	700	700
Adjusted R-squared	0.75	0.83	0.92	0.81	0.57

Constant included. Absolute value of t statistics in parentheses.

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

Table XI

Regression of Investment on Cash Flow and Background

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. MBA is a dummy variable equal to 1 if the CEO has an MBA. Technical education is a dummy variable equal to 1 if the CEO has an undergraduate or graduate degree in engineering, physics, operations research, chemistry, mathematics, biology, pharmacy, and other applied sciences. Finance background is a dummy variable equal to one if the CEO had prior employment experience in a financial position. Technical background is a dummy variable equal to one if the CEO had prior employment experience in a technical position. Industries are defined as the five Fama-French industry groups. Standard errors in columns 5 to 7 of each panel are robust to heteroskedasticity and arbitrary within-firm serial correlation.

A. Regression of Investment on Cash Flow and Educational Background

	Baseline	Fixed Effects & Controls			Clustered standard errors (by firm)		
		Technical	Finance	Both	Technical	Finance	Both
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	0.974	0.8639	0.9913	0.8839	0.8639	0.9913	0.8839
	(7.43)***	(6.36)***	(7.55)***	(6.49)***	(4.26)***	(4.17)***	(4.36)***
Q	0.011	0.0207	0.0147	0.0236	0.0207	0.0147	0.0236
	(0.68)	(1.27)	(0.91)	(1.44)	(0.24)	(0.17)	(0.27)
Technical education		-0.0627		-0.0591	-0.0627		-0.0591
		(2.75)***		(2.54)**	(2.38)**		(2.24)**
(Technical education)*(CF)		0.1532		0.1455	0.1532		0.1455
		(3.12)***		(2.95)***	(1.79)*		(1.78)*
MBA			0.0383	0.0275		0.0383	0.0275
			(1.60)	(1.13)		(1.64)	(1.14)
(MBA)*(CF)			-0.1247	-0.1102		-0.1247	-0.1102
			(2.31)**	(2.04)**		(1.70)*	(1.46)
Observations	2106	2106	2106	2106	2106	2106	2106
Adjusted R-squared	0.57	0.57	0.57	0.57	0.57	0.57	0.57

B. Regression of Investment on Cash Flow and Employment Background

	Baseline	Fixed Effects & Controls			Clustered standard errors (by firm)		
		Technical	Finance	Both	Technical	Finance	Both
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash flow	1.6089	1.5225	1.6065	1.5237	1.5225	1.6065	1.5237
	(9.73)***	(9.13)***	(9.72)***	(9.13)***	(3.61)***	(3.47)***	(3.62)***
Q	0.1023	0.1122	0.1061	0.1134	0.1122	0.1061	0.1134
	(5.87)***	(6.39)***	(6.01)***	(6.41)***	(1.49)	(1.39)	(1.49)
Technical career		-0.0604		-0.0584	-0.0604		-0.0584
		(1.88)*		(1.77)*	(1.52)		(1.40)
(Technical career)*(CF)		0.2542		0.2473	0.2542		0.2473
		(4.09)***		(3.88)***	(2.42)**		(2.25)**
Finance career			0.0242	0.0054		0.0242	0.0054
			(0.84)	(0.18)		(1.03)	(0.21)
(Finance career)*(CF)			-0.0964	-0.0429		-0.0964	-0.0429
			(1.41)	(0.62)		(1.02)	(0.44)
Observations	1911	1911	1911	1911	1911	1911	1911
Adjusted R-squared	0.63	0.64	0.63	0.64	0.64	0.63	0.64

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 interactions of (Year)*(CF) and (Industry)*(CF) are also included.

Table XII

Regression of Investment on Cash Flow and Technical Background 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 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. Technical career is a dummy variable equal to one if the CEO had prior employment experience in a technical position. Industries are defined as the five Fama-French industry groups.

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	1.9368	0.6561	0.839	1.2787	0.9894
	(2.30)**	(1.21)	(1.31)	(1.24)	(1.32)
Q	0.142	0.042	0.0839	-0.0305	-0.2154
	(3.46)***	(0.53)	(1.72)*	(0.62)	(3.14)***
Stock ownership (%)	-0.1836	-0.1614	-0.3964	0.4171	1.6284
	(2.35)**	(0.68)	(1.18)	(0.47)	(2.59)**
Vested options	0.7838	-0.3809	1.5111	-0.6927	2.5599
	(1.72)*	(0.99)	(2.64)***	(0.65)	(1.88)*
Size	0.0206	-0.0202	0.0134	0.0048	0.0824
	(0.57)	(0.56)	(0.40)	(0.07)	(1.13)
Corporate governance	-0.0194	0.0045	0.0049	-0.0305	0.0562
	(1.73)*	(0.43)	(0.67)	(1.43)	(2.69)***
(Q)*(Cash flow)	-0.1793	0.1549	-0.1847	0.1007	0.3033
	(1.80)*	(0.66)	(1.54)	(1.32)	(3.73)***
(Stock ownership)*(Cash flow)	-0.1465	-0.4246	1.1059	-1.1156	-1.6273
	(0.79)	(0.32)	(0.45)	(0.70)	(1.56)
(Vested options)*(Cash flow)	-0.8679	0.8498	-4.263	2.2748	-1.5876
	(1.38)	(1.12)	(2.07)**	(0.82)	(2.65)**
(Size)*(Cash flow)	-0.1649	-0.093	-0.0611	-0.0438	-0.1737
	(3.09)***	(1.86)*	(0.85)	(0.46)	(2.32)**
(Corporate governance)*(Cash flow)	0.0417	0.049	-0.0292	0.1054	-0.0972
	(1.00)	(0.62)	(0.80)	(1.37)	(2.84)***
Technical career	-0.0641	-0.0073	-0.0295	0.1095	-0.2086
	(1.10)	(0.19)	(0.72)	(1.01)	(2.10)**
(Technical career)*(Cash flow)	-0.2678	-0.2179	0.1285	0.3685	0.4529
	(0.75)	(1.43)	(0.96)	(1.14)	(2.58)**
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
(Industry fixed effects)*(Cash flow)	yes	yes	yes	yes	yes
Observations	361	367	369	358	352
Adjusted R-squared	0.81	0.89	0.95	0.84	0.84

Constant included. Absolute value of t statistics in parentheses.

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

Table XIII

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. Cohort 1930s is a dummy variable equal to one if the CEO was born in the 1930s. Finance career is a dummy variable equal to one if the CEO had prior employment experience in a financial position. Technical career is a dummy variable equal to one if the CEO had prior employment experience in a technical position. 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 five 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	1.656	1.5349	1.6234	1.3657	1.2358
	(3.31)***	(3.11)***	(3.21)***	(3.40)***	(3.27)***
Q	0.1079	0.098	0.1169	0.111	0.1221
	(1.41)	(1.24)	(1.49)	(1.38)	(1.49)
Titles	-0.0225			-0.026	-0.0256
	(0.91)			(1.01)	(0.99)
(Titles)*(CF)	0.1221			0.1449	0.1453
	(1.18)			(1.36)	(1.36)
Tenure	-0.0003	-0.0017		-0.0006	0.0008
	(0.14)	(0.93)		(0.31)	(0.41)
(Tenure)*(CF)	-0.0066	-0.0029		-0.0049	-0.0086
	(0.94)	(0.45)		(0.80)	(1.32)
Cohort 1930s		-0.0646		-0.0606	-0.0409
		(2.00)**		(1.99)**	(1.40)
(Cohort 1930s)*(CF)		0.2281		0.2283	0.1901
		(2.26)**		(2.51)**	(2.17)**
Finance career			0.0055	0.0233	0.0235
			(0.21)	(1.01)	(0.95)
(Finance career)*(CF)			-0.0435	-0.1356	-0.1371
			(0.44)	(1.24)	(1.27)
Technical career			-0.0596	-0.0393	-0.041
			(1.43)	(0.92)	(1.00)
(Technical career)*(CF)			0.2505	0.2059	0.2062
			(2.30)**	(1.88)*	(2.01)**
Longholder					-0.103
					(2.02)**
(Longholder)*(CF)					0.2191
					(1.67)*
Observations	1899	1899	1899	1899	1899
Adjusted R-squared	0.63	0.64	0.63	0.64	0.64

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.