

# Do CEO Beliefs Affect Corporate Cash Holdings?

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March 16, 2016

## Abstract

We examine the effect of CEO optimism on corporate cash holdings by developing an expanded trade-off model of cash holdings that incorporates CEO beliefs. The optimistic CEO views external financing as excessively costly but expects this cost to decline over time, thus delaying external financing and maintaining a lower cash balance than rational CEOs. Our results indicate that CEO optimism, on average, is associated with a 24 percent decline in the firm's cash balance. We also document that, relative to rational CEOs, optimistic CEOs exhibit a lower change in the cash balance over time, hold lower cash to fund the firm's growth opportunities, and save less cash out of their current cash flow. We confirm our findings with two different samples of firms and alternative measures of optimism.

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\*We are grateful to Ulrike Malmendier for providing the data on CEO overconfidence and for her insightful comments. We thank Irina Krop for research assistance. We gratefully acknowledge the helpful comments of the discussant Vikram Nanda and the session participants at the 2016 American Finance Association Annual Meeting, seminar participants at Brandeis University, Fangzhou Liu, and the session participants at the 2015 Financial Management Association Annual Meeting. Sanjay Deshmukh and Keith Howe are from the Department of Finance at DePaul University and Anand Goel is from Navigant Consulting.

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## I. INTRODUCTION

The current literature identifies several firm characteristics that impact corporate cash holdings (Opler, Pinkowitz, Stulz, and Williamson, 1999, and Bates, Kahle, and Stulz, 2009). However, little is known about how managerial characteristics affect cash holdings despite research documenting the effect of managerial characteristics on various corporate policies. For example, Bertrand and Schoar (2003) document that the variation in management “styles” of top executives accounts for some of the unexplained variation in a wide range of corporate policies. Cronqvist, Makhija, and Yonker (2012) find that corporate leverage choices mirror the personal leverage choices of CEOs. Graham, Harvey, and Puri (2013) use psychometric tests to identify behavioral traits of CEOs and provide evidence that these traits are related to corporate financial policies.

We examine the effect of managerial traits on corporate cash holdings. Specifically, we focus on CEO overconfidence or optimism. The finding that people are overconfident is one of the most robust in the psychology of judgment (De Bondt and Thaler, 1995, Kahneman, Paul, and Tversky, 1982, and Russo and Schoemaker, 1990). Overconfidence is defined either as an upward bias in expectations of future outcomes, also known as optimism, or as overestimation of the precision of one’s information leading to underestimation of risk. As with much of the work in behavioral finance, we focus on the first interpretation and use the terms optimism and overconfidence interchangeably.<sup>1</sup>

The literature on behavioral corporate finance has shown that CEO overconfidence (or optimism) affects investment, merger, dividend, and financing decisions (Malmendier and Tate, 2005, 2008, Malmendier, Tate, and Yan, 2011, and Deshmukh, Goel, and Howe, 2013). An important insight from this literature is that optimistic CEOs behave as if they are

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<sup>1</sup>The overestimation of future cash flows (optimism) is discussed in Hackbarth (2008), Heaton (2002), Hirshleifer (2001), and Malmendier and Tate (2005). The overestimation of the precision of one’s information is discussed in Barberis and Thaler (2003), Ben-David, Graham, and Harvey (2013), Bernardo and Welch (2001), Gervais, Heaton, and Odean (2011), Hackbarth (2008), Hirshleifer (2001), and Malmendier and Tate (2005). The former is a bias about the first moment of the outcome whereas the latter is a bias about the second moment of the outcome. As Hirshleifer (2001) points out, an overestimation of the precision of one’s information may lead to optimism.

financially constrained, given their belief that external financing is overly costly. However, the implied effect of optimism on cash holdings is not a foregone conclusion since an optimistic CEO's perceived financial constraints imply two opposing effects on cash holdings. On the one hand, optimistic CEOs may hold *more* cash than rational CEOs to finance future investments with internal cash rather than with future external financing that they expect to be unduly costly. On the other hand, optimistic CEOs may view current external financing as unduly costly and therefore, finance current investments with more internal cash and maintain a *lower* cash balance than rational CEOs. Thus, the effect of CEO optimism on cash holdings is indeterminate and depends on the CEO's beliefs about the relative costs of current and future external financing. In other words, the effect of optimism on cash holdings remains inconclusive and needs to be resolved both conceptually and empirically.

We exploit the tension between the perceived costs of current and future external financing to develop a model of corporate cash holdings. When the CEO and the investors in the market have identical beliefs, the optimal cash balance is determined based on a trade-off of the benefits and costs of holding cash. However, when the CEO and the investors differ in their beliefs, the CEO's preferred cash balance also depends on his/her perception about the cost of external financing. An optimistic CEO believes that the firm's equity is currently underpriced. Moreover, the CEO thinks that this underpricing will mitigate over time as investors learn about the profitability of the firm's investments. Consequently, an optimistic CEO expects the cost of external financing to decline and delays raising external financing. Until this anticipated decline in financing costs occurs, the optimistic CEO finances the firm's investments by relying more on internal cash, thus maintaining a lower cash balance than rational CEOs. The main prediction of the model is that a firm managed by an optimistic CEO maintains a lower cash balance than an otherwise identical firm managed by a rational CEO. The model also predicts the difference in cash holdings between higher-growth and lower-growth firms to be lower in firms managed by optimistic CEOs.

We test the model's predictions using a sample drawn from the Execucomp database over the period 1992-2012. As in Malmendier and Tate (2005, 2008) and Malmendier et al. (2011), we classify managers as optimistic if they overinvest personal funds in their company. For this classification, we follow Campbell, Gallmeyer, Johnson, Rutherford, and Stanley (2011) and use the data on option compensation. We classify CEOs as optimistic if they held an

option that was more than 100% in the money at least once during their tenure. Campbell et al. (2011) and Malmendier et al. (2011) show that comparable measures appear to capture optimism in managerial beliefs. We find that CEO optimism, on average, is associated with a 24 percent reduction in the firm's cash balance. In addition, optimistic CEOs exhibit a lower change in the cash balance from one year to the next than do rational CEOs. These results are consistent with the main prediction of our theoretical model. We also consider several alternative moneyness thresholds, based on existing literature, to identify optimistic CEOs and find that our main finding is robust to these alternative thresholds.

We also find that rational CEOs hold more cash in higher-growth firms than in lower-growth firms to finance higher future investments. However, the difference in cash holdings between higher-growth and lower-growth firms is smaller in firms managed by optimistic CEOs. This finding is consistent with an empirical prediction of our model. The intuition is that optimistic CEOs prefer to finance future investments by raising external financing in the future rather than by saving and hoarding cash because they expect the terms of financing to improve over time. Further, we find that firms managed by optimistic CEOs save less cash out of their current cash flow than those managed by rational CEOs. The intuition for this result is that a higher current cash flow reinforces an optimistic CEO's perception that the cost of external financing will decline in the future causing the CEO to save less cash out of current cash flow. We verify all of our results using an alternative measure of optimism and an alternative sample of large firms used in Malmendier and Tate (2005, 2008) and in Malmendier et al. (2011). We also perform several tests to rule out alternative explanations of our findings and to address potential endogeneity concerns.

There is a substantial body of research on corporate cash holdings. The early work by Keynes (1936) focuses on the costs and benefits of cash reserves. Kim, Mauer, and Sherman (1998) develop a trade-off model of cash holdings and find empirical support for many of its predictions. Opler et al. (1999) also examine the determinants of cash holdings and find support for a trade-off model of cash holdings. Recent research analyzes specific aspects of the determinants of cash holdings. For example, Harford (1999) examines the relation between cash holdings and acquisitions; Dittmar, Mahrt-Smith, and Servaes (2003) and Harford, Mansi, and Maxwell (2008) examine the role of corporate governance; Acharya, Davydenko, and Strebulaev (2012) and Harford, Klasa, and Maxwell (2014) examine the

interactions between credit risk and cash holdings; Bates et al. (2009) provide a summary of the different motives for firms to hold cash and explore the intertemporal growth in aggregate cash holdings; Duchin (2010) examines the relation between cash holdings and corporate diversification; Fresard (2010) studies the strategic effect of corporate cash policy; and Liu and Mauer (2011) explore the relation between CEO risk-taking incentives and cash holdings.

In a recent study, Dittmar and Duchin (2015) find that firms led by CEOs who experienced financial distress early in their career hold more cash. This study is closest to ours in spirit; both examine the impact of CEO characteristics on cash policy. However, there are fundamental differences. First, Dittmar and Duchin (2015) focus on past professional experiences of a CEO. In contrast, we examine CEO's beliefs about the future as they relate to the costs of external financing. Second, the focus in Dittmar and Duchin (2015) is not on the channel through which past experiences affect cash holdings. In contrast, in our theoretical model, we identify how CEO beliefs affect the trade-offs that determine a firm's cash holdings.

We contribute to the cash holdings literature by showing that managerial beliefs affect corporate cash holdings. We develop a new theoretical framework by modeling the trade-offs faced by an optimistic CEO in simultaneously determining cash holdings and choosing investment and financing levels, both of which have been shown to be affected by CEO beliefs. Our empirical results provide strong evidence that optimistic CEOs hold less cash than rational CEOs. We test additional predictions and the findings strengthen the optimism-based interpretation of our results.

We also contribute to the growing literature on behavioral corporate finance.<sup>2</sup> Our study is more closely related to the part of the behavioral corporate finance literature that explores

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<sup>2</sup>Baker, Ruback, and Wurgler (2007) survey the literature that examines the relation between corporate policies and behavioral characteristics of corporate managers and investors. See Hirshleifer (2015) for a recent review of behavioral finance. Hackbarth (2008) shows theoretically that overconfident managers tend to choose higher debt levels. Bernardo and Welch (2001), Gervais et al. (2011), and Goel and Thakor (2008) endogenize CEO overconfidence and consider the impact of CEO overconfidence on shareholders. Heaton (2002) examines how managerial optimism affects corporate policies, de Meza and Southey (1996) and Landier and Thesmar (2009) examine financial contracting with optimistic managers, and Bergman and Jenter (2007) link stock option compensation to employee optimism.

the effect of CEO overconfidence or CEO optimism on corporate policies. Malmendier and Tate (2005) document that firms managed by overconfident CEOs exhibit a greater sensitivity of investment spending to internal cash flow. Malmendier and Tate (2008) show that overconfident CEOs are more likely to engage in acquisitions that are value-destroying. Malmendier et al. (2011) argue that overconfident managers perceive their firms to be undervalued and are reluctant to raise funds through costly external sources. They find that the reluctance of overconfident CEOs to raise funds through external sources leads to both a pecking order of financing and debt conservatism. Hirshleifer, Low, and Teoh (2012) show that overconfident CEOs exploit innovative growth opportunities by increasing investment in risky projects. Ben-David et al. (2013) find that optimism among top corporate executives is associated with increased corporate investment. Deshmukh et al. (2013) show that firms managed by overconfident CEOs pay lower dividends. Our results are consistent with the central thesis of this literature that behavioral characteristics of CEOs affect corporate policies.

Finally, we add to the empirical literature on behavioral corporate finance by documenting qualitatively similar findings using the measures of optimism in Campbell et al. (2011), based on the Execucomp sample, and in Malmendier and Tate (2005, 2008), based on a sample of large firms compiled by *Forbes* magazine. Campbell et al. (2011) draw on Malmendier and Tate (2005, 2008) to develop their measure of CEO optimism. Our overall results suggest that the optimism measure developed by Campbell et al. (2011) serves as a reasonable alternative to the optimism measures developed by Malmendier and Tate (2005, 2008). The Execucomp dataset, with more recent coverage and many more firms, should provide researchers with an opportunity to explore many new issues in behavioral corporate finance.

The paper proceeds as follows. In Section II, we develop a model of cash holdings and CEO optimism. Section III describes the data and the variables. Section IV presents the empirical results. Section V summarizes our findings and discusses the implications of the study.

## II. MODEL

In this section, we present a model in which cash holdings are based on a comparison of the costs of current and future external financing. We begin with a numerical example to illustrate the intuition underlying the model.

**A. An Example.** Consider a firm that is waiting to see how its current product performs in the market. The firm will invest in follow-on products, Product A and Product B. Each of these products will be a “hit” with probability  $p$  and a “miss” with probability  $1 - p$ . A hit product will return \$2 if \$1 is invested and \$3.50 if \$2 is invested. A miss product returns 0. The probability  $p$  that either of these products is a hit depends on how the current product fares. If it is successful, then  $p = 0.85$ , otherwise  $p = 0.6$ . The firm will invest in Product A before observing the performance of its current product and in Product B after observing the performance of its current product.

Assume that the interest rate is zero. If the current product is successful, then the firm should invest \$2 in Product B because its net present value (NPV) of  $\$3.5 \times 0.85 - \$2 = \$0.975$  is higher than the NPV of  $\$2 \times 0.85 - \$1 = \$0.70$  from an investment of \$1. If the current product is not successful, then the firm should invest \$1 in Product B because its NPV of  $\$2 \times 0.6 - \$1 = \$0.20$  is higher than the NPV of  $\$3.50 \times 0.6 - \$2 = \$0.10$  from an investment of \$2. The firm will invest optimally in Product B, either using existing cash or through cash raised from investors who will share the same beliefs as the management based on the performance of the current product.

The investment in Product A, however, is made before observing the performance of the current product and depends on beliefs about the probability that the current product will be successful. Suppose the CEO believes that this probability is 0.6. Based on these beliefs, the probability that Product A will be a hit is  $0.6 \times 0.85 + 0.4 \times 0.6 = 0.75$ . The CEO prefers investing \$2 in Product A (NPV of \$0.625) to investing \$1 (NPV of \$0.50) in the absence of any financing constraints. Suppose that investors consider the CEO’s beliefs to be optimistic and estimate the probability of success of the current product to be only 0.1. They infer that Product A will be a hit with probability  $0.1 \times 0.85 + 0.9 \times 0.6 = 0.625$  and based on these beliefs, they consider an investment of \$1 in Product A (NPV of \$0.25) to be more value-enhancing than an investment of \$2 (NPV of \$0.1875). In the absence of external

financing requirements, the CEO will invest \$2 in Product A despite the disagreement with the investors.

However, investors' beliefs can influence the CEO's actions when investors determine the terms of financing available to the firm. One impact is the reduction in investment. Suppose the firm raises debt financing and debtholders are repaid only if Product A is a hit. Investors believe that this will occur with probability 0.625 so for each \$1 they invest, they demand repayment of  $\$1/0.625 = \$1.60$ , resulting in an expected repayment of \$1. The CEO believes that for each \$1 that debt investors provide, they will get back \$1.60 with probability 0.75 resulting in an expected repayment of \$1.20, and therefore, considers debt financing to be too costly. As a result, despite optimistic beliefs, the CEO will invest only \$1 because the shareholders' payoff net of debtholders' repayment equals  $\$2 - \$1.6 = \$0.40$ , which is higher than the payoff of  $\$3.50 - \$3.20 = \$0.30$  with an investment of \$2.

The other impact of the CEO's optimism is on cash policy. In addition to its investment needs for Product A, the firm holds excess cash for other uses of cash, e.g., transactions and precautionary needs (Opler et al., 1999). The amount of this excess cash depends on the benefits and costs of keeping excess cash. We assume that the net cost of keeping excess cash  $C$  is  $(C - 0.50)^2$ . This cost is minimized at excess cash of \$0.50. The optimistic CEO trades off this cost with the perceived cost of external financing. Assuming that the firm has no initial cash, the firm raises \$1 for investment in Product A and an additional  $C$  for maintaining excess cash. The CEO believes that shareholders' expected payoff, net of the cost of maintaining excess cash and the debt repayment, is  $C - (C - 0.50)^2 - 0.75 \times 1.6 \times (1 + C)$  which is maximized at  $C = \$0.40$ , less than the cash balance of \$0.50 that a rational CEO holds.

Thus, the key takeaway is that the CEO will hold less excess cash than the level which minimizes the costs of holding excess cash. The reason is that the CEO considers external financing to be too costly. Note that even though the CEO considers external financing to be too costly, he/she does not hoard cash for investing in Product B. The reason is that the CEO expects the temporary underpricing of debt securities to vanish before investing in Product B because, by then, the market would have learned about the performance of the current product. We now present the full model.

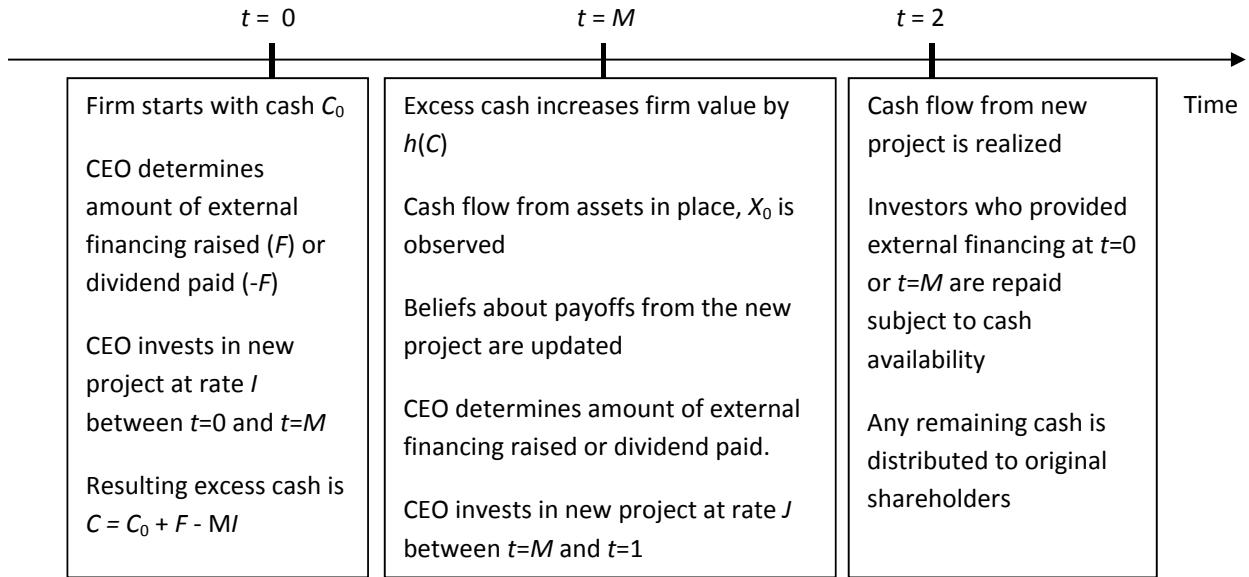


FIGURE 1. Timeline

B. **Timeline.** Consider a firm that is managed by a CEO who acts in the interest of original shareholders. All agents are risk neutral and the discount rate is zero. The firm starts with assets in place (existing projects) at time  $t = 0$  that result in cash flow at time  $t = M$ , where  $0 < M < 1$  indicates the maturity of the assets in place. The firm also pays out cash and/or raises external financing at time  $t = 0$  and at time  $t = M$ , invests continuously in a new project between  $t = 0$  and  $t = 1$ , and gets liquidated after realizing its final cash flow at time  $t = 2$ . Figure 1 shows the timeline of events.

C. **Investment Payoffs.** The assets in place have a maturity  $M$ . So the payoff  $X_0$  from the assets in place is realized at  $t = M$ , after investment in the new project has started ( $M > 0$ ) and before the investment in the new project is completed ( $M < 1$ ). The investment in the new project is made continuously over time with each instantaneous investment contributing to the aggregate payoff from the project at  $t = 2$ . Each instantaneous investment can be viewed either as a stage of a single lumpy investment or as one of a series of multiple identical atomic investments available to the firm at different points in time. Viewing investment as a continuous process allows us to distinguish between investment decisions made before the realization of cash flow at  $t = M$  and investment decisions made after  $t = M$ . An investment at the rate of  $I_t$  in an infinitesimal time interval  $dt$  at time  $t$  contributes  $X_t dt$  to the cash

flow at  $t = 2$  where

$$X_t = \begin{cases} 0 & \text{with probability } \pi_l \\ f(I_t) & \text{with probability } \pi_m \\ af(I_t) & \text{with probability } \pi_h \end{cases}$$

where  $f$  is an increasing and concave function,  $a \geq 1$  is a constant, and  $\pi_l, \pi_m$ , and  $\pi_h$  are probabilities of low, medium, and high project payoffs, respectively. These probabilities are unknown and are determined by an unobserved quality of the firm. This firm quality also impacts the payoff from assets in place such that a higher value of  $X_0$  indicates a higher quality and hence a higher value of  $X_t$ . Specifically,  $\pi_l(X_0)$  is decreasing in  $X_0$  (or equivalently  $\pi_h(X_0) + \pi_m(X_0)$  is increasing in  $X_0$ ) and  $\pi_h(X_0)/\pi_m(X_0)$  is increasing in  $X_0$ . Since new information is revealed only at  $t = M$ , the rate of investment chosen by the firm will not change between the interval  $t = 0$  to  $t = M$  or between the interval  $t = M$  to  $t = 1$ . Let the rate of investment be  $I$  per unit time before  $t = M$  and  $J$  per unit time after  $t = M$ .

**D. Preferred Cash Balance.** The firm starts with a cash balance of  $C_0$  at  $t = 0$ . Let  $F$  be the net amount raised by the firm between dates  $t = 0$  and  $t = M$ . For simplicity, we assume that the financing or payout decisions are taken at  $t = 0$  and then at  $t = M$  as no new information is revealed between these two points in time. If  $F$  is positive, the firm raises  $F$  through external financing and if  $F$  is negative, the firm pays out  $-F$  to investors. A part of the resulting cash balance is used to invest an amount  $M \times I$  before  $t = M$ . The cash balance that is in excess of the investment needs between  $t = 0$  and  $t = M$  is

$$C = C_0 + F - MI. \quad (1)$$

We call this cash balance excess cash, which is not used to meet investment needs before  $t = M$ . It can, however, be used to partly finance investment made after  $t = M$ , with the rest supplied by any additional capital that the firm raises at  $t = M$ . The firm's choice of the excess cash balance is also affected by other factors such as transactional motives, precautionary cash needs, and agency costs of excess cash. Without explicitly modeling such factors, we assume that there is an optimal cash balance and any deviation of excess cash balance from this optimum is costly. Specifically, we assume that the excess cash balance of  $C$  results in expected incremental firm value of  $h(C)$  at  $t = M$  where  $h(C^*) = C^*, h'(C^*) = 1, h'' < 0$ , and  $C^*$  is the optimal excess cash balance.

**E. Investment and Financing Decisions After  $t=M$ .** At  $t = M$ , both the CEO and the investors observe the realized cash flow ( $X_0$ ) and update their beliefs about the probability distribution of new investment ( $\pi_l$ ,  $\pi_m$ , and  $\pi_h$ ). Since the CEO and the investors share the same beliefs, external financing is fairly priced and the investment decision after  $t = M$  is independent of the financing policy. That is, the CEO chooses the NPV-maximizing investment rate  $J$  such that:

$$(\pi_m + a\pi_h) f(J) - J \geq (\pi_m + a\pi_h) f(J') - J' \quad \forall J'.$$

**F. CEO Optimism.** We now consider the possibility that the investors and the CEO disagree about the quality of the firm's projects before  $t = M$ . The CEO believes that the probability distribution of the payoff  $X_0$  from assets in place is  $g(X_0, p)$  where  $p$  is the CEO's degree of optimism. A value of  $p = 0$  indicates beliefs that coincide with those of the investors and a higher value indicates greater optimism while negative values indicate pessimism. We assume  $p > 0$ . Investors believe that the probability distribution of  $X_0$  is  $g(X_0, 0)$ . A higher value of  $p$  in the probability distribution  $g(X_0, p)$  makes higher outcomes more likely. Specifically, we assume that  $g$  follows monotone-likelihood-ratio-property with respect to  $p$  so the ratio  $g(x_2, p)/g(x_1, p)$  is increasing in  $p$  for  $x_2 > x_1$ . Our analysis does not depend on whether the CEO's beliefs are correct or the investors' beliefs are correct. While we focus on the interpretation that the CEO is optimistic relative to rational investors, our results will also apply if the difference in beliefs arises from CEO's private information.

**G. Financing Terms Before  $t=M$ .** The terms of financing are chosen so that new investors expect to earn zero NPV on their investment in the firm. Since an optimistic CEO's beliefs diverge from those of the investors, the CEO may consider the financing decision to have a nonzero NPV. This difference of opinion can impact both the level and the form of financing. In general, agents take positions which promise higher payoffs in states that they consider more likely than do other agents. This phenomenon has been used to explain portfolio choices of investors (DeTemple and Murthy, 1994), the capital structure choice (Yang, 2013), and the existence of financial intermediaries (Coval and Thakor, 2005). Since the CEO is more optimistic about the prospects of the firm than are the investors, the CEO may prefer debt financing to equity financing, consistent with the finding in Malmendier

et al. (2011).<sup>3</sup> The new investors (debtholders) provide financing  $F$  and set the face value of debt to  $F/E_0[\pi_m + \pi_h]$  because they consider the probability of repayment to be  $E_0[\pi_m + \pi_h]$ . The subscript in the expectation operator indicates the degree of optimism in the beliefs used to calculate the expectation. Here, the subscript 0 indicates that the expectation is based on investors' beliefs that exhibit zero optimism:  $E_0[.] \equiv E[. | g(X_0, 0)]$ .

**H. CEO's Objective.** The CEO disagrees with the investors and believes that new investors will be repaid with probability  $E_p[\pi_m + \pi_h]$  where the expectation is computed based on the beliefs of the CEO whose degree of optimism is  $p$ :  $E_p[.] \equiv E[. | g(X_0, p)]$ . The CEO uses these beliefs in computing the impact of new financing on the value of the firm to original shareholders. The CEO's objective is to maximize

$$Z(I, C, p) \equiv h(C) + X_0 + M E_p [\pi_m + a\pi_h] f(I) - (C + MI - C_0) \frac{E_p [\pi_m + \pi_h]}{E_0 [\pi_m + \pi_h]} + (1 - M) E_p \left[ \max_J \{(\pi_m + a\pi_h) f(J) - J\} \right]. \quad (2)$$

The first term in the objective is the value of the excess cash balance, the second term is the cash flow from assets in place, the third term is the expected cash flow from the investment made before  $t = M$ , the fourth term is the expected repayment to new investors, and the last term is the expected NPV of the investment to be made after  $t = M$ . Note that the last term does not depend on excess cash  $C$ . That is, even if an optimistic CEO overestimates future cash flow or expects a different investment level than a rational CEO, these considerations do not impact cash balance as the CEO expects to be able to raise financing at fair terms and the NPV of future investments is independent of available cash in absence of financing frictions. The CEO chooses the investment rate  $I$  and the excess cash balance  $C$  to maximize this objective. The cash balance of the firm equals  $C + MI$ , the sum of the excess cash balance and the cash kept to meet investment needs before  $t = M$ .

**I. Investment Policy.** The investment rate  $I$  that maximizes the CEO's objective (2) is given by the following first order condition:

$$E_p [\pi_m + a\pi_h] f'(I) = \frac{E_p [\pi_m + \pi_h]}{E_0 [\pi_m + \pi_h]}. \quad (3)$$

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<sup>3</sup>Our analysis goes through with equity financing too. Note that there is no distinction between equity and debt financing in the model if we choose  $a = 1$ .

A rational CEO chooses the NPV-maximizing investment rate  $I^*$  that is obtained from the above equation by substituting  $p = 0$ :

$$f'(I^*) = \frac{1}{E_0[\pi_m + a\pi_h]}. \quad (4)$$

If the CEO's beliefs differ from those of investors, the investment rate  $I$  is increasing in the CEO's degree of optimism. To see this, we rewrite (3) as

$$f'(I) = \frac{1}{E_0[\pi_m + \pi_h]} \left( 1 - \frac{a-1}{a + E_p[\pi_m]/E_p[\pi_h]} \right). \quad (5)$$

The ratio  $E_p[\pi_m]/E_p[\pi_h]$  is decreasing in  $p$  because a higher  $p$  makes a higher  $X_0$  more likely and a higher  $X_0$  increases the ratio  $\pi_h/\pi_m$ .<sup>4</sup> An increase in  $p$  lowers the ratio  $E_p[\pi_m]/E_p[\pi_h]$ , which lowers the right side of (5), and to maintain equality, the left side of (5) must be lowered by increasing  $I$ .

The intuition for this result is that as CEO optimism increases, it has three effects on the CEO's choice of investment. First, a more optimistic CEO estimates a higher value of the probability  $\pi_m + \pi_h$  that the project will have a positive payoff. This increases the CEO's estimate of the NPV of the project. Second, a more optimistic CEO estimates a higher value of the probability  $\pi_m + \pi_h$  of repayment to debt investors. However, as debt is priced using investors' lower estimation of the probability of repayment, the CEO perceives debt to be more underpriced. In the special case of  $a = 1$ , high and medium payoffs coincide and the only difference in beliefs is about the probability of repayment. The overestimation of project NPV is exactly offset by the overestimation of the cost of external financing because both are caused by an overestimation of  $\pi_m + \pi_h$ , so an optimistic CEO invests the same amount as the rational CEO. However, if  $a > 1$ , there is a third effect. The CEO also overestimates the probability of high payoff ( $\pi_h$ ) relative to the probability of medium payoff ( $\pi_m$ ), which further increases the NPV of the investment without affecting the perceived underpricing of debt. So if  $a > 1$ , a more optimistic CEO invests more, even though the CEO believes that the external financing is too costly.

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<sup>4</sup>Formally,  $\frac{E_p[\pi_m]}{E_p[\pi_h]} = \frac{\int \pi_m(x)g(x,p)dx}{\int \pi_m(x)\{\pi_h(x)/\pi_m(x)\}g(x,p)dx}$ . Since  $\pi_h(x)/\pi_m(x)$  is increasing in  $x$  and  $g$  follows monotone-likelihood-ratio-property,  $\frac{E_p[\pi_m]}{E_p[\pi_h]}$  is decreasing in  $p$  by Chebyshev's inequality.

**J. Cash Policy.** The excess cash balance  $C$  that maximizes the CEO's objective (2) is given by the following first-order condition:

$$h'(C) = \frac{E_p [\pi_m + \pi_h]}{E_0 [\pi_m + \pi_h]}. \quad (6)$$

For a rational CEO, the above condition is satisfied at the preferred cash balance  $C^*$ . However, if the CEO's beliefs differ from those of investors, the excess cash balance  $C$  is decreasing in the CEO's degree of optimism. To see this, consider a value for optimism  $p$  and a value for excess cash  $C$  that satisfy (6). For a more optimistic CEO, a higher value of  $p$  increases the right side of (6). To restore equality in (6), the left side must be increased by lowering  $C$ .

The intuition for this result is that as CEO optimism increases, the CEO overestimates future cash flows of the firm and consequently perceives financing to be more costly. The CEO's perceived cost of maintaining an excess cash balance is increasing in the CEO's optimism. However, the benefit of holding an excess cash balance (over and above the investment needs before  $t = M$ ) does not depend on optimism because the CEO expects the firm to raise financing at a zero NPV at  $t = M$ . As a result, the CEO chooses to hold lower excess cash.

The total cash balance of the firm consists of cash kept for investment before  $t = M$  and excess cash. We have shown that the former is increasing in CEO optimism while the latter is decreasing in CEO optimism. The total cash can be increasing or decreasing in CEO optimism depending on the relative size of cash kept for meeting investment needs and the excess cash retained for other reasons.

Note that the excess cash maintained by an optimistic CEO does depend on the size of investment needs after  $t = M$ . The reason is that investment needs after  $t = M$  can be met by either raising external financing earlier and maintaining a higher cash balance until  $t = M$  or by keeping a lower cash balance until  $t = M$  and then raising external financing. An optimistic CEO prefers the latter policy because he/she considers external financing to be too costly before  $t = M$ . Moreover, the CEO believes that the payoff from assets in place will be high at  $t = M$  and after observing that high payoff, investors will revise upwards their perception of the firm's projects' quality and offer financing on more advantageous terms.

While a rational CEO does not view financing as unduly costly, the CEO has no incentive to raise financing early for investment needs after  $t = M$ .

Thus, the firm maintains a cash balance only to meet investment needs before  $t = M$  but not for investment needs after  $t = M$ . This distinction between the two investment needs arises from the optimistic CEO's beliefs that financing costs will decline over time. Note that it is not important whether the CEO considers current or future investment opportunities to be more valuable. Thus, our explanation, based on the CEO's beliefs that the views of the CEO and the investors will converge over time, is distinct from a market timing explanation based on beliefs about time variation in investment opportunities.

The total cash held by the firm is  $C + MI$  where the investment rate  $I$ , determined by (5), is (weakly) increasing in CEO optimism, and the excess cash  $C$ , determined by (6), is decreasing in CEO optimism. If assets in place have a longer maturity ( $M$  is larger), then investment needs form a bigger fraction of the cash balance compared to excess cash and greater optimism results in a smaller decline in the total cash balance.<sup>5</sup> That is, optimistic CEOs hold a smaller cash balance when they expect cash flows from assets in place to be realized relatively early. However, if the CEO expects the difference of opinion to persist over a long period because assets in place are long-lived, then the reduction in excess cash is offset by the higher cash that the CEO raises to meet investment needs.

**K. Extension: Growth Opportunities.** We have shown that an optimistic CEO determines the firm's cash balance to meet investment needs based on a trade-off between the current and future costs of external financing. Since this trade-off depends on the relative size of current and future investment needs, the effect of CEO optimism on cash holdings is likely to depend on growth opportunities that determine the future investment needs of the firm.

To examine the effect of growth opportunities on an optimistic CEO's cash balance, we interpret growth opportunities, hereafter termed growth, as a measure of investment opportunities available after  $t = M$ . We noted earlier that the firm does not hold additional cash to meet investment needs after  $t = M$ . However, empirical evidence (see Opler et al., 1999)

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<sup>5</sup> $\partial^2(C + MI)/\partial p \partial M = \partial I/\partial p > 0$ .

that higher-growth firms hold more cash suggests there may be frictions, such as transaction costs of external financing, that induce firms to hold additional cash to meet growth needs.

We now assume that the firm may keep extra cash  $K$  to meet its growth needs, which is in addition to the cash kept for investment needs before  $t = M$  and for transactional and precautionary purposes. If a firm with growth  $g$  keeps extra cash  $K$  to meet its growth needs, then the marginal value of this cash is  $V(K/K^*(g))$ , where  $V$  is positive and decreasing, and  $K^*$ , a measure of cash needed for growth, is an increasing function. The optimal value of  $K$  is obtained by equating this marginal value of cash to the marginal cost of cash given by the right side of (6). A rational CEO keeps  $K = K^*(g)V^{-1}(1)$  to meet its growth needs while an optimistic CEO chooses a lower amount  $K = K^*(g)V^{-1}\left(\frac{E_p[\pi_m + \pi_h]}{E_0[\pi_m + \pi_h]}\right)$ .<sup>6</sup> Thus, the increase in cash holdings associated with higher growth is decreasing in CEO optimism. The intuition is that the cost of financing perceived by the optimistic CEO offsets the benefit of raising cash to meet future growth needs.

**L. Hypotheses.** Our model predicts the following three hypotheses:

**Hypothesis 1.** *Firms led by optimistic CEOs hold less cash than firms led by rational CEOs. This follows from Section J.*

**Hypothesis 2.** *The difference between the total cash held by a rational CEO and the total cash held by an optimistic CEO is smaller in a firm with longer maturity of assets ( $M$ ). This follows from Section J.*

**Hypothesis 3.** *The difference between the cash held by higher-growth firms and lower-growth firms is smaller in firms led by optimistic CEOs than in firms led by rational CEOs. This follows from Section K.*

In our empirical analysis, we test Hypotheses 1 and 3.

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<sup>6</sup>We assume the effect of CEO optimism on beliefs is same across higher-growth and lower-growth firms. If this effect varies across firms, CEO optimism may have a greater impact on cash holdings and other cash policies in firms where CEO optimism leads to a greater divergence of CEO's beliefs from rational beliefs.

### III. DATA AND VARIABLES

Our initial sample of firms is drawn from Standard and Poor's Execucomp database over the period 1992-2012. From this initial sample of firm-year observations, we eliminate observations for financial firms (SIC 6000-6999), utilities (SIC 4900-4999), and regulated telephone companies (SIC 4813). These data filters result in 19,328 firm-year observations for 2,172 firms for our main empirical analysis. We supplement the option-compensation data from Execucomp with various items from the COMPUSTAT database to construct our control variables.

We use the data on option compensation from the Execucomp database to construct our CEO optimism measures. Options typically represent a large component of CEO compensation packages. CEOs also have their human capital invested in the firm. Taken together, these effects cause CEOs to be underdiversified and thus highly exposed to company-specific risk. The options issued to CEOs are non-tradeable and the CEOs are typically prohibited from hedging their exposure by short selling their company stock. Underdiversified CEOs should rationally exercise their options early if they are sufficiently deep in-the-money (Hall and Murphy, 2002). An optimistic CEO, however, overestimates the expected value of the firm's future payoff and perceives the firm's stock to be undervalued. So, despite being underdiversified, an optimistic CEO is less likely to exercise stock options and thus holds the options longer than his/her rational counterparts. Malmendier and Tate (2005, 2008) use this rationale to derive portfolio-based CEO overconfidence measures based on the option-exercise behavior of CEOs. This rationale also underlies our measures of CEO optimism, *Optimism* and *Post-Optimism*. We now describe these two measures along with the various control variables we use in our empirical analysis.

*Optimism.* Malmendier and Tate (2005) classify CEOs as overconfident if they held options that were fully vested five years before expiration and were at least 67% in the money. As in Campbell et al. (2011), we adopt a threshold of 100% moneyness and set *Optimism* equal to one over all the CEO-years if the CEO held an option that was more than 100% in the money at least once during his/her tenure, and zero otherwise. The *Optimism* variable thus represents a fixed effect over all of a CEO's years. Unlike in Campbell et al. (2011), we do not require that the CEOs exceed the 100% moneyness threshold at least twice during

his/her tenure. The reason is that our focus in this paper is on the cash-holding behavior of optimistic CEOs relative to that of non-optimistic CEOs. In contrast, Campbell et al. (2011) examine the behavior of CEOs with high optimism, low optimism, and those who are moderately optimistic in the context of turnovers. Our requirement that CEOs exceed the 100% moneyness threshold only once in order to be classified as optimistic is consistent with that in Hirshleifer et al. (2012), who consider a 67% threshold. For robustness, however, we consider several alternative criteria for classifying CEOs as optimistic, based on both Campbell et al. (2011) and Hirshleifer et al. (2012), and show that our results are robust to these alternative classifications. We discuss these results in a later subsection.

Since the Execucomp database does not provide detailed data on the option holdings of a CEO or the exercise price associated with each option grant, we follow Campbell et al. (2011) to calculate the average moneyness of a CEO’s option holdings for each year in our sample period. First, we compute the realizable value per option as the ratio of the total realizable value of exercisable options to the number of exercisable options. Next, we subtract the realizable value per option from the fiscal-year-end stock price to obtain an estimate of the average exercise price of options. Last, to determine the average percentage moneyness of the options, we divide the realizable value per option by the estimated average exercise price.

In constructing *Optimism*, we face a trade-off between statistical power and effective identification of optimistic CEOs. We adopt a more conservative threshold of 100% moneyness, relative to the 67% cutoff in Malmendier and Tate (2005), to identify optimistic CEOs. However, this higher threshold also increases the likelihood that some optimistic CEOs get classified as non-optimistic. In this sense, the *Optimism* variable represents a noisy measure of optimism and CEOs not classified as optimistic may represent a mix of both rational and optimistic CEOs. For ease of exposition, we refer to the CEOs in this group as rational CEOs. The goal underlying our classification of CEOs is to ensure that the “optimistic” group is more likely to contain optimistic CEOs while the “rational” group is more likely to contain non-optimistic CEOs. Any noise in the *Optimism* variable likely introduces a bias against finding support for the hypothesized negative relation between cash holdings and CEO optimism.

*Post-Optimism.* Differences in optimism across people can arise from their inherent traits as well as life experiences (Gillham and Reivich, 2004). The *Post-Optimism* measure, also based

on the CEO’s option-exercise behavior, allows for time variation over the sample period and eliminates forward-looking information in the classification of a CEO. *Post-Optimism* equals one in all CEO-years following (and including) the first year in which the CEO holds an option that is more than 100% in the money, and zero otherwise. This measure is motivated by the *Post-Longholder* measure in Malmendier and Tate (2005, 2008) and is similar to the rationale underlying the high-optimism measure in Campbell et al. (2011).

*Control Variables.* The extant empirical literature indicates that cash holdings are influenced by many factors. In our empirical analysis, we control for factors shown to affect corporate cash holdings in Opler et al. (1999), Harford et al. (2008), and Bates et al. (2009). Specifically, we include growth, cash flow, firm size, leverage, net working capital, R&D expenditures, capital spending, acquisitions, bond rating, cash flow volatility, and CEO stock ownership. We also include CEO option ownership given that the variable *Optimism* is based on the CEO’s ownership of options.

We calculate *Growth* as the ratio of the market value of assets to net assets, where the market value of assets equals the market value of equity plus the book value of total liabilities and net assets equals the book value of total assets minus cash and short-term investments; *Cash Flow* as the ratio of operating income before depreciation less interest expense less income taxes less common and preferred dividends to net assets; *Leverage* as the ratio of the sum of long-term debt and debt in current liabilities to net assets; *NWC to Assets* as the ratio of net working capital (net of cash and short-term investments) to net assets; *RD to Assets* as the ratio of R&D expenditures to net assets (and set equal to zero if R&D is missing); *Capex to Assets* as the ratio of capital expenditures to net assets; *Acquisitions to Assets* as the ratio of acquisition expenditures to net assets; and *Cash Flow Volatility* as the standard deviation of the firm’s cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. We use the natural logarithm of sales, termed *Log of Sales*, as a proxy for firm size. For robustness, we use the natural logarithm of the book value of net assets as an alternative proxy for firm size. The CEO’s stock ownership, termed *Stock Ownership*, equals the company stock (excluding options) owned by the CEO as a fraction of common shares outstanding. The CEO’s option ownership, termed *Vested Options*, equals the ratio of the CEO’s holdings of exercisable options to common shares outstanding.

*Dependent Variable.* Following Opler et al. (1999), who note that a firm’s ability to generate future profits should depend on its non-cash assets, we use *Cash Holdings*, the ratio of cash and short-term investments to net assets, as our main dependent variable. However, Bates et al. (2009) argue that this measure of cash holdings can generate large outliers if firms hold most of their assets in cash. To reduce the potential problem of large outliers, we follow Foley, Hartzell, Titman, and Twite (2007) and use an alternative measure, *Log of Cash Holdings*, which equals the natural logarithm of one plus *Cash Holdings*. For robustness, we also estimate our main models using *Cash to Assets*, the main measure of cash holdings in Bates et al. (2009) and calculated as the ratio of cash and short-term investments to the book value of total assets.

Our treatment of data outliers is as follows. We trim *Cash Flow* at 0.5% to ensure that our results are not affected by outliers (Malmendier and Tate, 2005, 2008). We also trim *Growth* and *Cash Flow Volatility* at the 99.5% level, owing to the extremely large outliers. In addition, we remove about 1% of the observations for which the value of *Leverage* exceeds one. While all tabulated results reflect this treatment of the data, our main result regarding the negative relation between cash holdings and measures of CEO optimism is robust to including all the observations after winsorizing these four variables (at the respective levels at which we trim the observations).

#### IV. EMPIRICAL RESULTS

We begin our empirical analysis with univariate comparisons between subsamples with  $Optimism = 1$  (optimistic CEOs) and  $Optimism = 0$  (rational CEOs). Next, we perform a multivariate analysis by estimating a regression model of cash holdings as a function of CEO optimism and the control variables discussed in the previous section. Even though the univariate comparisons provide a general idea of the differences between firms managed by optimistic and rational CEOs, they do not account for the interaction among the various firm attributes in determining cash holdings. In contrast, the multivariate analysis that we perform allows us to investigate the marginal impact of CEO optimism on corporate cash holdings while controlling for other relevant factors. In all of the regression models, we control for both firm and year fixed effects and cluster standard errors by firm. We estimate

each model using those observations for which data are available on all variables for that model.

The summary statistics in Table 1 show that optimistic-CEO observations represent about 56% of the total firm-year observations. The mean and median values of cash holdings, our main variable of interest, are slightly higher for firms with optimistic CEOs. In addition, firms with optimistic CEOs have relatively higher CEO option ownership (as measured by vested options), higher growth, higher cash flow, higher R&D, higher capital expenditures, and higher CEO Tenure (tenure of the CEO with the firm in years).

[Table 1 here]

**A. Optimism and the Cash Level.** We estimate a regression model of cash holdings on the panel data for our sample firms. The independent variable of interest is CEO optimism. We also include the various control variables. The results from Model 1 in Table 2 indicate that the level of cash holdings is negatively related to CEO optimism and the coefficient is statistically significant at the 1% level. The results also indicate that the level of cash holdings is positively related to growth, cash flow, leverage, and R&D expenditures, and negatively related to firm size (as measured by the logarithm of sales), NWC, capital expenditures, acquisition expenditures, and the CEO's stock ownership. The coefficients on all of these control variables are statistically significant at either the 1% level or the 5% level and the results are generally consistent with the previous literature (Opler et al. (1999), Harford et al. (2008), and Bates et al. (2009)). Finally, the coefficients on bond rating, cash flow volatility, and vested options are not statistically significant at conventional levels.

[Table 2 here]

The negative coefficient on optimism indicates that the level of cash holdings is negatively related to the level of CEO optimism and is consistent with our main testable prediction (Hypothesis 1). The magnitude of the coefficient on optimism, which represents the incremental effect of CEO optimism on cash holdings, is 0.0208. This value is about 24% of the median level of cash holdings (of about 8.5%) for the overall sample. As an illustration of the economic significance of this coefficient, consider the median cash holdings of 6.99% for the sub-sample of non-optimistic CEOs. The cash holdings of a similar firm managed by an optimistic CEO will be about 30% lower, on average, at 4.91%.

In Model 2, we use post-optimism in place of the optimism variable. The overall results are qualitatively similar to those in Model 1. The coefficient on post-optimism is of a similar magnitude to that on optimism. The coefficient on post-optimism is also economically significant - its magnitude is roughly 24% of the median level of cash holdings (of about 8.5%) for the overall sample. In Models 3 and 4, we use log of cash holdings as the dependent variable. In Model 3, we estimate the model with optimism and in Model 4, we replace optimism with post-optimism. The coefficients on both optimism and post-optimism, respectively, continue to be negative and statistically significant at the 1% level. The coefficient on vested options is now negative and statistically significant at the 10% level or better. The rest of the results are qualitatively similar to those in Models 1 and 2.

**B. Optimism and Changes in the Cash Level.** We now examine the relation between the change in cash holdings and optimism. Based on the results in Table 2, we pose a simple follow-up question: given that optimistic CEOs hold a lower cash balance than rational CEOs, do they also accumulate cash at a lower level? In other words, are the changes in cash holdings lower in firms managed by optimistic CEOs? We follow Harford et al. (2008) and estimate a regression model with the change in cash holdings (over the fiscal year) as the dependent variable after including the lagged level of cash holdings as an explanatory variable. The rest of the explanatory variables are the same as in Table 2. Estimating this regression model allows us to explore whether CEO optimism can predict future cash holdings of the firm after controlling for the lagged value of cash holdings.

The results from Model 1 in Table 3 indicate that the change in cash holdings is negatively related to CEO optimism and the coefficient is statistically significant at the 1% level. Similarly, the results from Model 2 in Table 3 indicate that the change in cash holdings is negatively related to post-optimism and the coefficient is also statistically significant at the 1% level. The rest of the results are qualitatively similar to those in Table 2. In Models 3 and 4, we use the change in log of cash holdings as the dependent variable. In Model 3, we estimate the model with optimism and in Model 4, we replace optimism with post-optimism. The results are qualitatively similar to those in Models 1 and 2, respectively. For robustness, we also estimate the model with the change in cash to assets as the dependent variable. Again, the results remain qualitatively the same.

[Table 3 here]

**C. Endogeneity Concerns.** Our interpretation of the empirical results treats CEO optimism as exogenous. If CEO optimism is endogenously determined, then our results may be consistent with alternative explanations. We now consider and address these alternative explanations. First, the direction of causality may be the opposite of our interpretation. That is, cash holdings may impact CEO optimism. However, there is no prior theory or evidence to suggest this effect of cash holdings on CEO optimism. Moreover, if firms with low cash holdings attract optimistic CEOs, then this effect should remain cross-sectional. The negative relation between optimism and the temporal change in cash holdings that we document in Table 3 allays reverse causality concerns.

As a control for potential endogeneity arising from reverse causality, Harford et al. (2008) use the lagged value of their main explanatory variable when estimating their regression model of the change in cash holdings. We cannot do so with our main explanatory variable *Optimism*, which represents a CEO fixed effect. However, the post-optimism variable exhibits variation over time for a CEO when it switches from zero to one when the CEO is identified as “optimistic” and we exploit this variation by using its lagged value. The negative relation between change in cash holdings and (lagged) post-optimism remains statistically significant. Therefore, the negative effect of optimism on cash holdings, for a given CEO, is more pronounced after the CEO is identified as optimistic. This result cannot be explained by the effect of cash holdings on CEO optimism.

For another test to rule out reverse causality, we create a variable, Pre-Optimism, which equals one for those CEO years where Optimism equals one and Post-Optimism equals zero. As explained earlier, Post-Optimism equals one in all those CEO-years that follow (and include) the year in which the CEO, for the first time, holds an option that exceeds the 100% moneyness threshold. This split of the Optimism indicator variable into Pre-Optimism and Post-Optimism variables captures the time variation in CEO option-exercise behavior and eliminates forward-looking information in the classification of a CEO.

We estimate Model 1 and Model 3 from Table 2 after replacing the Optimism variable with both Pre- and Post-Optimism variables. In untabulated results from both models, the coefficient on Post-Optimism is negative and statistically significant while the coefficient on Pre-Optimism is nonsignificant. These results from the refinement in our model specification suggest that the impact of optimism on cash holdings exists only after the CEO has exhibited

optimism by delaying option exercise. If the option-exercise behavior of CEOs is driven by the cash holdings of a firm, then there should not be such a systematic difference in the relation between optimism and cash holdings in the Pre- and Post-Optimism years.

Another endogeneity concern is that a CEO's optimism (or option-exercise behavior) and the firm's cash policy may both be jointly determined by some other exogenous factor. For example, a CEO's private information may impact his/her option exercise behavior as well as cash policy. Our model and empirical analysis are both based on differences in beliefs between CEOs and investors and regardless of whether these differences arise from exogenous psychological biases or endogenous informational differences. The tests discussed above show that the effect on cash holdings follows the effect on CEO optimism, suggesting the causal effect of CEO optimism on cash holdings. However, in general, we cannot employ econometric techniques such as two-stage procedures to rule out the joint determination of CEO optimism and cash holdings because of the unavailability of exogenous factors that impact CEO optimism but are unrelated to cash holdings.

Fee, Hadlock, and Pierce (2013) highlight a board's CEO choice as one factor that may affect CEO style and corporate policies and propose that this endogeneity may affect tests of managerial-style effects. They suggest that managerial style inferred from management changes may not represent causation as boards may simultaneously change the firm's leadership and corporate policies. Their criticism is focused on the determination of managerial style with manager fixed effects, which may be capturing the effect of the board's policy changes. This criticism is inapplicable in our case because our measure of CEO optimism is determined solely by the CEO's option-exercise behavior and does not use any data on corporate policies. More generally, Fee et al. (2013) highlight that CEO selection is endogenous so one interpretation of our results can be that boards simultaneously choose optimistic CEOs and reduce cash holdings. Even this interpretation suggests that optimistic CEOs hold less cash and it is not clear why boards that want to lower cash holdings would choose optimistic CEOs if CEO optimism has no effect on cash holdings.

**D. Alternative Sample and Optimism Measure: Cash Holdings and Change in Cash Holdings.** We examine the implications of our model and the ensuing testable hypotheses using both an alternative sample and an alternative measure of optimism. The sample is identical to that in Malmendier and Tate (2005, 2008) and contains 477 firms. It is

based on the samples used in Yermack (1995) and in Hall and Liebman (1998) and consists of those firms that appear at least four times in one of the lists of the largest U.S. companies compiled by *Forbes* magazine over the period 1984-1994. This dataset provides detailed information on CEO stock and stock option holdings. Malmendier and Tate (2008) use the data on option holdings to derive their various portfolio-based optimism/overconfidence measures. In our tests below, we use *Longholder*, their main measure of CEO overconfidence.<sup>7</sup> To be consistent with our analysis thus far, we eliminate observations for financial firms (SIC 6000-6999), utilities (SIC 4900-4999), and regulated telephone companies (SIC 4813) from the panel data on the original sample of 477 firms. The data cover the period 1980-1994 and we supplement the above data on CEO overconfidence with various items from the COMPUSTAT database to construct our control variables. These data filters result in 2324 firm-year observations for 237 firms for our empirical analysis.

We estimate a regression model of cash holdings with *Longholder* as the independent variable of interest. The various control variables we include are the same as those in Table 2. The results from Model 1 in Table 4 indicate that the level of cash holdings is negatively related to *Longholder* and the coefficient is statistically significant at the 5% level. This result is consistent with our main testable prediction (Hypothesis 1) and with our findings in Table 2. The magnitude of the coefficient on *Longholder* is roughly of a similar magnitude to that on optimism in Table 2. The results also indicate that the level of cash holdings is positively related to growth, cash flow volatility, and vested options and negatively related to capital expenditures and acquisition expenditures. The coefficients on all of these control variables, with the exception of vested options, are statistically significant at the 5% level or better and these results are generally consistent with the previous literature. Finally, the coefficients on bond rating, log of sales, NWC to assets, cash flow, leverage, RD to assets, and stock ownership are not statistically significant at conventional levels.

[Table 4 here]

The magnitude of the coefficient on *Longholder*, which represents the incremental effect of CEO optimism on cash holdings, is 0.0265. This value is about 55% of the median level

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<sup>7</sup>Longholder is an indicator variable that identifies CEOs who hold an option until the year of expiration at least once during their tenure even though the option is at least 40% in the money. This variable (akin to our optimism variable) represents a fixed effect over all of a CEO's years.

of cash holdings (of about 4.8%) for the overall sample. As an illustration of the economic significance of this coefficient, consider the median cash holdings of 4.7% for the sub-sample of non-optimistic CEOs. The cash holdings of a similar firm led by an optimistic CEO, on average, will be about 56% lower at 2.05%. In Model 2, we use log of cash holdings as the dependent variable. The results indicate that the coefficient on Longholder is negative and statistically significant at the 10% level. The rest of the results are qualitatively similar to those in Model 1.

Next, we examine the relation between the change in cash holdings and Longholder in Model 3 of Table 4. As in Table 3, we include the lagged level of cash holdings as an explanatory variable. The rest of the explanatory variables are the same as in Model 1 of Table 4. The results from Model 3 indicate that the Change in Cash Holdings is negatively related to Longholder and the coefficient is statistically significant at the 5% level. The rest of the results are qualitatively similar to those in Model 1. In Model 4, we use the change in log of cash holdings as the dependent variable. Again, the change in cash holdings is negatively related to Longholder and the coefficient is statistically significant at the 5% level.

The qualitatively similar findings that we document for the two alternative measures of optimism indicate that the optimism measure based on Execucomp data captures the notion of CEO optimism reflected in the measure developed by Malmendier and Tate (2005, 2008). Since the Execucomp dataset covers a recent time period and many more firms, it should provide researchers with an opportunity to explore many new issues in behavioral corporate finance.

**E. Robustness Checks.** We consider alternative moneyness thresholds to identify optimistic CEOs. First, as in Malmendier and Tate (2005) and in Hirshleifer et al. (2012), we adopt a moneyness threshold of 67% and create Optimism67, which equals one over all the CEO-years if the CEO held an option that was more than 67% in the money at least once during his/her tenure and zero otherwise. We construct two more measures, OptimismTwice and Post-OptimismTwice. For these two measures, we follow Campbell et al. (2011) and focus on those CEOs who fail to exercise their options at least *twice* when the options are at least 100% in the money. We set OptimismTwice equal to one over all the CEO-years if the CEO held an option, that was more than 100% in the money, at least twice during his/her

tenure, and zero otherwise. Post-OptimismTwice equals one in all CEO-years following (and including) the first year in which the CEO holds an option, that is more than 100% in the money, at least twice during his/her tenure, and zero otherwise.

We estimate Model 1 and Model 3 from Table 2 by successively replacing Optimism with each of the three alternative measures: Optimism67, OptimismTwice, and Post-OptimismTwice. For both models and for each of these three optimism measures, we find that the coefficient on the optimism measure is negative and statistically significant at the 5% level.

We perform several other robustness checks of the results in Model 1 and Model 3 from Table 2 by estimating the relation between Optimism and two measures of cash holdings. Our main result with respect to the negative relation between cash holdings and optimism continues to hold qualitatively in these robustness checks which consist of replacing the natural logarithm of sales with the natural logarithm of the book value of net assets, clustering standard errors by CEO instead of by firm, using industry fixed effects (at the two-digit SIC level) instead of firm fixed effects, and using *Cash to Assets* as the dependent variable.<sup>8</sup>

The summary statistics in Table 1 indicate that optimistic CEOs have a longer CEO tenure. A positive association between optimism and CEO tenure is likely to arise mechanically given the way we construct CEO optimism. While there is no theoretical rationale for a relation between cash holdings and CEO tenure, we perform a robustness check to examine whether the relation between cash holdings and optimism simply represents a relation between cash holdings and CEO tenure. We estimate our main models after including CEO tenure and find that the relation between cash holdings and optimism remains negative and statistically significant.

Malmendier et al. (2011) use a measure of optimism, based on Execucomp data and calculated the way we do, and control for past stock return performance. We estimate both Model 1 and Model 3 after including five lags of annual stock return and find that the negative relation between cash holdings and optimism is robust to the inclusion of past stock return performance.

Many studies such as Opler et al. (1999) and Bates et al. (2009) include a dividend dummy (indicator) variable as an explanatory variable. This variable is used to proxy ease of access to external capital markets and is hypothesized to have a negative effect on cash

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<sup>8</sup>All of the results from the various robustness checks are available, upon request, from the authors.

holdings. Other studies such as Harford et al. (2008) use both a dividend dummy and a bond rating dummy. In Table 1, we use a bond rating dummy variable. We do not use the dividend dummy due to endogeneity concerns arising from the negative effect of CEO overconfidence on a firm's dividend payout documented in Deshmukh et al. (2013). As a check, we estimate both Model 1 and Model 3 after including both the bond rating dummy variable and a dividend dummy variable, which equals one if the firm pays dividends and zero otherwise. Our untabulated results indicate that the negative relation between cash holdings and optimism remains significant.

Our measures of optimism are based on the option-exercise behavior of the CEO, which may be determined by factors other than optimism. However, Malmendier and Tate (2005, 2008) rule out several alternative interpretations of the Longholder measure, which include taxes, board pressure, corporate governance, inside information, signaling, variation in volatility, and inertia. A CEO may postpone option exercise to defer a tax liability. However, personal income tax deferral by the CEO does not predict lower cash holdings for the firm. Board pressure may affect CEO's option-exercise behavior. Since board composition tends to be stable over time, our inclusion of firm fixed effects should control for differences in board influence and corporate governance. If CEOs hold options longer due to a higher willingness to take risk, then their preferences are likely to be better aligned with diversified investors and their beliefs will coincide with those of investors. It is unlikely that these CEOs face greater financing frictions that cause them to hold lower cash. Moreover, we control for cash flow volatility, a measure of risk and stock ownership and vested options, which are likely to depend on the CEO's risk preferences. Thus, alternative interpretations of our optimism measure are unlikely to explain our findings.

The precautionary motive ascribed for maintaining cash balance is that a cash buffer can protect a firm against adverse cash flow shocks (Bates et al., 2009). If optimistic CEOs underestimate the risk of adverse cash shocks, they may see less need for precautionary cash. This may be another rationale for optimistic CEOs to hold less cash. However, this is unlikely to have a large effect on cash holdings as our results reported in Table 2 show that cash volatility is not a significant predictor of cash holdings in our data.

**F. Interaction Effects.** We now examine the interactive effects of both growth and cash flow with optimism on a firm's cash policy.

*Interactive Effect of Optimism and Growth.* Hypothesis 3 states that the difference between the cash holdings of higher-growth firms and lower-growth firms is smaller in firms led by optimistic CEOs than in firms led by rational CEOs. We estimate the regression model of cash holdings in Model 1, Table 2 by including the interaction between optimism and growth. The results in Model 1, Table 5 indicate that the coefficient on growth is positive while the coefficient on the interaction between growth and optimism is negative. Both of these coefficients are significantly different from zero at the 1% level.

The positive coefficient on growth indicates that a rational CEO in a higher-growth firm holds more cash than a similar CEO in a lower-growth firm. The negative coefficient on the interaction term, however, shows that the increase in cash holdings resulting from higher growth is lower in firms managed by optimistic CEOs. This result is consistent with Hypothesis 3. The coefficient on the interaction term is also economically significant in that the marginal impact of growth on cash holdings is about 34% lower in firms managed by optimistic CEOs. Since optimistic CEOs expect the terms of financing to improve over time, they prefer to finance the greater future investment needs through external financing in the future rather than through internal cash accumulated by raising external financing earlier. We obtain qualitatively similar results with respect to both growth and the interactive effect when we use Post-Optimism (Model 2) in place of Optimism and when we use the alternative sample and the Longholder measure (Model 3).

[Table 5 here]

*Interactive Effect of Optimism and Cash Flow: Cash-Flow Sensitivity of Cash.* Two determinants of a firm's cash holdings are cash flow (Harford et al., 2008) and CEO optimism (Table 2 and Section A). Malmendier and Tate (2005) show that CEO optimism and cash flow interact in determining investment spending. Specifically, CEO overconfidence (or optimism) strengthens the positive relation between cash flow and investment spending. Since investment spending also affects cash holdings, we expect optimism and cash flow to interact in determining a firm's cash holdings.

Our model provides a theoretical rationale for this interactive effect. In the model, an optimistic CEO and a rational CEO differ in their beliefs about the unknown quality of the firm until this uncertainty is resolved at  $t = M$ . However, prior to  $t = M$ , there is no learning about quality and the optimistic CEO overestimates the value of the firm

relative to a rational CEO. Now, suppose that the cash flow realized from past investments is correlated with firm quality. If optimistic CEOs exhibit an attribution bias, then they will view a higher cash flow as a validation of their beliefs, widening the divergence between the CEO's estimate of firm quality and a rational investor's estimate of firm quality.<sup>9</sup> The optimistic CEO will then view current external financing as even more costly, causing the difference between the cash balances held by optimistic and rational CEOs to increase. In contrast, if the firm realizes a lower cash flow, then the divergence in the estimates of firm quality, between optimistic and rational CEOs, will not increase and the difference between their cash balances will not widen. Therefore, for a given increase in cash flow, the increase in cash holdings in a firm led by an optimistic CEO will be smaller than that in a firm led by a rational CEO.

We examine the interactive effect of optimism and cash flow on a firm's cash holdings by using the empirical framework in Almeida, Campello, and Weisbach (2004), who examine the effect of financial constraints on the relation between the change in cash holdings and cash flow. Specifically, they estimate the cash flow sensitivity of cash, which measures the change in cash holdings for a one-dollar increase in cash flow. Based on the theoretical rationale discussed above, we predict the cash flow sensitivity of cash to be lower in firms managed by optimistic CEOs.

We follow Almeida et al. (2004) and estimate a regression model with the change in cash holdings as the dependent variable. The explanatory variables are optimism, cash flow, cash flow interacted with optimism, growth, the logarithm of the book value of net assets as a proxy for firm size, capital expenditures, acquisition expenditures, change in net working capital, and change in short-term debt. Here, the change in cash holdings represents the net effect of several sources and competing uses of cash. Therefore, as in Almeida et al. (2004), we use an instrumental-variable (IV) approach to control for the potential endogeneity of investment and financial decisions in determining the change in cash holdings. We use the same set of instruments as in Almeida et al. (2004): two lags of the level of fixed capital (net property, plant, and equipment (PPE) to net assets), lagged acquisitions to net assets, lagged

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<sup>9</sup>Evidence from psychology documents that attribution bias leads people to interpret evidence in a way that strengthens their biased beliefs. Billett and Qian (2008) find evidence consistent with self-attribution bias leading to managerial overconfidence.

net working capital to net assets, lagged short-term debt to net assets, twice lagged sales growth, and two-digit SIC indicators. We estimate a fixed effects IV model, controlling for year effects. The standard errors are based on the conventionally-derived variance estimator for generalized least-squares regression.

The results from Model 1 in Table 6 indicate that the average firm in our sample exhibits a positive cash-flow sensitivity of cash. In other words, firms in our sample, on average, increase their cash holdings when they experience an extra dollar of cash flow. The coefficient on the interaction of optimism and cash flow, however, is negative and statistically significant at the 1% level. This negative sign suggests that firms managed by optimistic CEOs save less cash out of an extra dollar of cash flow than firms managed by rational CEOs. For example, the coefficient of about 0.60 on cash flow suggests that when cash flow increases by \$1, rational CEOs save about 60 cents. In contrast, the coefficient on the interactive term (of cash flow and optimism) of -0.30 suggests that when cash flow increases by \$1, optimistic CEOs save only about 30 cents. We obtain qualitatively the same result (in Model 2) when we use post-optimism in place of optimism. We also estimate this model on the alternative sample and the Longholder measure. The results, presented in Model 3, indicate that the main results are both quantitatively and qualitatively similar to those in Model 1. Specifically, the magnitude of the coefficient on cash flow is similar across both Model 1 and Model 3. In addition, the magnitude of the coefficient on the interactive term cash flow \* Longholder is similar to that on cash flow \* optimism.

Since optimistic CEOs behave as if they are financially constrained, we want to rule out the possibility that optimism might serve as a proxy for financial constraints. To do so, we estimate Model 1, Table 6 separately for financially constrained and unconstrained firms. We use two of the variables in Almeida et al. (2004) to identify constrained and unconstrained firms: the bond rating dummy and the dividend dummy. A value of zero for both of these variables identifies constrained firms while a value of one identifies unconstrained firms. In total, we estimate four models: two for constrained firms (i.e., bond rating dummy = 0 and dividend dummy = 0) and two for unconstrained firms (i.e., bond rating dummy = 1 and dividend dummy = 1). Our untabulated results indicate that the coefficient on cash flow is positive and significant at the 1% level in all of the four cases while the coefficient on the interaction of cash flow and optimism is negative and significant at the 1% level in three

cases. In the fourth case (bond rating dummy = 1), the coefficient on the interaction of cash flow and optimism is negative but nonsignificant ( $p = 0.139$ ). Overall, these findings suggest that optimism does not serve as a proxy for financial constraints and has an independent negative effect on the relation between cash holdings and cash flow.

[Table 6 here]

## V. CONCLUSION

The key message of the paper is that CEO beliefs, specifically those characterized as optimism, play a significant role in corporate cash policy. Contrary to the intuitive implications based on extant research, we find that optimistic CEOs hold less cash than their rational counterparts. This reduction in cash holdings resulting from CEO optimism is both statistically and economically significant. Our empirical results show that firms managed by optimistic CEOs hold cash balances that are, on average, 24 percent lower than those in firms managed by rational CEOs.

The central hypothesis of a negative relation between CEO optimism and cash holdings derives from an expanded trade-off model of corporate cash holdings. Specifically, the model adds managerial beliefs (i.e., optimism) to the traditional trade-off model of costs and benefits of holding cash. The intuition is that an optimistic CEO believes external financing to be excessively costly but expects this cost to decrease over time as investors learn about the profitability of existing investments. As a result, the CEO delays raising external financing while funding current investments with internal cash, resulting in a lower cash balance.

In addition to maintaining a lower cash balance, firms managed by optimistic CEOs exhibit a lower change in their cash balance over time. Moreover, optimistic CEOs save less cash out of their current cash flow than firms managed by rational CEOs. This finding suggests that a higher current cash flow reinforces an optimistic CEO's perception that the cost of external financing will decline in the future, causing the CEO to save less cash out of current cash flow. We also find that CEO optimism weakens the positive relation between cash holdings and a firm's growth opportunities. This finding suggests that firms led by optimistic CEOs prefer to finance future investments by raising external financing in the future because they expect to raise funds on more attractive terms. We confirm all of our results using two different datasets and two different measures of optimism.

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**Table 1**  
**Summary Statistics: Optimistic CEOs vs. Non-Optimistic CEOs**

*Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Log of Cash Holdings* equals the natural logarithm of one plus *Cash Holdings*. *Growth* equals the ratio of the market value of assets to book value of *net assets*, where the market value of assets equals the market value of equity plus the book value of total liabilities. *Net assets* equals the difference between total assets and cash & short-term investments. *Cash Flow* equals the ratio of operating income before depreciation *less* interest expense *less* income taxes *less* common and preferred dividends *to* book value of net assets. *Leverage* equals the ratio of the sum of long-term debt and debt in current liabilities to net assets. *NWC to Assets* equals the ratio of net working capital (net of cash and short-term investments) to net assets. *RD to Assets* equals the ratio of R&D expenditures to net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets; *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Cash Flow Volatility* equals the standard deviation of the firm's cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. *Stock Ownership* equals the fraction of the company stock owned by the CEO (excluding options) as a fraction of common shares outstanding. *Vested Options* equals the ratio of the CEO's holdings of exercisable options as a fraction of common shares outstanding. *CEO Tenure* is the tenure of the CEO with the firm in years.

Variable	Optimistic CEOs			Non-Optimistic CEOs			Optimistic vs. Non-Optimistic CEOs	
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	p-value for Difference (in Means)	p-value for Difference (in Medians)
Cash Holdings	0.2386	0.0859	0.42	0.1852	0.0699	0.36	0.00	0.00
Growth	2.7889	1.9530	2.46	1.9703	1.5631	1.45	0.00	0.00
Cash Flow	0.1161	0.1076	0.12	0.0842	0.0842	0.11	0.00	0.00
Book Value of Assets (in \$ millions)	4464.89	1113.53	13240.58	5763.63	1368.40	15750.75	0.00	0.00
Net Sales (in \$ millions)	4523.66	1160.25	16381.23	5541.12	1464.64	14480.21	0.00	0.00
Leverage	0.2331	0.2191	0.18	0.2549	0.2471	0.18	0.00	0.00
NWC to Assets	0.0934	0.0884	0.18	0.0961	0.0901	0.19	0.31	0.28
RD to Assets	0.0517	0.0021	0.11	0.0412	0.0031	0.10	0.00	0.00
Capex to Assets	0.0756	0.0551	0.07	0.0596	0.0443	0.05	0.00	0.00
Acquisitions to Assets	0.0386	0.0018	0.08	0.0313	0.0005	0.07	0.00	0.00
Bond Rating	0.5031	1.0000	0.50	0.5614	1.0000	0.50	0.00	0.00
Cash Flow Volatility	0.0840	0.0372	0.17	0.0667	0.0321	0.12	0.00	0.00
Stock Ownership	0.0264	0.0052	0.06	0.0143	0.0022	0.04	0.00	0.00
Vested Options	0.0099	0.0060	0.01	0.0067	0.0038	0.01	0.00	0.00
CEO Tenure (years)	8.4441	7.0000	7.90	5.0183	3.0000	5.94	0.00	0.00
Observations	11257			8701				

**Table 2**  
**CEO Optimism and Cash Holdings**

This table provides estimates from a regression model, which is estimated on the pooled data over the period 1992-2012. *Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Log of Cash Holdings* equals the natural logarithm of one plus *Cash Holdings*. *Optimism* equals one over all the CEO-years if the CEO held an option that was more than 100% in the money at least once during his/her tenure, and zero otherwise. *Post-Optimism* equals one in all CEO-years following (and including) the first year in which the CEO holds an option that is more than 100% in the money, and zero otherwise. *Growth* equals the ratio of the market value of assets to book value of *net assets*, where the market value of assets equals the market value of equity plus the book value of total liabilities. *Net assets* equals the difference between total assets and cash & short-term investments. *Cash Flow* equals the ratio of operating income before depreciation *less* interest expense *less* income taxes *less* common and preferred dividends to book value of net assets. *Log of Sales* equals the natural logarithm of net sales. *Leverage* equals the ratio of the sum of long-term debt and debt in current liabilities to net assets. *NWC to Assets* equals the ratio of net working capital (net of cash and short-term investments) to net assets. *RD to Assets* equals the ratio of R&D expenditures to net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets. *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Cash Flow Volatility* equals the standard deviation of the firm's cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. *Stock Ownership* equals the fraction of the company stock owned by the CEO (excluding options) as a fraction of common shares outstanding. *Vested Options* equals the ratio of the CEO's holdings of exercisable options as a fraction of common shares outstanding. All models include firm and year fixed effects and the standard errors are clustered by firm.

	Dependent Variable			
	Cash Holdings (Model 1)	Cash Holdings (Model 2)	Log of Cash Holdings (Model 3)	Log of Cash Holdings (Model 4)
Optimism	-0.0208*** (-3.32)		-0.0104*** (-2.92)	
Post-Optimism		-0.0203*** (-3.53)		-0.0088*** (-2.81)
Growth	0.0609*** (11.39)	0.0618*** (11.03)	0.0325*** (15.88)	0.0328*** (15.45)
Cash Flow	0.2343*** (3.17)	0.2363*** (3.00)	0.1623*** (5.71)	0.1606*** (5.35)
Log of Sales	-0.0522*** (-6.02)	-0.0493*** (-5.64)	-0.0353*** (-7.42)	-0.0345*** (-7.17)
Leverage	0.0774** (2.48)	0.0826** (2.55)	0.0443*** (2.69)	0.0475*** (2.80)
NWC to Assets	-0.2979*** (-3.75)	-0.2811*** (-3.50)	-0.1471*** (-4.92)	-0.1417*** (-4.67)
RD to Assets	1.5121*** (7.38)	1.5095*** (7.09)	0.6021*** (8.13)	0.6128*** (7.72)
Capex to Assets	-0.1693** (-2.55)	-0.1639** (-2.40)	-0.0638* (-1.92)	-0.0634* (-1.85)
Acquisitions to Assets	-0.2205*** (-7.56)	-0.2035*** (-6.94)	-0.1527*** (-11.11)	-0.1479*** (-10.61)
Bond Rating	0.0062 (0.63)	0.0043 (0.43)	-0.0005 (-0.08)	-0.0016 (-0.28)
Cash Flow Volatility	0.0575 (1.01)	0.0608 (1.03)	0.0324 (1.16)	0.0305 (1.06)
Stock Ownership	-0.1417** (-2.29)	-0.1382** (-2.25)	-0.0796** (-2.17)	-0.0746** (-2.01)
Vested Options	-0.1980 (-0.41)	-0.0911 (-0.18)	-0.3932** (-2.16)	-0.3588* (-1.85)
Firm-Year Observations	19877	18808	19877	18808
Adjusted R <sup>2</sup>	0.7774	0.7826	0.8265	0.8296

\*\*\* Significant at the 0.01 level; \*\* Significant at the 0.05 level; \* Significant at the 0.10 level.

**Table 3**  
**CEO Optimism and Change in Cash Holdings**

This table provides estimates from a regression model, which is estimated on the pooled data over the period 1992-2012. *Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Log of Cash Holdings* equals the natural logarithm of one plus *Cash Holdings*. *Optimism* equals one over all the CEO-years if the CEO held an option that was more than 100% in the money at least once during his/her tenure, and zero otherwise. *Post-Optimism* equals one in all CEO-years following (and including) the first year in which the CEO holds an option that is more than 100% in the money, and zero otherwise. *Growth* equals the ratio of the market value of assets to book value of *net assets*, where the market value of assets equals the market value of equity plus the book value of total liabilities. *Net assets* equals the difference between total assets and cash & short-term investments. *Cash Flow* equals the ratio of operating income before depreciation *less* interest expense *less* income taxes *less* common and preferred dividends *to* book value of net assets. *Log of Sales* equals the natural logarithm of net sales. *Leverage* equals the ratio of the sum of long-term debt and debt in current liabilities to net assets. *NWC to Assets* equals the ratio of net working capital (net of cash and short-term investments) to net assets. *RD to Assets* equals the ratio of R&D expenditures to net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets. *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Cash Flow Volatility* equals the standard deviation of the firm's cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. *Stock Ownership* equals the fraction of the company stock owned by the CEO (excluding options) as a fraction of common shares outstanding. *Vested Options* equals the ratio of the CEO's holdings of exercisable options as a fraction of common shares outstanding. All models include firm and year fixed effects and the standard errors are clustered by firm.

	Dependent Variable			
	Change in Cash Holdings (Model 1)	Change in Cash Holdings (Model 2)	Change in Log of Cash Holdings (Model 3)	Change in Log of Cash Holdings (Model 4)
Optimism	-0.0204*** (-3.31)		-0.0077*** (-2.99)	
Post-Optimism		-0.0202*** (-3.56)		-0.0075*** (-3.17)
Lagged Cash Holdings	-0.9842*** (-61.90)	-0.9857*** (-68.26)		
Lagged Log of Cash Holdings			-0.6596*** (-19.50)	-0.6695*** (-19.36)
Growth	0.0604*** (11.35)	0.0614*** (11.01)	0.0260*** (14.08)	0.0266*** (13.74)
Cash Flow	0.2310*** (3.15)	0.2330*** (2.98)	0.1453*** (6.11)	0.1450*** (5.73)
Log of Sales	-0.0488*** (-5.86)	-0.0460*** (-5.47)	-0.0200*** (-5.36)	-0.0196*** (-5.11)
Leverage	0.0797*** (2.57)	0.0847*** (2.64)	0.0673*** (5.12)	0.0698*** (5.08)
NWC to Assets	-0.2978*** (-3.76)	-0.2814*** (-3.51)	-0.1376*** (-5.46)	-0.1349*** (-5.21)
RD to Assets	1.5015*** (7.34)	1.4991*** (7.06)	0.4922*** (7.02)	0.4983*** (6.68)
Capex to Assets	-0.1804*** (-2.70)	-0.1742** (-2.54)	-0.1779*** (-5.75)	-0.1743*** (-5.47)
Acquisitions to Assets	-0.2449*** (-8.05)	-0.2261*** (-7.53)	-0.2957*** (-17.67)	-0.2870*** (-17.34)
Bond Rating	0.0070 (0.71)	0.0051 (0.51)	0.0019 (0.45)	0.0009 (0.21)
Cash Flow Volatility	0.0529 (0.94)	0.0569 (0.97)	-0.0107 (-0.46)	-0.0083 (-0.34)
Stock Ownership	-0.1408** (-2.31)	-0.1373** (-2.27)	-0.0688** (-2.43)	-0.0628** (-2.23)
Vested Options	-0.1784 (-0.37)	-0.0709 (-0.14)	-0.2626* (-1.80)	-0.2223 (-1.44)
Firm-Year Observations	19872	18803	19872	18803
Adjusted R <sup>2</sup>	0.9688	0.9716	0.5569	0.5687

\*\*\* Significant at the 0.01 level; \*\* Significant at the 0.05 level; \* Significant at the 0.10 level.

**Table 4**  
**CEO Optimism, Cash Holdings, and Change in Cash Holdings: Alternative Sample and Optimism Measure**

This table provides estimates from a regression model, which is estimated on the pooled data over the period 1980-1994. *Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Log of Cash Holdings* equals the natural logarithm of one plus *Cash Holdings*. *Longholder* is a binary variable that equals 1 if the CEO held an option package until the last year before expiration at least once during his/her tenure and the option package held was at least 40% in the money entering its final year. *Growth* equals the ratio of the market value of assets to book value of *net assets*, where the market value of assets equals the market value of equity plus the book value of total liabilities. *Net assets* equals the difference between total assets and cash & short-term investments. *Cash Flow* equals the ratio of operating income before depreciation less interest expense less income taxes less common and preferred dividends to book value of net assets. *Log of Sales* equals the natural logarithm of net sales. *Leverage* equals the ratio of the sum of long-term debt and debt in current liabilities to net assets. *NWC to Assets* equals the ratio of net working capital (net of cash and short-term investments) to net assets. *RD to Assets* equals the ratio of R&D expenditures to net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets. *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Cash Flow Volatility* equals the standard deviation of the firm's cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. *Stock Ownership* equals the fraction of the company stock owned by the CEO (excluding options) as a fraction of common shares outstanding. *Vested Options* equals the ratio of the CEO's holdings of exercisable options as a fraction of common shares outstanding. All models include firm and year fixed effects and the standard errors are clustered by firm.

	Dependent Variable			
	Cash Holdings (Model 1)	Log of Cash Holdings (Model 2)	Change in Cash Holdings (Model 3)	Change in Log of Cash Holdings (Model 4)
Longholder	-0.0265** (-2.03)	-0.0210* (-1.92)	-0.0213** (-2.11)	-0.0156** (-1.97)
Lagged Cash Holdings			-0.6337*** (-11.06)	
Lagged Log of Cash Holdings				-0.5758*** (-13.41)
Growth	0.0658*** (5.34)	0.0492*** (5.62)	0.0534*** (4.65)	0.0377*** (4.83)
Cash Flow	0.0940 (0.55)	0.0940 (0.80)	0.2161 (1.44)	0.1807* (1.82)
Log of Sales	-0.0165 (-1.31)	-0.0145 (-1.50)	-0.0124 (-1.29)	-0.0112* (-1.66)
Leverage	0.0275 (0.54)	0.0068 (0.18)	0.0794 (1.63)	0.0527 (1.52)
NWC to Assets	-0.0631 (-1.26)	-0.0647* (-1.65)	-0.0158 (-1.20)	-0.0543* (-1.69)
RD to Assets	0.4562 (1.03)	0.3557 (1.08)	0.4278 (1.12)	0.3136 (1.12)
Capex to Assets	-0.1631** (-2.57)	-0.1385*** (-2.61)	-0.2728*** (-4.29)	-0.2412*** (-4.80)
Acquisitions to Assets	-0.1094*** (-3.39)	-0.0860*** (-3.52)	-0.2091*** (-5.06)	-0.1741*** (-5.35)
Bond Rating	0.0122 (1.04)	0.0111 (1.29)	0.0119 (1.40)	0.0100* (1.66)
Cash Flow Volatility	0.9172** (2.58)	0.5199*** (2.74)	1.091** (2.06)	0.5192** (2.02)
Stock Ownership	-0.1425 (-1.23)	-0.1117 (-1.20)	-0.1042 (-1.26)	-0.0797 (-1.25)
Vested Options	0.0416* (1.82)	0.0329* (1.93)	0.0354* (1.79)	0.0229* (1.73)
Firm-Year Observations	2324	2324	2324	2324
Adjusted R <sup>2</sup>	0.6873	0.6801	0.4869	0.4175

\*\*\* Significant at the 0.01 level; \*\* Significant at the 0.05 level; \* Significant at the 0.10 level.

**Table 5**  
**Interactive Effect of CEO Optimism and Growth on Cash Holdings**

This table provides estimates from a regression model, which is estimated on the pooled data over the period 1992-2012. *Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Optimism* equals one over all the CEO-years if the CEO held an option that was more than 100% in the money at least once during his/her tenure, and zero otherwise. *Post-Optimism* equals one in all CEO-years following (and including) the first year in which the CEO holds an option that is more than 100% in the money, and zero otherwise. *Longholder* is a binary variable that equals 1 if the CEO held an option package until the last year before expiration at least once during his/her tenure and the option package held was at least 40% in the money entering its final year. *Growth* equals the ratio of the market value of assets to book value of *net* assets, where the market value of assets equals the market value of equity plus the book value of total liabilities. *Net assets* equals the difference between total assets and cash & short-term investments. *Cash Flow* equals the ratio of operating income before depreciation *less* interest expense *less* common and preferred dividends to book value of net assets. *Log of Sales* equals the natural logarithm of net sales. *Leverage* equals the ratio of the sum of long-term debt and debt in current liabilities to net assets. *NWC to Assets* equals the ratio of net working capital (net of cash and short-term investments) to net assets. *RD to Assets* equals the ratio of R&D expenditures to net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets. *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Cash Flow Volatility* equals the standard deviation of the firm's cash flow over the prior ten-year period. *Bond Rating* is an indicator variable that equals one if the firm has a long-term debt rating and zero otherwise. *Stock Ownership* equals the fraction of the company stock owned by the CEO (excluding options) as a fraction of common shares outstanding. *Vested Options* equals the ratio of the CEO's holdings of exercisable options as a fraction of common shares outstanding. All models include firm and year fixed effects and the standard errors are clustered by firm.

	Dependent Variable		
	Cash Holdings (Model 1)	Cash Holdings (Model 2)	Cash Holdings (Model 3)
Optimism	0.0407* (1.94)		
Post-Optimism		0.0338* (1.93)	
Longholder			0.0265 (0.97)
Growth	0.0873*** (7.83)	0.0839*** (8.86)	0.0743*** (5.54)
Optimism * Growth	-0.0299*** (-2.79)		
Post-Optimism * Growth		-0.0255*** (-2.90)	
Longholder * Growth			-0.0331** (-2.16)
Cash Flow	0.2198*** (3.02)	0.2182*** (2.81)	0.0870 (0.51)
Log of Sales	-0.0526*** (-6.12)	-0.0488*** (-5.70)	-0.0161 (-1.28)
Leverage	0.0803*** (2.59)	0.0865*** (2.69)	0.0249 (0.50)
NWC to Assets	-0.2763*** (-3.38)	-0.2583*** (-3.09)	-0.0630 (-1.25)
RD to Assets	1.4800*** (7.33)	1.4636*** (6.80)	0.4757 (1.05)
Capex to Assets	-0.1697** (-2.56)	-0.1682** (-2.44)	-0.1561** (-2.43)
Acquisitions to Assets	-0.2184*** (-7.56)	-0.2030*** (-6.99)	-0.1101*** (-3.41)
Bond Rating	0.0078 (0.79)	0.0047 (0.46)	0.0113 (0.97)
Cash Flow Volatility	0.0525 (0.93)	0.0602 (1.02)	0.9009** (2.56)
Stock Ownership	-0.1501** (-2.45)	-0.1514** (-2.17)	-0.1506 (-1.31)
Vested Options	-0.1400 (-0.29)	-0.0565 (-0.11)	0.0389* (1.87)
Firm-Year Observations	19877	18808	2324
Adjusted R <sup>2</sup>	0.7794	0.7845	0.6899

\*\*\* Significant at the 0.01 level; \*\* Significant at the 0.05 level; \* Significant at the 0.10 level.

Table 6

## Interactive Effect of CEO Optimism and Cash Flow on Change in Cash Holdings: Cash-Flow Sensitivity of Cash

This table provides estimates from a (firm) fixed-effect IV estimation of a regression model, which is estimated on the pooled data over the period 1992-2012 for the main sample and over 1980-1994 for the alternative sample. *Cash Holdings* equals the ratio of cash and short-term investments to net assets. *Optimism* equals one over all the CEO-years if the CEO held an option that was more than 100% in the money at least once during his/her tenure, and zero otherwise. *Post-Optimism* equals one in all CEO-years following (and including) the first year in which the CEO holds an option that is more than 100% in the money, and zero otherwise. *Longholder* is a binary variable that equals 1 if the CEO held an option package until the last year before expiration at least once during his/her tenure and the option package held was at least 40% in the money entering its final year. *Cash Flow* equals the ratio of operating income before depreciation less interest expense less income taxes less common and preferred dividends to book value of net assets. *Growth* equals the ratio of the market value of assets to book value of *net assets*, where the market value of assets equals the market value of equity plus the book value of total liabilities. Net assets equals the difference between total assets and cash & short-term investments. *Size* equals the natural logarithm of the book value of net assets. *Capex to Assets* equals the ratio of capital expenditures to net assets. *Acquisitions to Assets* equals the ratio of acquisitions to net assets. *Change in NWC* equals the change in net working capital (net of cash and short-term investments) over the fiscal year divided by net assets. *Change in Short-Term Debt* equals the change in debt in current liabilities over the fiscal year divided by net assets. All models include year fixed effects and the standard errors are based on the conventionally-derived variance estimator for generalized least-squares regression.

	Dependent Variable		
	Change in Cash Holdings (Model 1)	Change in Cash Holdings (Model 2)	Change in Cash Holdings (Model 3)
Optimism	0.0266*** (2.56)		
Post-Optimism		0.0249*** (3.04)	
Longholder			0.0146 (0.74)
Cash Flow	0.6029*** (11.56)	0.5415*** (13.90)	0.5663*** (6.26)
Cash Flow * Optimism	-0.3009*** (-5.10)		
Cash Flow * Post-Optimism		-0.2085*** (-4.65)	
Cash Flow * Longholder			-0.3241** (-2.05)
Growth	0.0325*** (8.92)	0.0284*** (9.53)	0.0428*** (6.14)
Size	0.0594*** (3.74)	0.0142 (1.24)	-0.0269*** (-2.56)
Capex to Assets	-1.2014 (-1.53)	-1.6480*** (-2.56)	-0.8165* (-1.84)
Acquisitions to Assets	-1.6989*** (-4.28)	-1.9354*** (-6.33)	0.0525 (0.13)
Change in NWC	-1.5241*** (-12.17)	-1.5093*** (-13.82)	-0.8787*** (-5.52)
Change in Short-Term Debt	-0.9826*** (-6.61)	-0.9240*** (-7.40)	-0.8593*** (-5.22)
Firm-Year Observations	19106	18077	2253
$\chi^2$	732.20***	1141.74***	225.53***

\*\*\* Significant at the 0.01 level; \*\* Significant at the 0.05 level; \* Significant at the 0.10 level.