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Sanjay Deshmukh, Anand M. Goel, and Keith M. Howe

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Abstract

We develop a model of the effect of CEO overconfidence on dividend policy and empirically examine many of its predictions. Consistent with our main prediction, we find that the level of dividend payout is lower in firms managed by overconfident CEOs. We document that this reduction in dividends associated with CEO overconfidence is greater in firms with lower growth opportunities, lower cash flow, and greater information asymmetry. We also show that the magnitude of the positive market reaction to a dividend-increase announcement is lower for firms managed by overconfident CEOs. Our overall results are consistent with the predictions of our model.

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I. Introduction

The literature on dividend policy is extensive and follows Miller and Modigliani (1961), who establish the irrelevance of dividend policy in the presence of perfect capital markets. Subsequent research draws on various market imperfections such as agency problems, asymmetric information, and taxes to explain the dividend decision. The empirical evidence, however, is inconclusive and much of the variation in dividend policy across firms remains unexplained (see Allen and Michaely, 2003). Further, recent survey evidence in Brav, Graham, Harvey, and Michaely (2005) provides scant support from financial executives for many theoretical explanations, such as those based on signalling and taxes.

We examine an alternative explanation based on differences in managerial beliefs to shed light on the unexplained variation in dividend policy. Recent research has explored behavioral explanations of various corporate policies. For instance, Malmendier and Tate (2005) classify managerial beliefs using an overconfidence measure and document that firms managed by overconfident CEOs exhibit a greater sensitivity of investment spending to internal cash flow.[1] Malmendier and Tate (2008) show that overconfident CEOs are more likely to engage in acquisitions that are value-destroying. Malmendier, Tate, and Yan (2007) argue that overconfident managers perceive their firms to be undervalued and are reluctant to raise funds through (costly) external sources. They document that the reluctance of overconfident CEOs to raise funds through external sources leads to both a pecking order of financing and debt conservatism. In short, overconfident CEOs appear to prefer internal to external funds.

The findings in Malmendier and Tate (2005) and in Malmendier, Tate, and Yan (2007) provide interesting and important implications for dividend policy. An overconfident CEO's preference for internal over external funds suggests that the CEO is likely to adopt a lower dividend payout to enhance the availability of internal funds. We elaborate on

[1]Overconfidence is defined as overestimation of the precision of one's information or, equivalently, underestimation of risk. The finding that people are overconfident is one of the most robust in the psychology of judgment. See DeBondt and Thaler (1995), Kahneman, Slovic, and Tversky (1982), and Russo and Schoemaker (1990).

this key idea and develop a simple model of the interaction between dividend policy and CEO overconfidence. The main testable prediction of the model is that an overconfident CEO pays a lower level of dividends relative to a rational CEO. This prediction is also robust to an extension of our model with alternative modeling assumptions. The model also predicts the effect of CEO overconfidence on the dividend payout to be weaker for firms with higher growth opportunities. In addition, the model predicts the stock price response to announcements of dividend changes to be an increasing function of the informativeness of the announcement about CEO overconfidence. We test the model's predictions, along with other implications drawn from the dividend literature, using a panel data of large U.S. companies over the period, 1980-1994. We employ the measures of CEO overconfidence derived by and used in Malmendier and Tate (2005, 2008) and in Malmendier, Tate, and Yan (2007).

Our results indicate that the level of dividend payout is lower in firms managed by overconfident CEOs. This result is robust to alternative measures of CEO overconfidence and to several control variables. We also examine the effect of CEO overconfidence on the relation between dividend policy and growth, cash flow, and the level of asymmetric information, respectively. Consistent with previous evidence, we find a negative relation between growth and dividend payout. However, we show that the difference in the dividend payout between higher-growth and lower-growth firms is smaller for firms with overconfident CEOs. Alternatively, the reduction in dividend payout caused by CEO overconfidence is smaller in higher-growth firms, which is consistent with the prediction of our model. We also find that the positive relation between dividend payout and cash flow, documented in previous studies, is stronger in firms with overconfident CEOs. One interpretation of this finding is that overconfident CEOs perceive their cash flow to be greater than it actually is and thus adopt a higher dividend payout relative to rational CEOs. We also show that the negative effect of asymmetric information on dividend payout is stronger for firms with overconfident CEOs. With asymmetric information, overconfident CEOs perceive a higher wedge between the cost of internal and external funds and, thus, respond by adopting a lower dividend payout to enhance the availability of internal funds.

Finally, we analyze the stock-market response to dividend changes by identifying announcements of dividend increases of at least 10% made by our sample firms over the sample period. We control for the endogeneity of the dividend-increase decision and estimate a multivariate regression model to investigate the relation between CEO overconfidence and the stock-market response to the dividend-increase announcement. Our results here indicate that the magnitude of the positive stock price response is higher for firms with uncertainty about CEO overconfidence than for firms whose CEOs have previously been identified as overconfident. This result is consistent with our hypothesis that dividends provide information about CEO overconfidence – dividend increases indicate lower CEO overconfidence – and that this informativeness is higher when there is greater uncertainty about CEO overconfidence.

We make three contributions to the dividend policy literature: First, we model and test the relation between managerial overconfidence and dividend policy to show that CEO overconfidence affects dividend policy. Second, we examine the effect of CEO overconfidence on the relation between dividend policy and cash flow, growth opportunities, and the level of asymmetric information, respectively. Growth opportunities, cash flow, and firm size (a measure of asymmetric information) appear to be the three most important factors that affect dividend policy (see Smith and Watts, 1992; Fama and French, 2001, 2002). Third, the findings on the stock market response to announcements of dividend increases by overconfident CEOs indicate that the market recognizes the relation between CEO overconfidence and dividend policy. Our results thus provide an alternative explanation for the stock market response to announcements of dividend changes. Taken together, our results in this paper document a robust effect of CEO overconfidence on dividend policy.

Our paper contributes to the growing literature on behavioral corporate finance. Hirshleifer (2001) and Barberis and Thaler (2003) survey the literature that attempts to explain asset pricing and return patterns based on behavioral characteristics of investors. The literature on behavioral corporate finance that examines the relation between corporate policies and the behavioral characteristics of corporate managers and investors is surveyed by Baker, Ruback, and Wurgler (2007). Ben-David, Graham, and Harvey

(2007), Hackbarth (2008), Malmendier and Tate (2005, 2008), and Malmendier, Tate, and Yan (2007) examine the effect of overconfidence in top executives on corporate finance policies. Bernardo and Welch (2002), Gervais, Heaton, and Odean (2009), 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 (2008) examine financial contracting with optimistic managers, and Bergman and Jenter (2007) link stock option compensation to employee optimism. Bertrand and Schoar (2003) show that differences in style across managers significantly explain corporate decisions and performance. Our results on the relation between CEO overconfidence and dividend policy corroborate the central thesis of this literature that behavioral characteristics of CEOs affect corporate finance policies.

The paper proceeds as follows. In Section II, we develop a simple model of dividend policy and CEO overconfidence. Section III describes the data and method, and Section IV presents the empirical results. Section V extends our model to endogenize the cost of external financing and decouple investment and payout decisions. Section VI summarizes our findings and discusses the implications of the study.

II. Model

In this section, we present a model of investment and dividend policies of a firm. We determine the optimal policies of a rational CEO and then examine how the policies of an overconfident CEO differ from those of the rational CEO. We use a parsimonious model to derive the firm's optimal dividend policy and use that as a benchmark to analyze how CEO overconfidence affects the dividend policy.

A. **Model Basics.** This subsection specifies the timing of events, the preferences and actions of the CEO, and the information structure.

A.1. *Firm.* Consider an all-equity firm with a CEO who acts in the interest of shareholders. The number of shares is normalized to one and all investors are risk neutral. The risk-free interest rate is zero.

A.2. *Dates.* There are three dates. At date 0, the CEO and the market observe signals about a project available to the firm. At date 1, the CEO declares a dividend and/or raises external financing, and also invests capital in the project.[2] At date 2, the cash flows from the project are realized. The cash flows are used to pay off creditors who provided external financing at date 1 and to pay dividends to original shareholders. We assume that the CEO wants to maximize the value to all the investors in the firm, instead of favoring one set of investors over another.

A.3. *Project.* An investment $I \geq 0$ in the project at date 1 yields $Yf(I)$ at date 2 where Y, the project quality, is a random variable normally distributed with mean μ_y and precision η_y (standard deviation $\frac{1}{\eta_y}$) and function f is increasing and concave with $f(0) = 0$.

A.4. *Payout and External Financing.* The firm starts with cash $C_0 > 0$ at date 0. The CEO declares dividend $D \geq 0$ and raises external financing $F \geq 0$ at date 1. External financing is costly so the net cash received by the firm is $(1 - \beta)F$ where β is the cost of external financing with $0 \leq \beta < 1$. The amount of dividend paid is limited by the total cash available - the initial cash and the net cash raised through external financing. Any cash remaining after dividend payout is invested in the project.

A.5. *Signal and CEO's Problem.* The CEO observes a signal s about the project at date 0. The signal is normally distributed with mean equal to the project quality Y and precision η_s. The expected value of the project quality conditional on the signal s is calculated using Bayes rule as

$$y(s) \equiv E[Y|s] = \frac{\eta_y \mu_y + \eta_s s}{\eta_y + \eta_s}\,. \tag{1}$$

The initial beliefs about the project follow the condition:

$$\mu_y f'(0) \leq 1\,. \tag{2}$$

[2]Dividends and share repurchases are perfect substitutes in our model. Moreover, the CEO is indifferent between them as the CEO is acting in the interest of all shareholders and ignores any wealth transfer that may occur among shareholders with share repurchases. Our results about dividends thus generalize to total payout.

This condition stipulates that prior to observing a signal, the project has negative present value and does not merit any investment from the shareholders' perspective. Thus, the CEO takes the investment decision only after observing the signal about the project. The CEO chooses a policy (I, D, F) to simultaneously determine the levels of investment, dividend, and external financing based on the signal s. His problem is

$$\max_{I,D,F} \; Z(s, I, D, F) \equiv y(s) f(I) + D - F \,, \tag{3}$$

subject to

$$I = C_0 - D + (1-\beta) F \,, \text{ and} \tag{4}$$

$$I \geq 0, D \geq 0, F \geq 0 \,. \tag{5}$$

The objective in (3) is the firm value calculated as the net cash flow to all investors across dates 1 and 2 and constraint (4) is the cash clearing identity on date 1. We will call a policy (I, D, F) feasible if it satisfies (4) and (5). We define $Z(s, I)$ as the maximum value of the CEO's objective $Z(s, I, D, F)$ over all feasible policies with investment I.

B. **Equilibrium Investment, Financing, and Dividend Policies.** This subsection characterizes how the CEO's corporate investment, financing, and dividend decisions depend on his inference about the project quality based on the signal. The results of this section do not depend on whether the CEO rationally interprets the signal but only require that the CEO associate a higher signal with a higher expected project quality, i.e., $\mathrm{d}y/\mathrm{d}s > 0$. The next subsection will examine how overconfidence impacts CEO's policies.

Proposition 1. *If external financing is costless, i.e., $\beta = 0$, then*

(a) *if the signal is below a threshold, $s \leq \underline{s}$, there is no investment, and the net payout (dividend minus external capital raised) equals the initial cash C_0, and*

(b) *if the signal is above the threshold, $s > \underline{s}$, investment is positive and an increasing function of s while net payout is a decreasing function of s,*

where the threshold $\underline{s}$ is defined by $y(\underline{s}) = 1/f'(0)$.

This proposition is straightforward. A higher value of the signal s suggests a higher project quality and results in a greater investment. However, if the signal is sufficiently low, the CEO does not invest in the project. Since external financing is costless, the dividend or the amount of external financing is indeterminate. The difference of the two, the net payout, equals the cash available minus the investment in the project, and is thus decreasing in the realized signal. In the following analysis, external financing is assumed to be costly, i.e., $\beta > 0$.

Lemma 1. *Paying a dividend and raising external financing are mutually exclusive on date 1. Specifically,*

$$\begin{aligned} D &= \max\left(C_0 - I, 0\right), \\ F &= \max\left(\frac{I - C_0}{1-\beta}, 0\right), \text{ and} \\ Z\left(s, I\right) &= y\left(s\right) f\left(I\right) - \max\left(I - C_0, \frac{I - C_0}{1-\beta}\right). \end{aligned}$$

The right hand side of the equation for $Z\left(s, I\right)$ shows that the CEO's objective equals the expected cash flow from the project, the first term, minus the net cash raised from investors, the second term. The net cash raised is either the negative of dividend payment or equals the new capital raised on date 1. The above lemma shows that the cost of external financing makes it inefficient to distribute dividends and raise external financing on date 1. Thus, if the firm pays a dividend, it does not raise external financing and if it raises external financing, it does not pay a dividend.[3] Since we have assumed a positive cost of raising external financing but zero cost of paying a dividend, the tradeoff that the firm faces between a marginal dollar on date 0 and a marginal dollar on date 1 differs in the two scenarios: the scenario when the signal is low and the firm pays a dividend and the scenario when the signal is high and the firm raises external financing. These scenarios are represented by the two terms in the maximum function in the above equation for $Z\left(s, I\right)$.

Proposition 2. *The investment, dividend, and financing policies depend on the signal s in the following manner:*

[3] The model can be extended with information asymmetry about cash balance or gradual information arrival to accommodate the possibility of simultaneous dividend payout and equity issues. However, this issue is tangential to the focus of the paper.

(a) *for lowest signal values,* $s \leq \underline{s}$*, there is no investment, no external capital is raised, and the initial cash* C_0 *is paid out as a dividend,*

(b) *for higher signal values,* $\underline{s} < s < \hat{s}$*, investment is positive but less than* C_0 *and is an increasing function of* s*, dividend is positive and a decreasing function of* s*, and external capital is not raised,*

(c) *for even higher signal values,* $\hat{s} \leq s < \bar{s}$*, investment equals* C_0*, dividend is not declared, and external capital is not raised, and*

(d) *for highest signal values,* $s > \bar{s}$*, investment exceeds* C_0 *and is an increasing function of* s*, dividend is not declared, and the amount of external financing is an increasing function of* s*,*

where,

$$f'(0) = \frac{1}{y(\underline{s})}, \; f'(C_0) = \frac{1}{y(\hat{s})} = \frac{1}{(1-\beta)\, y(\bar{s})}. \tag{6}$$

This proposition shows that the range of the value of the signal s can be partitioned into four continuous regions, which characterize different corporate policies. The first region, the *full-payout region*, corresponds to signal values so low that the CEO believes that the return on any investment is negative. In this region, the cash balance C_0 is paid out as a dividend. The *partial-payout region* consists of higher signal values such that the CEO believes the marginal return is positive with no investment but negative if the entire cash balance C_0 is invested, so the CEO invests a fraction of C_0 and pays out the rest as a dividend. The *zero-payout region* consists of even higher signal values such that the CEO believes that the marginal return with investment of C_0 is positive but less than the cost of external financing, so the CEO invests all of C_0 but does not raise external financing. The *negative-payout region* consists of the highest values of the signal s for which the CEO believes the marginal return from an investment of C_0 exceeds the marginal cost of external financing, so the CEO raises external financing to invest more than C_0. Investment is an increasing function of the signal s in the partial-payout region and the negative-payout region. Thus, the dividend is a decreasing function of s and the external financing is an increasing function of s.

C. **Impact of CEO Overconfidence.** The previous subsection characterized the CEO's investment, financing, and payout choices as functions of his inference about the project quality. This inference depends on the CEO's signal as well as his beliefs about the precision of the signal. A rational CEO correctly believes that the precision of the signal is η_s and his inference about the project quality is given by (1). In contrast, an overconfident CEO overestimates the precision of his signal.[4] Specifically, a CEO with degree of overconfidence $C > 1$ believes that the signal s has precision $C\eta_s$ and is more informative than it really is.[5] He estimates the expected value of the project quality conditional on the signal s as

$$y(s, C) \equiv E[Y|s, C] = \frac{\eta_y \mu_y + C\eta_s s}{\eta_y + C\eta_s} \tag{7}$$

An overconfident CEO determines investment, dividend, and external financing as a function of his signal in qualitatively the same way as the rational CEO. However, his decisions differ from those of a rational CEO due to differences in how they interpret the signal about . The following result explains how CEO overconfidence and financing costs influence corporate policies.

Proposition 3. *(a) Investment is a weakly increasing function of CEO overconfidence and cash balance and a weakly decreasing function of the cost of external financing. (b) Dividend is a weakly decreasing function of CEO overconfidence and a weakly increasing function of cash balance. (c) The amount of capital raised through external financing is a weakly increasing function of CEO overconfidence and a weakly decreasing function of cash balance and the cost of external financing.*

[4]This definition of overconfidence is consistent with most of the literature on behavioral finance, which includes Barberis and Thaler (2003), Ben-David, Graham, and Harvey (2007), Bernardo and Welch (2001), Gervais, Heaton, and Odean (2009), Hackbarth (2008), and Hirshleifer (2001). Daniel, Hirshleifer, and Subrahmanyam (1998) list psychological evidence about overconfidence. Malmendier and Tate (2005) consider this as well as another interpretation of overconfidence: an overconfident CEO may overestimate the cash flows of his firm. This latter interpretation is often referred to as overoptimism (see Hackbarth (2008), Heaton (2002), and Hirshleifer (2001)). As Hirshleifer (2001) points out, overconfidence may lead to overoptimism.

[5]Our assumption that CEO overconfidence is about uncertain future investment opportunities rather than more predictable current cash flow is consistent with the psychological evidence that overconfidence is rampant in difficult tasks and is eliminated in very easy tasks (see Griffin and Tversky (1992) and Klayman, Soll, González-Vallejo, and Barlas(1999)).

The proposition shows that the more overconfident a CEO is, the more he will invest. The intuition is that overconfidence causes the CEO to overestimate the precision of his signal and hence to overreact to the signal. When a signal is above average, a rational CEO raises his expectation of project quality An overconfident CEO also does so but overreacts and arrives at an expectation of project quality that is higher than what a rational CEO would arrive at. On the other hand, when the signal is below average, a rational CEO lowers his expectation of project quality An overconfident CEO also does so but by overreacting, he arrives at too low an expectation of project quality. Thus, overreaction may cause an overconfident CEO to be optimistic or pessimistic about the project. His optimism, in the case of a good signal, causes him to invest too much in the project relative to a rational CEO. On the other hand, his pessimism, which is associated with lower signal values, causes him to not invest in the project and this action is indistinguishable from that of the rational CEO. Thus, CEO overconfidence leads to overinvestment but not underinvestment. The proposition establishes that this investment distortion is greater when the CEO is more overconfident. Further, the investment distortion directly leads to distortions in dividend policy and external financing policy. Since, an overconfident CEO overinvests relative to a rational CEO, he declares lower dividends and raises more external financing than a rational CEO.

We now relate the results of Proposition 3, a centerpiece of our model, to the existing empirical literature along three dimensions.

Investment Policy. Part (a) of the proposition asserts that investment is positively related to CEO overconfidence. This implication has been empirically verified in Malmendier and Tate (2005) and in Malmendier and Tate (2008). They show that overconfident CEOs invest more if internal funds are available. However, they also argue that overconfident CEOs curtail investments financed by issuing risky securities because they view external funds as unduly costly. While Proposition 3 also shows that investment is sensitive to cash balance, it is not obvious that this sensitivity is always higher for overconfident CEOs than for rational CEOs. The reason for this divergence is that we assume an exogenous cost of external financing that is a deadweight cost from the perspective of the firm and does not depend on whether the CEO is rational or overconfident. Malmendier and Tate (2005, 2008) assume that the CEO views external financing as too costly because of the difference of opinion between the CEO and the new investors. This cost is simply a transfer of wealth among different investors of the firm rather than a deadweight cost and its impact on the CEO's investment policy depends on the CEO's objective. If the CEO acts in the interest of all shareholders, as we assume, this cost will not impact the CEO's investment decisions. If the CEO acts in the interest of old shareholders, as assumed in Malmendier and Tate, the deadweight cost of external financing is independent of whether the CEO is rational or overconfident. On the other hand, the perceived underpricing of newly issued securities is seen as a cost only by the overconfident CEO, causing the overconfident CEO's investment to be more sensitive to availability of internal funds. This distinction is not important for our dividend results because, in equilibrium, the firm does not raise any external financing when it pays out dividend.

Financing Policy. Malmendier, Tate, and Yan (2007) examine the relation between CEO overconfidence and financing choices. They document two main findings. First, conditional on accessing public markets for external financing, overconfident CEOs are more likely to raise debt than equity. Second, overconfident CEOs are less likely to raise external financing. The two results together show that CEO overconfidence leads to a greater inclination to follow a pecking order: internal capital is preferred to issuing debt, which in turn is preferred to issuing equity. Proposition 2 is consistent with the first finding as the firm (in our model) prefers internal funds over external financing. We obtain this result by assuming an exogenous cost of external financing while in Malmendier, Tate, and Yan (2007), the CEO perceives this cost as a result of the difference between his beliefs and those of the investors. The CEO's preference for debt over equity arises in Malmendier, Tate, and Yan (2007) because the difference of beliefs affects equity value more than debt value. We obtain the same result in our model if we assume that the CEO acts in the interest of old shareholders rather than all investors in the firm. Malmendier, Tate, and Yan (2007) point out that their second result about overconfident CEOs being less likely to access external capital may reverse if investment is endogenized as overconfident CEOs invest more. This is exactly what Proposition 3 shows. However, the empirical evidence in Malmendier, Tate, and Yan (2007) shows that overconfident CEOs are less likely to access external markets. This finding suggests that CEOs may care more about old shareholders and an overconfident CEO's concern about underpricing of new securities dominates the preference for overinvestment based on biased beliefs.

Dividend Policy. The third corporate policy that Proposition 3 addresses is dividend policy. To our knowledge, the relation between dividend policy and CEO overconfidence has not been explored comprehensively. We examine our predictions about this relation empirically.

A natural questions that arises is: How do shareholders react to the firm's dividend policy decisions? An overconfident CEO who acts in the interest of all shareholders believes that his investment, financing, and dividend policies are maximizing the wealth of all investors in the firm. Investors may disagree with the CEO, which may impact the price at which the firm can issue new securities. This disagreement doesn't affect CEO actions as pricing of securities only affects the sharing of wealth among different investors of the firm and the CEO doesn't care about short-term price performance. Nonetheless, the share price reaction to the CEO's policies is still an interesting issue and can be used to test the implications of our theoretical model.

Allen and Michaely (2003) note that the market on average reacts positively to announcements of increases in dividends and negatively to announcements of dividend decreases. The most common explanation for this reaction is the signaling hypothesis – higher dividends are announced by the managers to signal higher future cash flows. Allen and Michaely (2003) point out a problem with the theory; there is little empirical evidence that higher earnings follow larger dividends. Thus, they conclude that if firms use dividends as a signal, the signal is not about future growth in earnings or cash flows. In that spirit, we show below that dividends may convey information about CEO overconfidence. In our model, the CEO's actions depend on his interpretation of his signal, which is determined not only by the signal itself but also by the CEO's overconfidence. Thus, the CEO's dividend announcement on date 1 conveys incremental information to the market about the firm's investment opportunities as well as about the CEO's overconfidence. The following result shows how investors react to a dividend announcement.

Proposition 4. *Suppose the CEO can be rational or overconfident. If there is no information asymmetry about the project (i.e., the CEO's signal s is also observed by the investors) and the investors do not know the CEO's degree of overconfidence C, then the share price response to a dividend announcement is increasing in the dividend announced. If there is information asymmetry about the project (i.e., the CEO's signal s is private information) and investors do not know the CEO's degree of overconfidence, then the sensitivity of share price response to dividend announced is increasing in the uncertainty about the CEO's overconfidence.*

The market response to a dividend announcement depends on what the market learns about the quality of the project and about the CEO's overconfidence from the dividend announcement. Proposition 4 shows that when the market knows the quality of the project, it is learning only about the CEO's overconfidence. Since overconfident CEOs overinvest, a higher dividend indicates lower overinvestment and hence results in a higher stock price. When there is information asymmetry about the project quality in addition to uncertainty about the CEO's overconfidence, then the stock price response will also depend on what the market learns about the project quality. Since investment is increasing in project quality and the dividend is decreasing in project quality (see Proposition 2), a higher dividend signals lower project quality, thus reducing the stock price. However, the stock price response also reflects the learning about CEO's overconfidence. The latter effect leads to an increase in stock price because a higher dividend indicates lower overconfidence and lower overinvestment. The net change in stock price depends on which effect dominates. Proposition 4 shows that when there is greater uncertainty about the CEO's overconfidence, the stock price will be more sensitive to the amount of dividend declared.[6]

[6]Bouwman (2008) analyzes the stock price reaction to dividend announcements by managers who may be rational or optimistic and finds that announcement returns are higher for dividend increases by optimistic CEOs than by rational CEOs. Our model does not yield this result regardless of whether investors can distinguish between rational and overconfident CEOs.

We have so far assumed that the overconfident CEO always misinterprets information about the investment opportunity. However, the effect of overconfidence is strongest for new, private information and weaker for information that is widely held and accepted (see Daniel, Hirshleifer, and Subrahmanyam, 1998). A CEO's beliefs about some investment opportunities may be based on private information while for others, the CEO's beliefs may depend on widely available public information. CEO overconfidence will have a greater impact in the former case than in the latter. To incorporate this aspect of overconfidence, we now allow the firm to have access to a typical project and a novel project. The novel project's payoff replaces the single project we have considered so far and now the signal s is informative about the novel project. The signal provides no incremental information about the payoff distribution of the typical project. It is common knowledge that an investment $I \geq 0$ in the typical project yields $Qf(I)$ where $Q > 0$ is a positive constant known to all. We assume that the projects are mutually exclusive so the firm cannot simultaneously invest in both the typical project and the novel project.

The CEO now determines the levels of investment, dividend, and external financing based on the signal s and also decides whether the investment, if any, is made in the typical project or the novel project.

Proposition 5. *(a) The difference between an overconfident CEO's investment and a rational CEO's investment is a decreasing function of Q. (b) The difference between the dividend payout by a rational CEO and that by an overconfident CEO is a decreasing function of Q.*

The intuition behind Proposition 5 is as follows. The difference between the policies of the rational CEO and the overconfident CEO arises because the two CEOs differ in their interpretation of the quality of the novel project. However, when a CEO has a choice between investing in the typical project about which all information is public and in the novel project with some private information, CEO overconfidence impacts his views solely about the novel project because overconfidence acts only on the private signal and not on public information. Thus, CEO overconfidence will affect corporate policies if he chooses to invest in the novel project but not if he invests in the typical project. If the typical project has high quality (Q), then the CEO is less likely to invest in the novel project, and hence overconfidence is less likely to influence the CEO's dividend decision.

For our empirical analysis, we derive and test the following four hypotheses from our model:

Hypothesis 1. *Overconfident CEOs declare smaller dividends than rational CEOs. This hypothesis follows from Proposition 3.*

Hypothesis 2. *The difference between the dividend payments by a rational CEO and an overconfident CEO is smaller in a firm with a typical project of high-quality (Q). This follows from Proposition 5.*

The variable Q can be measured empirically by the market-to-book ratio of assets. A higher-quality typical project will lead to a higher valuation and to a higher market-to-book ratio, when the distribution of project quality for the novel project is fixed. CEO overconfidence leads to a smaller dividend payment but higher growth (market-to book ratio) mitigates the reduction in the dividend caused by CEO overconfidence. Therefore, in a regression model with dividend payout as the dependent variable, the coefficient on the interaction term of CEO overconfidence and growth should be positive.

Hypothesis 3. *The stock price reaction to an increase in dividend is positive if there is uncertainty about CEO overconfidence but not about the project quality. This hypothesis follows from Proposition 4.*

Hypothesis 4. *The sensitivity of the stock price response to the dividend increase is increasing in the uncertainty about the CEO overconfidence. This hypothesis also follows from Proposition 4.*

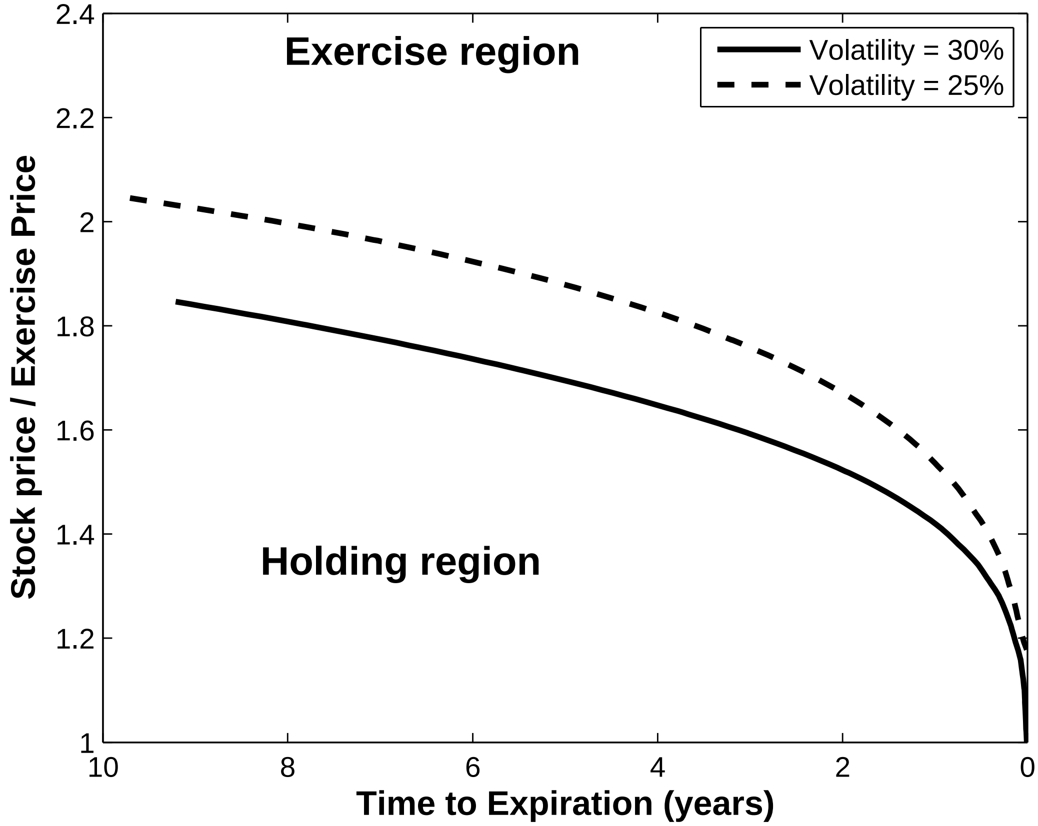
III. Data and Variables

A. **Data.** Our initial sample of firms is identical to that in Malmendier and Tate (2005, 2008) and in Malmendier, Tate, and Yan (2007), and is based on the sample of 477 firms in Hall and Liebman (1998) and in Yermack (1995). To be a part of this sample, a firm must 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 data set provides detailed information on CEO stock and stock option holdings. The dynamics of the option grants and holdings provide a reasonably clear picture of how a CEO rebalances his or her portfolio over his/her tenure. Malmendier and Tate (2008) use the data on option holdings to derive their portfolio-based overconfidence measures.[7] They rule out alternative explanations for these portfolio-based measures and argue that the measures capture the notion of CEO overconfidence quite well. They also use data from articles about CEOs in the business press to derive alternative press-based overconfidence measures. We use these overconfidence measures in our analysis of dividend policy.

Overconfidence is inferred in our sample from the CEO's option-exercise behavior. There are two reasons why an overconfident CEO is less likely to exercise an in-the-money stock option than a rational CEO. First, Section II shows that the overconfident CEO's investments are based on favorable private information. Since the CEO thinks the information is more precise than it actually is, he is overoptimistic about the expected value of the firm's future payoff (expected-value effect). He perceives his firm's stock to be undervalued and is reluctant to exercise stock options. Second, the overconfident CEO underestimates the volatility of the future payoff (volatility effect) whose effect on the CEO's exercise behavior is less obvious. While a lower stock return volatility reduces the value of the option to a diversified investor, the reduction in the risk imposed by the option on the underdiversified CEO increases the CEO's utility from holding on to the option. An overconfident CEO, thus, delays exercising the option compared to a rational CEO. Our replication of the Hall and Murphy (2002) analysis shows (see Figure

[7] Option grants usually represent a large component of CEO compensation packages. These options cannot be traded and the firms prohibit CEOs to hedge this exposure via short-selling their company stock. In addition, CEOs have their human capital invested in the firm. These effects in unison cause the CEO to be underdiversified and highly exposed to firm-specific risk. A CEO should exercise the options well before the expiration date, given rational exercise thresholds, to reduce the underdiversification. But, overconfident CEOs may hold the options longer (than rational CEOs) if they believe that the benefits of leaving the options unexercised outweigh the costs of underdiversification. Malmendier and Tate use this rationale to derive their portfolio-based overconfidence measures based on the option-exercise behavior of CEOs. For further details on these CEO overconfidence measures, see Malmendier and Tate (2005, 2008) and Malmendier, Tate, and Yan (2007).

Figure 1. **Stock Return Volatility and Option Exercise Boundary**



1) that the threshold moneyness for exercising an option with one year to maturity changes from slightly above 40% when the stock volatility is 30% to about 50% when the stock volatility is lowered to 25%, leaving all other parameters unchanged. Thus, both effects make overconfident CEOs less likely to exercise stock options than their rational counterparts.

From the panel data on the original sample of 477 firms, we eliminate firm-year observations for financial firms (SIC 6000-6999), utilities (SIC 4900-4999), and regulated telephone companies (SIC 4813). Our data cover the period, 1980-1994. We supplement the above data on CEO overconfidence with various items from the COMPUSTAT database to construct our control variables.

B. **Variables.** The various measures of overconfidence that we use in our study are as follows:

Longholder: This indicator variable 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. Malmendier and Tate (2008) use the calibrated exercise threshold of 40% based on the model in Hall and Murphy (2002) and assume that a CEO has a constant relative risk-aversion of 3 and 67% of his or her wealth is in the company stock. The Longholder variable represents a fixed effect over all of a CEO's years.

Pre-/Post-Longholder: Pre- and Post-Longholder represent a split of the Longholder (indicator) variable. These two measures, also based on the CEO's option-exercise behavior, allow for time variation over the sample period and eliminate forward-looking information in the classification of a CEO. Post-Longholder equals one in all those CEO-years that follow the year in which the CEO, for the first time, holds an option until the last year of expiration. Pre-Longholder equals one for those CEO years where Longholder equals one and Post-Longholder equals zero.[8]

TOTALconfident: Malmendier and Tate (2008) collect data on the CEO from articles in The New York Times, Business Week, Financial Times, The Economist, and The Wall Street Journal. For CEO i and sample year t, they compare the number of articles that refer to the CEO with the terms "confident" or "confidence" (a_{it}) and "optimistic" or "optimism" (b_{it}) *to* the number of articles that refer to the CEO as "not confident" (c_{it}) or "not optimistic" (d_{it}), and "reliable," "cautious," "conservative," "practical," "frugal," or "steady" (e_{it}). They use these data to construct the following press-based measure of overconfidence for CEO i in year t:

$$\text{TOTALconfident}_{it} = \begin{cases} 1 \text{ if } \sum_{s=1}^{t-1} a_{is} + b_{is} > \sum_{s=1}^{t-1} c_{is} + d_{is} + e_{is} \\ 0 \text{ otherwise} \end{cases}$$

As in Malmendier and Tate (2008), when we use TOTALconfident, we control for the

[8]For robustness, we also use the Holder67 measure from Malmendier and Tate (2008) and from Malmendier, Tate, and Yan (2007) despite its lack of power. Only 40% of the observations where the Longholder equals 1 or 0 fall in the Holder67 category. In other words, we lose 60% of the observations when we use the Holder67 variable.

total number of press mentions of a CEO (TOTALmentions) over the same period (i.e., over all the preceding sample years). The reason is that a press bias towards positive mentions might imply a positive association between press mentions of "confident" or "optimistic" *and* the total number of mentions.

The extant empirical literature on dividends indicates that dividend policy is strongly influenced by growth opportunities, cash flow, and firm size (Fama and French, 2001, 2002; Fenn and Liang, 2001; Smith and Watts, 1993). The overall evidence indicates dividends are positively related to both firm size and cash flow and negatively related to growth opportunities. Fenn and Liang (2001) also document the importance of stock and option ownership in determining dividend policy.

In the empirical analysis, we control for CEO stock ownership, CEO option ownership, growth opportunities, cash flow, and firm size.[9] The CEO's stock ownership, termed as *Stock Ownership*, equals the fraction of the company stock owned by the CEO and his immediate family as a fraction of common shares outstanding. The CEO's option ownership, termed as *Vested Options*, equals the ratio of the CEO's holdings of vested options, exercisable within six months, as a fraction of common shares outstanding. We use the natural logarithm of sales, termed as *Log of Sales,* as a proxy for firm size. For robustness, we also use the natural logarithm of the book value of assets.[10] We calculate *Growth* as the ratio of the market value of assets to book value of assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity[11]; *Cash Flow* as the ratio of operating income before depreciation to book value of assets (Opler and Titman, 1993; Fenn and Liang, 2001). We follow Fenn and Liang (2001) and calculate the *Dividend Payout*,

[9]We thank Ulrike Malmendier for providing us the data on both CEO stock ownership and CEO option ownership.

[10]The positive relation between size and dividend policy that is widely documented in the literature is consistent with several explanations. For instance, larger firms are viewed as having less asymmetric information and lower financing costs (see Fenn and Liang, 2001; Opler and Titman, 1993; Smith and Watts, 1992). In addition, larger firms are considered to have less volatile cash flows. Fama and French (2002) argue that firm size serves as a reasonable proxy for cash flow volatility, and firms with lower cash flow volatility are predicted to pay higher dividends (Fenn and Liang, 2001).

[11]See Smith and Watts (1992), Opler and Titman (1993), and Fenn and Liang (2001).

our dependent variable, as the ratio of common stock dividends to the market value of equity.

IV. Empirical Results

A. **Cross-Sectional Analysis.** First, we provide univariate comparisons between the subsample of firms with overconfident CEOs (i.e., Longholder = 1) and that with rational CEOs (Longholder = 0). Next, we perform a multivariate analysis by estimating a random-effects tobit model of dividend payout as a function of CEO overconfidence (or Longholder) and the various control variables discussed above. By using a multivariate tobit analysis, we control for all the relevant factors while examining the marginal impact of CEO overconfidence on dividend policy. To estimate our tobit model, we use those observations for which data are available on all our variables.

The summary statistics in Table I show that firms with Longholder (i.e., overconfident) CEOs have a lower dividend yield, which is our main variable of interest. In addition, firms with Longholder CEOs have a higher CEO option ownership and a higher CEO tenure. The associations between Longholder and CEO option ownership/tenure are likely to arise mechanically given the construction of the Longholder measure. We control for these variables in our empirical analysis.

[Table I here]

Next, we estimate a random-effects tobit model of dividend payout on the panel data for our sample firms. The independent variables are stock ownership, vested options, Longholder, growth, cash flow, and log of sales. The results from Model 1 in Table II indicate that the level of dividend payout is negatively related to Longholder, growth, stock ownership, and vested options. The coefficients on Longholder, growth, and vested options are statistically significant at the 1% level, and the coefficient on stock ownership is statistically significant at the 5% level. The results also indicate that the level of dividend payout is positively related to firm size, as measured by the logarithm of sales, and to cash flow. The coefficients on size and cash flow are statistically significant at the 1% level. The result with respect to firm size is robust when we use the logarithm of the book value of assets.

The negative coefficient on Longholder indicates that the level of dividend payout is negatively related to the level of CEO overconfidence and conforms to our main testable prediction (Hypothesis 1).[12] The rest of the results are consistent with previous evidence (see Fama and French, 2001, 2002; Fenn and Liang, 2001; Smith and Watts, 1992).

In untabulated analyses, we estimate a random-effects tobit model with an R&D intensity variable in place of the growth variable. We calculate R&D intensity as the ratio of R&D expenditures to book value of assets. However, R&D expenditures are available for only 60% of the observations. Except for the nonsignificance of the coefficient on stock ownership, the results remain robust to this specification. We use an alternative measure of cash flow calculated as operating income before depreciation less capital expenditures, scaled by the book value of assets (as in Fenn and Liang, 2001). Again, our results remain robust to this specification. Our overall results also remain robust to the inclusion of cash balances and to an alternative measure of growth, calculated as the annual percentage increase in assets (see Fama and French, 2002). Finally, our results are also robust to the inclusion of industry effects and when we winsorize the data at the 99$^{\text{th}}$ percentile and the 1$^{\text{st}}$ percentile (where applicable).[13]

In all the models, a likelihood ratio test strongly rejects a tobit model on pooled data and thus favors a random-effects specification. We test for collinearity by computing the variance inflation factors for the independent variables used in Model 1, Table II. The highest value for the variance inflation factor is 1.61 with an average value of 1.26 across all the variables. The low value for the variance inflation factors indicates that collinearity is not a problem in our data.[14]

[12] We also estimate a model with the Holder67 variable as a measure of CEO overconfidence. As suspected, the coefficient on Holder67 is not significantly different from zero (see footnote 7).

[13] We also estimate a random-effects tobit model with industry effects. We follow Malmendier and Tate (2008) and control for the following industries via indicator variables: Technical (SIC 1000-1799, 8711), Manufacturing ((SIC 2000-3999), Transportation (SIC 4000-4899), Trade (5000-5999), and Service (SIC 7000-8710, 8712-8720, 8722-8999). Except for the nonsignificance of the size variable, the results remain robust to the inclusion of industry effects.

[14] Collinearity might be a problem if the largest variance inflation factor (VIF) is greater than ten and the mean of the VIFs (across all independent variables) is substantially larger than one. For further details, see Chatterjee, Hadi, and Price (2000).

In Model 2, Table II, we use Pre- and Post-Longholder, in place of the Longholder variable. The overall results are qualitatively similar to those in Model 1. The coefficient on Post-Longholder, however, has much stronger statistical significance than that on the Pre-Longholder variable. The results from this refinement in our model specification suggest that the impact of overconfidence on dividend policy appears to be stronger after the CEO has exhibited his/her overconfidence via his/her actions (i.e., delaying option exercise until expiration).

[Table II here]

Our summary statistics in Table I indicate that, on average, Longholder CEOs have a longer tenure with the firm. To ensure that the relation between Longholder and dividend payout is not driven by a longer CEO tenure, we control for CEO tenure in our analysis. The results, presented in Model 1, Table III, indicate that the negative relation between Longholder and dividend payout is robust to the inclusion of CEO tenure. The coefficient on CEO tenure is nonsignificant and suggests that CEO tenure has no effect on dividend policy.

Fenn and Liang (2001) and Fama and French (2002) document a negative relation between dividends and leverage. For robustness, we control for leverage in the random-effects tobit model even though leverage is not exogenous. We calculate leverage as the ratio of total long-term debt plus the amount of (long-term) debt in current liabilities to book value of assets. Our results indicate that the coefficient on leverage is negative and significant and is consistent with the findings in Fama and French (2002) and in Fenn and Liang (2002). Again, the negative relation between Longholder and dividend payout is robust to the inclusion of leverage. The rest of the results remain qualitatively the same. The results in Table III also remain qualitatively the same when we replace Longholder with Pre-Longholder and Post-Longholder.

[Table III here]

We measure CEO overconfidence with the Longholder variable, which is based on the option-exercise behavior of CEOs. Specifically, Longholder, a binary variable, equals one for those CEOs who delay option exercise until the last year of the option's life and zero otherwise. An alternative explanation for the negative relation that we document between Longholder and dividend payout is that a lower dividend payout leads to delayed option exercise. However, we do not believe that our findings result from this reverse causality for the following five reasons.

First, our (untabulated) results indicate that there is no statistically significant difference in the median dividend yield between observations with Longholder = 1 and those with Longholder = 0. Figure 2 shows our results for the option exercise boundaries based on the assumptions of Hall and Murphy (2002) for three cases: no dividends, dividend yield of 2.3% (the median for Longholder CEOs), and dividend yield of 2.9% (the mean for Non-Longholder CEOs). There is little difference between the threshold moneyness for the latter two cases suggesting that the delayed option-exercise of Longholder CEOs does not appear to be caused by a lower dividend payout.

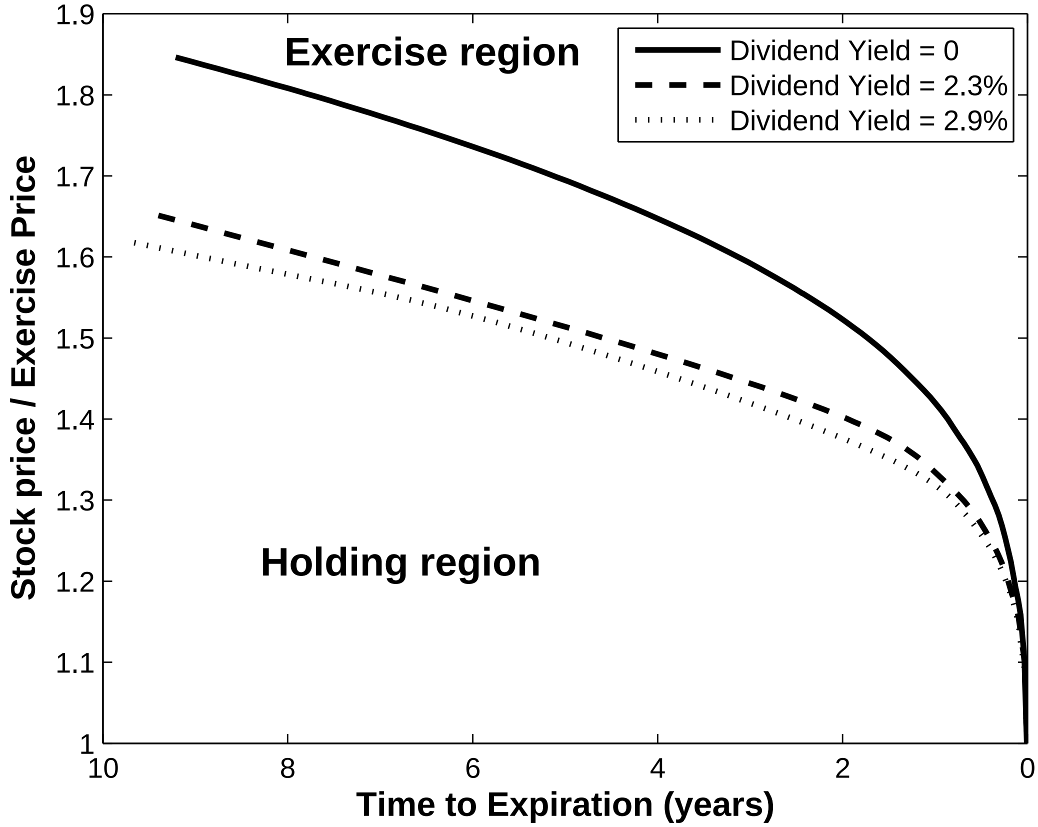
Second, our results in Table II indicate that the magnitude of the coefficient on the Post-Longholder variable is about 2.5 times as large as that on the Pre-Longholder variable. Note that the Pre- and the Post-Longholder variables represent a split of the Longholder variable for a given firm across time. If the option-exercise behavior of CEOs is driven by the dividend payout of a firm, then there should not be such a systematic difference in the relation between the dividend payout in the Pre and Post-Longholder years.

Third, the reverse-causality argument suggests that firms with a lower dividend payout have CEOs that exercise stock options late. However, it does not explain why some firms have CEOs that suboptimally delay option exercise and also pay lower dividends compared to other firms.

Fourth, if the reverse-causality explanation is true, then the relation between the Longholder variable and dividend payout should be stronger in firms where CEOs hold more options than in other firms. We test this hypothesis by interacting the Longholder variable with i) a dummy variable that equals one for above-median holdings of Vested Options and ii) with Vested Options itself. In either case, we do not find any evidence that the relation between dividend payout and the Longholder variable is stronger for firms where CEOs hold more vested options.

Finally, we use an alternative measure of CEO overconfidence that is based on the

FIGURE 2. **Dividend Yield and Option Exercise Boundary**



characterization of the CEO by the press. Since press mentions of CEOs are unlikely to be affected by dividend policy, this variable allows for a clean and robust test of the relation between CEO overconfidence and dividend policy. We estimate a random-effects tobit model of dividend payout with TOTALconfident, the press-based measure of CEO overconfidence. The rest of the explanatory variables are the same as in Model 1, Table II. The results under Model 1 in Table IV indicate that the coefficient on TOTALconfident is negative and significant at the 1% level. This confirms the finding with respect to Longholder and is consistent with Hypothesis 1. We also control for the total number of CEO mentions and find that our findings remain robust as documented in Model 2, Table IV.

[Table IV here]

We also examine the relation between total payout and CEO overconfidence. Following Allen and Michaely (2003), we calculate total payout as the sum of dividends and share repurchases divided by the market value of equity.[15] We estimate a tobit model using total payout as the dependent variable, with the independent variables the same as those in Model 1, Table II. Our untabulated results indicate that the (negative) coefficient on the Longholder variable is not significantly different from zero. In a second tobit model, we replace Longholder with Pre- and Post-Longholder and again find the (negative) coefficients on Pre- and Post-Longholder not significantly different from zero. Finally, we use the press-based measure, TotalConfident, as the measure of CEO overconfidence and find that its coefficient is negative and significant at the 5% level. In these models, the rest of the results remain qualitatively the same as those when dividend payout is used as the dependent variable.

The finance literature suggests important differences between dividends and repurchases, which may lead to these weaker results with respect to CEO overconfidence. Dividends represent a stronger commitment to a stable policy and, accordingly, tend to be paid out of permanent earnings. Repurchases, in contrast, are flexible and more volatile, and tend to be paid out of temporary cash flows (Jagannathan, Stephens, and Weisbach, 2000). In addition, firms appear to time repurchases in response to other considerations such as when the stock price is low and when there is a build-up of cash (see Allen and Michaely, 2003; Brav, Graham, Harvey, and Michaely, 2005; Lie, 2000). As a result, the irregular nature of repurchases introduces a notable element of randomness in the total payout variable, which will be less predictable (and more noisy) than dividends alone. In light of these basic differences, it is not surprising to find much weaker results when using total payout instead of dividend payout.

Growth opportunities, cash flow, and firm size appear to be the three most important factors that affect dividend policy (see Smith and Watts, 1992; Fama and French, 2001, 2002). Firm size is widely accepted as a measure of asymmetric information in that

[15] Share repurchases equal the value of the purchase of common and preferred stock (compustat data item 115) minus any reduction in the redemption value of preferred stock (compustat data item 56).

larger firms have less asymmetric information (see Bhushan, 1989). Therefore, the evidence on the relation between size and dividends suggests a link between dividend policy and asymmetric information. Given these findings, we examine how the relations between dividend payout and growth, cash flow, and the level of asymmetric information, respectively, are influenced by CEO overconfidence. We use the Longholder measure of overconfidence to assess how the dividend payout depends on the interaction between overconfidence and these other determinants of dividend policy.

Hypothesis 2 predicts the difference in the dividend payout between overconfident and rational CEOs to be smaller for firms with existing projects of high quality. Our (empirical) measure for growth opportunities represents the value of both assets in place and future investments. This measure, however, is based on public information and can thus be viewed as "the typical asset" in the context of our model. A higher value for our (empirical) growth measure corresponds to existing assets (or "typical projects") of higher quality. Therefore, Hypothesis 2 predicts the negative relation between growth and dividend payout to be weaker for firms with overconfident CEOs.

Our results in Model 1 in Table V are consistent with our hypothesis. The negative coefficients on growth and Longholder indicate that both higher growth and overconfidence are associated with a lower dividend payout. The coefficient on the interaction term between growth and Longholder is positive. Taken together, these results indicate that regardless of whether the CEOs are rational or overconfident, a CEO in a higher-growth firm pays a smaller dividend than a similar CEO in a lower-growth firm. However, the difference in the dividend payout between higher-growth and lower-growth firms is smaller for overconfident CEOs than for rational CEOs. Stated equivalently, the decline in dividend payout caused by CEO overconfidence is smaller for higher-growth firms than for lower-growth firms.

Our model does not provide any predictions on the effect of CEO overconfidence on the relation between dividend payout and cash flow. Neither does the literature on behavioral corporate finance. In spite of the lack of a predicted relation, we investigate the effect of CEO overconfidence on the widely documented relation between dividend policy and cash flow. Our results in Model 2 in Table V indicate that the magnitude of the positive coefficient on cash flow is higher for firms with overconfident CEOs. One possible explanation for this finding is that for a given level of cash flow, an overconfident CEO perceives the future cash flow to be higher relative to a rational CEO and thus adopt a higher payout.

We draw on the existing literature on both corporate and behavioral finance to derive a testable hypothesis concerning the influence of CEO overconfidence on the relation between dividend payout and asymmetric information. Asymmetric information problems can make managers reluctant to raise funds through external sources, which might lead to underinvestment (Myers and Majluf, 1984). Since overconfident managers perceive their firms to be undervalued (Malmendier, Tate, and Yan, 2007), they would be more reluctant to raise funds through external sources thus exacerbating the underinvestment problem caused by asymmetric information. One mechanism to control the underinvestment problem is to increase financial slack via a lower dividend payout (see Fama and French, 2002). Here, the negative effect of CEO overconfidence on dividend payout is complemented by the negative effect of asymmetric information. Therefore, we expect the negative relation between asymmetric information and dividend payout to be stronger for firms managed by overconfident CEOs.

We believe that firm size may also capture attributes of a firm other than information asymmetry and that asset tangibility is a more accurate measure of information asymmetry. Therefore, we control for firm size (via the logarithm of sales) and use asset tangibility as a proxy for the level of asymmetric information. We calculate asset tangibility as the ratio of property, plant, and equipment to book value of assets. The higher the asset tangibility, the lower the level of asymmetric information. The results under Model 3 in Table V indicate that the coefficient on asset tangibility is positive. This finding indicates that firms with more asymmetric information pay lower dividends. The results also indicate that the magnitude of the positive coefficient on asset tangibility is higher for firms with overconfident CEOs. Therefore, the negative effect of asymmetric information on dividend payout is stronger for firms with overconfident CEOs, consistent with our prediction. In the presence of asymmetric information, overconfident CEOs perceive a higher wedge between the cost of internal and external funds and, thus, respond by adopting a lower dividend payout to enhance the availability of internal funds. This finding corroborates the evidence in Malmendier, Tate, and Yan (2007), who document that overconfident CEOs exhibit a pecking order behavior.

[Table V here]

B. **Dividend Changes: Analysis of Stock Market Effects.** We use a standard market-model methodology to measure the impact of dividend-increase announcements on the stock price of announcing firms.[16] To enhance the likelihood of a notable unexpected component in the announcements, we only include announcements of dividend increases of at least 10%. This lower bound of 10% ensures that we include only economically significant dividend increases. This approach is consistent with the extant body of research on dividend changes. For instance, Grullon, Michaely, and Swaminathan (2002) use dividend changes of at least 12.5% in their comprehensive study of dividend changes. Their results remain robust when they consider dividend changes of at least 10%. The authors examine the frequency distribution of dividend changes and argue that the lower bound of 12.5% (or 10%) seems to be the best in terms of including big dividend changes. They also argue that dividend changes of at least 12.5% (or 10%) are likely to be categorized as surprises (or unexpected changes) regardless of the underlying dividend expectation model. To the extent that our lower bound of 10% may also include dividend increases that are not unexpected, we introduce a bias against finding both statistically and economically significant relations between the stock-market response and the variables we use.

We identify 898 dividend-increase announcements, from CRSP, over our sample period, 1980-1994. We use data from CRSP to estimate the market-model parameters. The estimation period is 255 days and ends 46 trading days before the announcement

[16]The empirical evidence on dividend policy suggests that dividend increases are significantly more frequent than dividend decreases as firms are usually reluctant to decrease dividends. Based on the data in Allen and Michaely (2003), the median (annual) number of dividend increases over the sample period of our study, i.e., between 1980 and 1994, is 1635 and the median (annual) number of dividend decreases is 95. Over this period, the minimum (maximum) number of dividend increases is 1072 (2513) and the minimum (maximum) number of dividend decreases is 59 (322). Given the paucity of data on dividend decreases, we focus on the sample of dividend increases.

date. We compute cumulative abnormal returns (CAR) over a three-day window that begins the day before and ends the day after the announcement date. We estimate a market model using the CRSP value-weighted index. The (untabulated) results from the market model indicate that both the mean and the median three-day cumulative abnormal return are significantly positive, consistent with previous findings.

The positive market reaction to the dividend increase announcement is also consistent with Hypothesis 3. Given our overconfidence measure, investors can ascribe overconfidence with a greater likelihood when a CEO holds an option until expiration. Those overconfident CEOs, who have not held an option until expiration, will not be identified as such. These unidentified overconfident CEOs get pooled with the rational CEOs, resulting in uncertainty about CEO overconfidence. As proposition 4 suggests, an announcement of a dividend change provides information on both project quality and the level of CEO overconfidence. A dividend increase announcement conveys information that the project quality is poorer (implying a stock price decrease) and/or that the CEO is less overconfident implying lower overinvestment (and a higher stock price). In our sample, the net stock price response across all firms is positive and suggests that the dividend increase announcement, on average, appears to be more informative about CEO overconfidence. This finding provides an alternative explanation of the positive stock market response to dividend increase announcements.

Our objective, however, is to examine the relation between CEO overconfidence and the stock-market response to dividend-increase announcements. A univariate comparison of the CAR between Longholder CEOs and Non-Longholder CEOs yields no statistically significant difference between the two groups. This result is not surprising as the CAR is likely to be affected by several factors that can easily confound the results in a univariate analysis. Therefore, we employ a multivariate analysis and examine the relation between the CAR and CEO overconfidence while controlling for relevant attributes.

An OLS regression of the announcement-period returns or CAR (for dividend-increasing firms only) may yield biased estimates of the parameters if the decision to increase dividends depends systematically on firm-specific attributes. A failure to control for this choice will introduce a selection bias in our empirical analysis. To control for a potential selection bias, we estimate a regression model with sample selection using full maximum likelihood. We use the Post-Longholder variable to measure CEO overconfidence. We do not use the Longholder variable as it represents a managerial fixed effect and identifies the CEO as overconfident in all firm-years. However, investors can ascribe overconfidence only after the CEO has held the option until expiration. Thus, from the investors' perspective, the Post-Longholder variable appropriately identifies overconfident CEOs.

The dependent variable in the selection equation is an indicator variable that equals one if the firm increased its dividends, and zero otherwise. In the selection equation, the independent variables are stock ownership, vested options, Pre-Longholder, Post-Longholder, growth, cash flow, log of sales, CEO tenure, and leverage. In the selection equation, which examines the CEO's decision to increase dividends, we use the Pre-Longholder variable both for completeness and to examine if the decision to increase dividends (by the CEO) differs across Pre- and Post-Longholder years. The results, reported in Table VI (under selection equation), indicate that the likelihood of a dividend increase is positively related to Post-Longholder. The CEO becomes more likely to increase dividends after he or he has held an option, for the first time, until the final year of expiration. The coefficient on the Pre-Longholder variable is nonsignificant.

The dependent variable in the regression equation is the three-day CAR based on the value-weighted index. In the regression equation, the independent variables are stock ownership, vested options, Post-Longholder, growth, cash flow, log of sales, and the percentage increase in dividends. The coefficient on Post-Longholder is negative and significant ($p = \mathit{0.038}$) and this finding is consistent with Hypothesis 4. For the subset of firms with Post-Longholder CEOs, a dividend increase announcement conveys more information about (poorer) project quality than about the level of overconfidence.[17]

[17] To see that the overconfidence of Post-Longholder CEOs is known more precisely, consider two groups of CEOs: highly overconfident with overconfidence $C = C_H + \epsilon$ and less overconfident with overconfidence $C = C_L + \epsilon$. A Post-Longholder CEO has been revealed to be a highly overconfident CEO while a CEO who is not a Post-Longholder may be highly confident with probability π. Then $Var(C) = Var(\epsilon)$ for PostLongholder CEOs while $Var(C) = Var(\epsilon) + \pi(1-\pi)(C_H - C_L)^2 > Var(\epsilon)$ for CEOs who are not a Post-Longholder.

In contrast, for the remaining firms, the dividend-increase announcement conveys relatively more information about the level of overconfidence. Thus, the magnitude of the positive reaction to the dividend-increase announcement is lower for firms managed by Post-Longholder CEOs.[18]These results indicate that the market response to dividend announcements depends on investors' perception of CEO overconfidence, among other factors.

V. Model Extension: Endogenous Cost of Financing Future Investment

This section extends the model to show the robustness of our main result to endogenizing the cost of external financing. We also introduce a dynamic aspect to the model so that the dividend is not simply residual of concurrent investment needs and is based on expectation of future investment needs. These changes highlight the intuition that overconfident CEOs who view external financing as excessively costly build financial slack for future investment needs by lowering dividend payout.

We modify the model in Section II by introducing an additional date, date 3. The CEO still observes a signal about an investment project at date 0. However, this project becomes available to the firm at date 2 rather than at date 1 and its cash flow is realized at date 3. For simplicity, we assume that the investment required for the project I is fixed but the may or may not invest in the project. The firm also makes an investment at date 1 but there is no uncertainty about this investment. The firm starts with a cash balance C_0 and must maintain non-negative cash balance at all dates. At date 1, the firm invests an amount $I_1 < C_0$ and this investment yields a payoff of X at date 2. The CEO determines the dividend D_1 and the amount of external financing to raise F_1. We eliminate the exogenous cost of external financing in the main model by assuming $\beta = 0$. The cash balance of the firm changes to $C_1 = C_0 - I_1 - D_1 + F_1$. The firm may hold an arbitrarily high amount of cash indefinitely if there is no cost of holding cash . To prevent this unrealistic scenario, we assume that cash balance is dissipated between

[18]A likelihood ratio test overwhelmingly rejects the null hypothesis of zero correlation between the selection and regression equations in our model of sample selection. This finding suggests that the dividend increases we study are not random choices and, thus, a simple OLS model would have produced biased estimates of the parameters.

dates 1 and 2 and between dates 2 and 3 so that a cash balance of C_t at Date $t \in \{1, 2\}$ reduces to $g(C_t)$ at Date $t+1$ where $g(0) = 0, g'(0) = 1$, and $g'' < 0$. This cost could be thought of as the opportunity cost of holding liquid assets or agency cost of maintaining cash as in Jensen (1986).

We assume that the firm needs external financing at date 1 or at date 2 if it invests in the project at date 2: $I > g(C_0 - I_1) + X$. At date 2, the CEO determines the dividend D_2 and the amount of external financing to be raised F_2. The new cash balance C_2 equals $g(C_1) + X - I - D_2 + F_2$ if the CEO invests and $g(C_1) + X - D_2 + F_2$ otherwise. If the firm invests at date 2, the investment yields $Yf(I)$ at date 3 so the firm distributes $g(C_2) + Yf(I)$ to investors. If the firm does not invest at date 2, it distributes $g(C_2)$ to investors.

We now analyze the cash balance the firm maintains. First note that the firm does not hold any cash balance after date 2 ($C_2 = 0$) because holding cash is costly so it is better to pay out cash as dividend at date 2 rather than at date 3. The firm's actions at date 1 depend on whether it will invest at date 2. The CEO bases this decision on the signal observed at date 0 about the project quality. If the firm is not going to invest at date 2, it does not hold any cash after date 1. If it is going to invest at date 2, it may hold cash to reduce the amount of external financing necessary for financing the project at date 2. The firm's actions at date 1 help investors noisily infer the CEO's signal. All uncertainty is resolved at date 1 and everyone anticipates the equilibrium behavior at date 2.

Next, consider the financing decisions. First note that the firm will never raise external financing and pay dividends simultaneously. Raising external financing to simultaneously pay out dividend is a positive-NPV transaction for current shareholders only if the firm's securities are undervalued so in equilibrium, new investors will not provide capital for dividend payout. The firm has sufficient cash to invest at date 1 ($C_0 > I_1$). Since there is a cost of retaining cash, the firm would prefer to raise external financing at date 2 rather than raise external financing at date 1 for investment at date 2. Thus, no external financing is raised at date 1, $F_1 = 0$. At date 2, the firm may raise external financing for investment only if it does not pay any dividend ($D_2 = 0$) or retain cash

$(C_2 = 0)$.

Now, we focus on the dividend decision at date 1. If the CEO is not going to invest at date 2, he pays dividend $D_1 = C_0 - I_1$ to bring cash balance C_1 to zero. If the CEO is going to invest at date 1, the dividend decision depends on the perceived cost of date-2 external financing which in turn depends on the perceived underpricing of equity. Let y_C be the CEO's estimate of the project quality and let $y_M(D_1)$ be the market's expectation of the project quality as inferred from dividend D_1. Note that the market cannot noiselessly recover the CEO's signal because the dividend D_1 depends on the CEO's signal as well as the CEO's overconfidence that is unknown to the market. The CEO believes that the value of the firm after the events at date 2 equals $y_C f(I)$. The investors' estimate of that value equals $y_M(D) f(I)$. The equity will be priced so that new investors at date 2 expect to get a stake which equals their contribution F_2. Thus, original shareholders will retain a fraction $(y_M(D) f(I) - F_2) / (y_M(D) f(I))$ that is decreasing in the amount of external financing raised. The latter is just sufficient to bridge the gap between the firm's investment need and its cash balance: $F_2 = I - g(C_1) - X = I - g(C_0 - I_1 - D_1) - X$. Thus, the CEO believes that the stake of original shareholders in the firm is worth

$$y_C \frac{y_M(D_1) f(I) - I + g(C_0 - I_1 - D_1) + X}{y_M(D_1)}. \tag{8}$$

The CEO believes this stake to be more valuable if he estimates the project quality y_C to be higher and also when the investors' estimate the project $y_M(D_1)$ to be higher because that enables the firm to get better terms on external financing. At date 1, the CEO's dividend decision maximizes the total payoff to the original shareholders: the dividend payout D_1 and their stake in the firm as given by (8). Thus, conditional on investment at date 2, the payoff to the original shareholders is

$$\max_{0 \le D_1 \le C_0 - I_1} D_1 + y_C \frac{y_M(D_1) f(I) - I + g(C_0 - I_1 - D_1) + X}{y_M(D_1)}. \tag{9}$$

The CEO's investment decision is based on a comparison of (9) with the following payoff to shareholders when the firm does not invest at date 2:

$$C_0 - I_1 + X. \tag{10}$$

Note that the CEO's overconfidence C and the private signal s enter the CEO's problem in (9) and (10) only through the CEO's estimate of project quality y_C so the CEO's decisions must depend only on y_C. Consider a value of y_C such that the CEO invests at date 2. This requires that (9) exceeds (10). Since the dividend $D_1 \leq C_0 - I_1$ in (9) is less than the payoff in (10), the coefficient of y_c must be positive in (9). Then, (9) will continue to exceed (10) for even higher values of y_C. Thus, the CEO will invest at date 2 precisely if his estimate of project quality y_C exceeds a threshold $\bar{y}_C$.

The equilibrium must be of a form in which a CEO declares maximum dividend of $C_0 - I_1$ at date 1 and doesn't invest at date 2 if he estimates project quality $y_C < \bar{y}_C$, and declares dividend $D_1 = h(y_C)$ and invests at date 2 if $y_C > \bar{y}_C$. We assume that h is invertible so on observing less than maximum dividend, investors infer expected project quality as $y_M(D_1) = E\left[y\,|y_C = h^{-1}(D_1)\right]$. The CEO's objective in (9) can be rewritten as

$$\max_{0 \leq D_1 \leq C_0 - I_1} D_1 + y_C f(I) - \frac{y_C}{y_M(D_1)} \left\{I - g\left(C_0 - I_1 - D_1\right) - X\right\}. \tag{11}$$

This objective is maximized when the CEO follows equilibrium dividend policy. If the equilibrium dividend level for a CEO who estimates project quality as y_C is $D_1 = D^* \equiv h(y_C)$, the first-order condition is:

$$1 - \frac{y_C}{y_M(D^*)} \left[g'\left(C_0 - I_1 - D^*\right) - \frac{y_M'(D^*)}{y_M(D^*)} \left\{I - g\left(C_0 - I_1 - D^*\right) - X\right\}\right] = 0. \tag{12}$$

A CEO who estimates a higher project quality $\hat{y}_C > y_C$ will prefer to pay lower dividend at date 1 because the objective in (11) is decreasing in D_1 at $D_1 = D^*$. This is seen by recalculating the derivative in (12) with the CEO's project quality estimate $\hat{y}_C$:

$$1 - \frac{\hat{y}_C}{y_M(D^*)} \left[g'\left(C_0 - I_1 - D^*\right) - \frac{y_M'(D^*)}{y_M(D^*)} \left\{I - g\left(C_0 - I_1 - D^*\right) - X\right\}\right] < 0. \tag{13}$$

The inequality is obtained from (12) and $\hat{y}_C > y_C$. The intuition is that a CEO choosing less than maximum dividend payout is trading off the benefit of higher payout to investors versus the cost of reduced future payoff to investors. A more overconfident CEO perceives the cost of dividend payout to be higher because he perceives the external financing that will be needed in future following a larger dividend payout to be more costly due to equity undervaluation. Thus, a CEO with a higher estimate of project quality pays a lower dividend. A higher estimate of project quality can result from a higher signal about the project quality or from higher CEO overconfidence.

We draw two main results from this analysis. First, a more overconfident CEO is more likely to invest in the project at date 2 than a less overconfident or rational CEO even when both observe the same signal. Second, conditional on investing in the project at date 2, the firm led by a more overconfident CEO declares lower dividend at date 1 than a firm led by a less overconfident or rational CEO even if the two CEOs observe the same signal about the project quality. The reason for the overinvestment by the overconfident CEO is the overestimation of the project quality compared to a rational CEO. The reason for the lower dividend payout by the overconfident CEO is that the overconfident CEO perceives equity as more undervalued and hence external financing as more costly than does a rational CEO. While the model in Section II showed that an overconfident CEO may reduce dividend payout in order to increase concurrent investment, this extension shows that the reduction in dividend may also be motivated by a desire to build internal capital for future investment when external financing is perceived to be costly.

VI. Conclusion

Our model of the effect of CEO overconfidence on dividend policy yields several testable predictions that we examine empirically. The main testable prediction is that an overconfident CEO pays a lower level of dividends relative to a rational CEO. Our model also predicts the difference in the dividend payout between higher and lower-growth firms to be smaller in firms managed by overconfident CEOs. Another prediction is that the stock price response to announcements of dividend changes is an increasing function of the uncertainty about CEO overconfidence. We test these predictions, along with other implications from the dividend literature, using a panel data of large U.S. companies. We use the measures of CEO overconfidence derived by and used in Malmendier and Tate (2005, 2008) and in Malmendier,Tate, and Yan (2007).

Consistent with our main prediction, we find that the level of dividend payout is lower in firms managed by overconfident CEOs. Next, we document that the difference in the dividend payout between higher-growth and lower-growth firms is smaller for firms with overconfident CEOs. This finding indicates that the reduction in dividend payout caused by CEO overconfidence is smaller in higher-growth firms and is also consistent with the prediction of our model. We also document that, in firms with overconfident CEOs, both the positive relation between dividend payout and cash flow and the negative relation between asymmetric information and dividend payout are stronger.

Finally, we analyze market perceptions about the relation between CEO overconfidence and dividend policy by examining the stock price response to announcements of dividend increases by our sample firms. We find that the magnitude of the positive stock price response to announcements of dividend increases is higher in firms in which there is uncertainty about the level of CEO's overconfidence. This finding is consistent with our hypothesis that dividends provide information about CEO overconfidence. Specifically, dividend increases indicate lower CEO overconfidence and that this informativeness is higher when there is greater uncertainty about CEO overconfidence.

Proof of Proposition 1: (a) With $\beta = 0$, (3) and (4) can be combined to get

$$Z(s,I,D,F) = Z(s,I) = y(s) f(I) - I + C_0 \tag{14}$$

Consider $s \leq \underline{s}$. For $I > 0$,

$$\begin{aligned} \frac{\partial Z(s,I)}{\partial I} &= y(s) f'(I) - 1 \\ &< 0. \quad (\text{because } f'(I) < f'(0) = 1/y(\underline{s}) \leq 1/y(s)\,) \end{aligned}$$

Thus, optimal investment is 0. The result about net payout follows from (4).

(b) Define $I^*(s)$ by

$$f'(I^*(s)) = 1/y(s). \tag{15}$$

$I^*(s)$ is the optimal investment level because it maximizes the CEO's objective in (14). Further, it is increasing in s because $y(s)$ is increasing in s (see (1)). The result about net payout follows from (4). □

Proof of Lemma 1: Combining (3) and (4) in the problem (3)-(5), we get

$$Z(s,I) = \max_{D,F} \; y(s) f(I) - I + C_0 - \beta F \tag{16}$$

subject to

$$D = C_0 + (1-\beta) F - I \geq 0, \text{ and} \tag{17}$$

$$F \geq 0. \tag{18}$$

If $I \leq C_0$, (17) follows from (18) and can be ignored. The optimal solution is $F = 0$ and $D = C_0 - I$. If $I > C_0$, (18) follows from (17) and can be ignored. The optimal solution is $D = 0$ and $F = (I - C_0)/(1-\beta)$. Substituting the two solutions in (16) gives the desired expression for Z. □

Proof of Proposition 2: (a) For $I > 0$,

$$\begin{aligned} Z(s,I) &\leq y(s) f(I) - I + C_0 = C_0 + \int_0^I \{y(s) f'(x) - 1\} \,\mathrm{d}x \\ &< C_0 \quad (\text{because } f'(x) < f'(0) = 1/y(\underline{s}) \leq 1/y(s)) \\ &= Z(s,0,C_0,0) \leq Z(s,0). \end{aligned}$$

Thus, optimal investment is 0. The results about dividends and external financing follow from Lemma 1.

(b) Define $I^*(s)$ as in (15). Since $\underline{s} < s < \hat{s}$, (15) and (6) imply that $0 < I^*(s) < C_0$. Further, $I^*(s)$ maximizes $y(s) f(I) - I$ so for arbitrary $I \geq 0$,

$$\begin{aligned} Z(s, I^*(s), C_0 - I^*(s), 0) &= y(s) f(I^*(s)) - I^*(s) + C_0 \\ &\geq y(s) f(I) - I + C_0 \geq Z(s, I), \end{aligned}$$

where the second inequality follows from Lemma 1. Thus, optimal investment is $I^*(s)$. Further, it is increasing in s because $y(s)$ is increasing in s and f is concave in (15). The results about dividends and external financing follow from Lemma 1.

(c) For $I < C_0$,

$$\begin{aligned} Z(s, C_0, 0, 0) &= y(s) f(C_0) = y(s) f(I) - I + C_0 + \int_I^{C_0} \{y(s) f'(x) - 1\} \mathrm{d}x \\ &\geq y(s) f(I) - I + C_0 \\ &= Z(s, I) \quad \text{(from Lemma 1)}, \end{aligned}$$

where the inequality follows because $f'(x) > f'(C_0) = 1/y(\hat{s}) \leq 1/y(s)$.

For $I > C_0$,

$$\begin{aligned} Z(s, C_0, 0, 0) &= y(s) f(C_0) = y(s) f(I) - \frac{I - C_0}{1 - \beta} - \int_{C_0}^{I} \left\{ y(s) f'(x) - \frac{1}{1-\beta} \right\} \mathrm{d}x \\ &\geq y(s) f(I) - \frac{I - C_0}{1 - \beta} \\ &= Z(s, I) \quad \text{(from Lemma 1)}, \end{aligned}$$

where the inequality follows from $f'(x) < f'(C_0) = \frac{1}{(1-\beta) y(\bar{s})} < \frac{1}{(1-\beta) y(s)}$.

(d) Define $I^*(s)$ by

$$f'(I^*(s)) = \frac{1}{(1-\beta) y(s)}. \tag{19}$$

Since $s > \bar{s}$, (6) and (19) imply that $I^*(s) > C_0$. Further, $I^*(s)$ maximizes $y(s) f(I) -$

$I/(1-\beta)$. For $I \geq C_0$,

$$\begin{aligned} Z\left(s, I^*(s)\right) &= y(s) f\left(I^*(s)\right) - \frac{I^*(s) - C_0}{1-\beta} \\ &\geq y(s) f(I) - \frac{I - C_0}{1-\beta} = Z(s, I) \quad \text{(from Lemma 1).} \end{aligned}$$

For $I \leq C_0$,

$$\begin{aligned} Z\left(s, I^*(s)\right) \geq Z\left(s, C_0\right) &= y(s) f\left(C_0\right) = y(s) f(I) - I + C_0 + \int_I^{C_0} \left\{y(s) f'(x) - 1\right\} \mathrm{d}x \\ &\geq y(s) f(I) - I + C_0 \\ &= Z(s, I) \ , \end{aligned}$$

where the inequality follows from $f'(x) > f'(C_0) = 1/y(\hat{s}) > 1/y(s)$. $\square$

Proof of Proposition 3: Note that the signal thresholds $\underline{s}$, $\hat{s}$, and $\bar{s}$ in (6) depend on C as y depends on C (see (7)). Consider part (a). From (7) and (6), we get

$$\underline{s} = \frac{1}{f'(0)} + \frac{\eta_y}{C\eta_s}\left(\frac{1}{f'(0)} - \mu_y\right) \tag{20}$$

From (2) and (20), $\underline{s} > \mu_y$, so for $s < \mu_y$, $I = 0$ regardless of C. Now, consider $s > \mu_y$. From lemma 1, we get

$$\frac{\mathrm{d}^2}{\mathrm{d}I\,\mathrm{d}C} Z(s, I) = f'(I) \frac{\mathrm{d}}{\mathrm{d}C} y(s, C) > 0\,,$$

because for $s > \mu_y$, $y(s, C)$ is an increasing function of C (see (7)). Thus, if a CEO with lower C is indifferent towards or prefers a higher I, a CEO with higher C prefers a higher I. Thus, I is increasing in C.

Next, consider $I_2 > I_1$. If $C_0 > I_2 > I_1$, then using Lemma 1, we get

$$Z(s, I_2) - Z(s, I_1) = y(s, C)\left\{f(I_2) - f(I_1)\right\} - (I_2 - I_1) \ .$$

If $I_2 > C_0 > I_1$, then,

$$Z(s, I_2) - Z(s, I_1) = y(s, C)\left\{f(I_2) - f(I_1)\right\} - \frac{I_2 - C_0}{1-\beta} + (I_1 - C_0) \ .$$

If $I_2 > I_1 > C_0$, then,

$$Z(s, I_2) - Z(s, I_1) = y(s, C)\left\{f(I_2) - f(I_1)\right\} - \frac{I_2 - I_1}{1-\beta}\,.$$

In the first of the three cases above, $Z(s, I_2) - Z(s, I_1)$ is independent of β while in the remaining two cases it is decreasing in β. Thus, $Z(s, I_2) - Z(s, I_1)$ is weakly decreasing in β. Similarly, $Z(s, I_2) - Z(s, I_1)$ is increasing in C_0 in the second case but independent of C_0 in the other two cases so $Z(s, I_2) - Z(s, I_1)$ is weakly increasing in C_0. Thus, the optimal investment must be weakly decreasing in β and weakly increasing in C_0.

In parts (b) and (c), $\frac{\mathrm{d}D}{\mathrm{d}C} \leq 0$ and $\frac{\mathrm{d}F}{\mathrm{d}C} \geq 0$ follow from part (a) and Lemma 1. Consider the effect of initial cash C_0. If dividend $D > 0$, investment I is not constrained by initial cash C_0. An increase in C_0 leaves I unchanged and increases D. If $D = 0$, an increase in C_0 cannot decrease D further. Thus, $\frac{\mathrm{d}D}{\mathrm{d}C_0} \geq 0$. Similarly, if the amount of capital raised through external financing $F > 0$, investment I exceeds initial cash C_0 and is determined by (19). A decrease in C_0 leaves I unchanged and increases F. If $F = 0$, a decrease in C_0 cannot decrease F further. Thus, $\frac{\mathrm{d}F}{\mathrm{d}C_0} \leq 0$.

Finally, consider the effect of cost of external financing β. If $F > 0$, investment I is determined by (19), which shows that a decrease in β increases I which in turn increases F (from Lemma 1). If $F = 0$, a decrease in β cannot decrease F further. Thus, $\frac{\mathrm{d}F}{\mathrm{d}\beta} \leq 0$. $\square$

Proof of Proposition 4: When there is no uncertainty about s, a higher dividend conveys no information about s but indicates lower overconfidence C and results in a share price increase because a less overconfident CEO overinvests to a lesser extent (see Proposition 3). When there is uncertainty about s as well as C, the share price at dividend announcement equals the expected value of $Z(s, I)$ minus expected loss from underpricing to new investors at date 1. However, since all investors are rational and the firm raises capital in a competitive market, new securities are fairly priced based on rational investors' expectations. Thus, the share price equals the expected value of $Z(s, I)$. Let $P(D)$ be the share price when dividend is D and no external capital is raised ($F = 0$). From (3) and (4), the share price with full payout is $P(C_0) = C_0$. From (3), (4), and (15), the share price with partial payout ($0 < D < C_0$) is $P(D) = E[y(s, 1)\,|y(s, C) = 1/f'(C_0 - D)]\, f(C_0 - D) + D$. The sensitivity of share price change to dividends is proportional to $P(C_0) - P(D)$, which is decreasing in $E\left[y\left(s,1\right)\left|y\left(s,C\right)=1/f'\left(C_0-D\right)\right.\right]$. Thus, we need to show that $E\left[s\left|y\left(s,C\right)=1/f'\left(C_0-D\right)\right.\right]$ is decreasing in uncertainty about C. Define $x\equiv 1/\left(C\eta_s\right)$. Since a distribution with greater uncertainty in the second-order-stochastic dominance sense can be achieved through a series of mean preserving spreads (see Mas-Colell, Whinston, and Green (1995)), we compare two cases: one in which x has a point distribution and another a binary distribution, representing a mean preserving spread around the point distribution. To ensure that the distributions differ only in uncertainty and not in mean, we shall keep $E\left[x\right]$ fixed for the two cases. First consider the point distribution with $x=\overline{x}$. From (7), we get

$$E\left[s\left|y\left(s,C\right)=1/f'\left(C_0-D\right)\right.\right]=\left(1+\eta_y\overline{x}\right)\left(\frac{1}{f'\left(C_0-D\right)}-\mu_y\right)+\mu_y. \tag{21}$$

Now consider the binary distribution such that $x=x^H$ with probability π and $x=x^L$ with probability $1-\pi$ where $x^H>x^L$ and

$$\pi x^H+\left(1-\pi\right)x^L=\overline{x}. \tag{22}$$

Let s^H and s^L be the values of s conditional on $x=x^H$ and $x=x^L$, respectively. Then,

$$s^H=\left(1+\eta_y x^H\right)\left(\frac{1}{f'\left(C_0-D\right)}-\mu_y\right)+\mu_y, \tag{23}$$

and

$$s^L=\left(1+\eta_y x^L\right)\left(\frac{1}{f'\left(C_0-D\right)}-\mu_y\right)+\mu_y. \tag{24}$$

The expected value of s, using Bayes rule, is

$$\begin{aligned} E\left[s\left|y\left(s,C\right)=1/f'\left(C_0-D\right)\right.\right] &= \frac{\pi f\left(s^H\right)s^H+\left(1-\pi\right)f\left(s^L\right)s^L}{\pi f\left(s^H\right)+\left(1-\pi\right)f\left(s^L\right)} \\ &< \pi s^H+\left(1-\pi\right)s^L \\ &= \left(1+\eta_y\overline{x}\right)\left(\frac{1}{f'\left(C_0-D\right)}-\mu_y\right)+\mu_y. \end{aligned} \tag{25}$$

Here, the inequality follows from $f\left(s^H\right)<f\left(s^L\right)$ as (23) and (24) show that $s^H>$

$s^L > \mu_y$. Comparison of (21) and (25) shows that when there is more uncertainty about C (or x), $E[s]$ is lower so stock price reaction is more sensitive to dividend payout. $\square$

Proof of Proposition 5: (a) In absence of the typical project, Proposition 2 shows that investment is a weakly increasing function and dividend is a weakly decreasing function of the signal s. Further, since, the signal affects the CEO's choice solely through its effect on $y(s, C)$, investment is an increasing function $I^*(y(s, C))$ while dividend is a decreasing function $D^*(y(s, C))$. The sole effect of the access to the typical project is that the CEO prefers the novel project over the typical project if $y(s, C) > Q$ and the typical project over the novel project if $y(s, C) < Q$. Thus, CEO's policy depends on $\max(Q, y(s, C))$ with investment $I^*(\max(Q, y(s, C)))$ and dividend $D^*(\max(Q, y(s, C)))$.
Differentiating investment with respect to C, we have

$$\begin{aligned}
\frac{\mathrm{d}I}{\mathrm{d}C} &= \frac{\mathrm{d}}{\mathrm{d}C} I^*\left(\max\left(Q, y\left(s, C\right)\right)\right) \\
&= \left.\frac{\mathrm{d}I^*\left(x\right)}{\mathrm{d}x}\right|_{x=\max(Q, y(s,C))} \times \frac{\mathrm{d}y\left(s, C\right)}{\mathrm{d}C} \times \mathbf{1}\left(Q < y\left(s, C\right)\right) \\
&= \left.\frac{\mathrm{d}I^*\left(x\right)}{\mathrm{d}x}\right|_{x=y(s,C)} \times \frac{\mathrm{d}y\left(s, C\right)}{\mathrm{d}C} \times \mathbf{1}\left(Q < y\left(s, C\right)\right) \\
&= \frac{\mathrm{d}I^*\left(y\left(s, C\right)\right)}{\mathrm{d}C} \times \mathbf{1}\left(Q < y\left(s, C\right)\right) \,, \qquad (26)
\end{aligned}$$

where indicator function $\mathbf{1}(A)$ equals 1 if expression A is true and 0 otherwise. The first term on the right hand side of (26) is positive from Proposition 3 while the second term is a decreasing function of Q so $\mathrm{d}I/\mathrm{d}C$ is decreasing in Q.
(b) Proceeding as in part (a), we can show that

$$\frac{\mathrm{d}D}{\mathrm{d}C} = \frac{\mathrm{d}D^*\left(y\left(s, C\right)\right)}{\mathrm{d}C} \times \mathbf{1}\left(Q < y\left(s, C\right)\right) \,.$$

Since the first term on the right hand side is negative while the second term is decreasing in Q, $\mathrm{d}D/\mathrm{d}C$ is increasing in Q. $\square$

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Table I
Summary Statistics: Longholder CEO Firms vs. Non-Longholder CEO Firms

Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. 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 assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales. Leverage equals the ratio of long-term debt to book value of assets. CEO Tenure is the tenure of the CEO (in years) with the firm. We base the summary statistics on pooled observations (across firms and time) with available data for the variables.

	Longholder CEOs			**Non-Longholder CEOs**		
Variable	**Mean**	**Median**	**Standard Deviation**	**Mean**	**Median**	**Standard Deviation**
Dividends to Market Value of Equity	0.024	0.023	0.02	0.029	0.024	0.11
Book Value of Assets (in $ millions)	3427.91	1768.77	5706.75	3961.40	1904.83	6576.33
Sales (in $ millions)	3846.03	2234.89	4894.28	4398.17	2345.08	6347.38
Stock Ownership	0.016	0.003	0.04	0.031	0.002	0.09
Vested Options	0.066	0.021	0.14	0.017	0.005	0.04
Growth	1.751	1.451	1.03	1.625	1.312	1.01
Cash Flow	0.179	0.171	0.09	0.158	0.153	0.08
Leverage	0.214	0.208	0.13	0.238	0.223	0.15
CEO Tenure (years)	10.88	9.00	7.20	8.34	6.00	7.60
Observations		573			2236	

Table II
Does CEO Overconfidence Affect Dividend Payout?

This table provides estimates from a random-effects tobit model, which is estimated on the pooled data. The dependent variable equals the ratio of total dividends to market value of equity. Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. 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. Post-Longholder is a binary variable that equals 1 for all CEO-years after the CEO, for the first time, holds the option package until expiration. Pre-Longholder is a binary variable that equals 1 for CEO-years where Post-Longholder equals 0 and Longholder equals 1. Growth equals the ratio of the market value of assets to book value of assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales.

	Model 1			**Model 2**		
Variable	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**
Constant	-0.0052	-0.37	0.708	-0.0089	-0.71	0.481
Stock Ownership	-0.0356	-2.41	0.016**	-0.0382	-5.07	0.000***
Vested Options	-0.0372	-2.99	0.003***	-0.0390	-3.56	0.000***
Longholder	-0.0040	-2.62	0.009***			
Post-Longholder				-0.0066	-4.04	0.000***
Pre-Longholder				-0.0026	-1.72	0.085*
Growth	-0.0104	-13.39	0.000***	-0.0102	-14.04	0.000***
Cash Flow	0.0454	5.68	0.000***	0.0449	6.34	0.000***
Log of Sales	0.0018	2.95	0.003***	0.0019	3.42	0.001***
Observations	2809			2809		
Number of Firms	244			244		
Log Likelihood	4510.07			4513.10		
χ^2	328.39***			363.42***		

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

Table III

CEO Overconfidence and Dividend Payout: Controlling for CEO Tenure and Leverage

This table provides estimates from a random-effects tobit model, which is estimated on the pooled data. The dependent variable equals the ratio of total dividends to market value of equity. Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. 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 assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales. CEO Tenure is the tenure of the CEO (in years) with the firm. Leverage equals the ratio of long-term debt to book value of assets.

	Model 1			**Model 2**		
Variable	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**
Constant	-0.0066	-0.54	0.589	-0.0055	-0.46	0.646
Stock Ownership	-0.0368	-6.12	0.000***	-0.0373	-5.78	0.000***
Vested Options	-0.0364	-3.47	0.001***	-0.0396	-4.03	0.000***
Longholder	-0.0039	-2.53	0.012**	-0.0047	-3.79	0.000***
Growth	-0.0104	-12.03	0.000***	-0.0102	-15.89	0.000***
Cash Flow	0.0477	6.64	0.000***	0.0405	5.84	0.000***
Log of Sales	0.0018	3.34	0.001***	0.0019	3.51	0.000***
CEO Tenure	-0.0001	-1.36	0.172			
Leverage				-0.0085	-2.56	0.011**
Observations	2775			2806		
Number of Firms	242			244		
Log Likelihood	4476.41			4513.62		
χ^2	315.44***			420.22***		

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

Table IV

CEO Overconfidence and Dividend Payout: Press Measures of Overconfidence

This table provides estimates from a random-effects tobit model, which is estimated on the pooled data. The dependent variable equals the ratio of total dividends to market value of equity. Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. TOTALconfident is a binary variable that equals 1 when the number of "confident" and "optimistic" mentions for a CEO exceeds the number of "not confident", "not optimistic", and "reliable, cautious, practical, conservative, steady, frugal" mentions. TOTALmentions is the total number of articles mentioning the CEO in both searches. Both TOTALconfident and TOTALmentions are based on the total number of articles over the sample period up to the previous year. Growth equals the ratio of the market value of assets to book value of assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales.

	Model 1			**Model 2**		
Variable	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**
Constant	-0.0307	-3.02	0.003***	-0.0342	-3.36	0.001***
Stock Ownership	-0.0305	-5.83	0.000***	-0.0299	-5.63	0.000***
Vested Options	-0.0340	-5.13	0.000***	-0.0331	-4.99	0.000***
TOTALconfident	-0.0045	-5.05	0.000***	-0.0042	-4.66	0.000***
TOTALmentions				-0.00001	-1.90	0.058*
Growth	-0.0096	-16.70	0.000***	-0.0096	-16.69	0.000***
Cash Flow	0.0369	6.29	0.000***	0.0359	6.08	0.000***
Log of Sales	0.0030	6.52	0.000***	0.0031	6.89	0.000***
Observations	2432			2432		
Number of Firms	245			245		
Log Likelihood	2509.55			2511.24		
χ^2	573.42***			582.46***		

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

Table V
CEO Overconfidence and Dividend Payout: Interactive Effects of Overconfidence with Growth Opportunities, Cash Flow, and Asymmetric Information

This table provides estimates from a random-effects tobit model, which is estimated on the pooled data. The dependent variable equals the ratio of total dividends to market value of equity. Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. 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 assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales. Asset Tangibility equals the ratio of property, plant, and equipment (PPE) to book value of assets.

	Model 1			**Model 2**			**Model 3**		
Variable	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**
Constant	-0.0067	-0.60	0.548	-0.0053	-0.41	0.679	0.0261	14.28	0.000***
Stock Ownership	-0.0318	-4.16	0.000***	-0.0312	-4.47	0.000***	-0.0448	-8.32	0.000***
Vested Options	-0.0380	-3.77	0.000***	-0.0332	-3.83	0.000***	-0.0406	-5.12	0.001***
Longholder	-0.0101	-4.57	0.000***	-0.0113	-4.37	0.000***	-0.0010	-3.01	0.003***
Longholder*Growth	0.0036	3.50	0.000***						
Longholder*Cash Flow				0.0443	3.42	0.001***			
Longholder*Asset Tangibility							0.0147	1.95	0.052*
Growth	-0.0119	-19.15	0.000***	-0.0112	-12.76	0.000***	-0.0090	-15.86	0.000***
Cash Flow	0.0429	5.97	0.000***	0.0426	5.52	0.000***	0.0543	7.73	0.000***
Log of Sales	0.0020	3.96	0.000***	0.0018	3.19	0.001***			
Asset Tangibility							0.0103	3.52	0.000***
Observations	2809			2809			2802		
Number of Firms	244			244			244		
Log Likelihood	4515.73			4512.71			4507.03		
χ^2	527.89***			268.01***			446.83***		

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

Table VI
Announcements of Dividend Increases: Stock Market Effects and CEO Overconfidence

This table provides the maximum likelihood estimates from a regression model with sample selection. In the selection equation, the dependent variable equals one if the firm announced a dividend increase of at least 10% and zero otherwise. In the regression equation, the dependent variable equals the three-day cumulative abnormal return associated with the dividend-increase announcement. The sample contains 899 dividend-increase announcements (or has uncensored observations). Stock Ownership is the ratio of total shares (owned by the CEO and his immediate family) to the number of shares outstanding. Vested options equals the CEO's ownership of options (exercisable within six months of the beginning of the year) as a fraction of shares outstanding. Post-Longholder is a binary variable that equals 1 for all CEO-years after the CEO, for the first time, holds the option package until expiration. Pre-Longholder is a binary variable that equals 1 for CEO-years where Post-Longholder equals 0 and Longholder equals 1. 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 assets, where the market value of assets equals the market value of equity plus the book value of total assets minus the book value of equity. Cash Flow equals the ratio of operating income before depreciation to book value of assets. Log of Sales equals the natural logarithm of sales. CEO Tenure is the tenure of the CEO (in years) with the firm. Leverage equals the ratio of long-term debt to book value of assets. Dividend Increase is the percentage increase in the dividend from the preceding period.

	Selection Equation			**Regression Equation**		
Variable	**Coefficient**	**z**	**Pr>z**	**Coefficient**	**z**	**Pr>z**
Constant	-4.0398	-7.26	0.000***	0.0832	2.87	0.004***
Stock Ownership	0.4900	1.33	0.183	0.0332	1.68	0.093*
Vested Options	-1.0854	-2.64	0.008***	0.0776	3.10	0.002***
Post-Longholder	0.2248	2.32	0.020**	-0.0088	-2.07	0.038**
Pre-Longholder	-0.1225	-1.61	0.108			
Growth	-0.0000	-0.00	1.000	-0.0001	-0.04	0.964
Cash Flow	6.8291	15.07	0.000***	-0.1200	-4.50	0.000***
Log of Sales	0.1132	4.59	0.000***	-0.0013	-1.09	0.275
CEO Tenure	-0.0017	-0.48	0.632			
Leverage	-0.1233	-0.69	0.489			
Dividend Increase				0.0107	1.90	0.058*
Observations			2828			
Uncensored			899			
Log Likelihood			218.10			
Wald χ^2			42.83***			
χ^2 for LR Test ($\rho = 0$)			13.32***			

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

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