R&D Expenditures and CEO Compensation

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ABSTRACT: This study investigates whether compensation committees seek to prevent opportunistic reductions in R&D expenditures. I hypothesize that changes in R&D spending are more strongly positively associated with changes in CEO compensation in two situations: (1) when the CEO approaches retirement, and (2) when the firm faces a small earnings decline or a small loss. Consistent with these hypotheses, the results indicate that the association between changes in R&D spending and changes in the value of CEO annual option grants is significantly positive in the above two situations, and insignificant otherwise. Similar results hold for changes in CEO annual total compensation. The results also show that neither situation is associated with reduced R&D spending. Overall, these findings suggest that compensation committees respond to, and effectively mitigate, potential opportunistic reductions in R&D spending.

Keywords: R&D expenditures; CEO compensation; managerial opportunism.

Data Availability: Data are available from sources identified in the paper.

I. INTRODUCTION

Previous studies document that R&D spending is both an impetus for firm growth and a source of competitive advantage (e.g., Ettlie 1998; Lev and Sougiannis 1996). However, managers may reduce R&D spending to opportunistically boost short-term performance (e.g., Bushee 1998). Indeed, opportunistic reductions in R&D spending become more likely when: (1) the CEO approaches retirement (Dechow and Sloan 1991)—the horizon problem, and (2) the firm faces a small earnings decline or a small loss (Baber et al. 1991)—the earnings benchmarking myopia problem.

This study investigates whether the compensation committees of boards of directors deter opportunistic reductions in R&D spending in the presence of the horizon and myopia...
problems. Prior studies (e.g., Gibbons and Murphy 1992) suggest that compensation committees adjust CEO incentive arrangements to mitigate more severe potential of cutting R&D spending. A positive association between changes in R&D spending and changes in CEO compensation discourages CEOs from reducing R&D spending. Therefore, I hypothesize that changes in R&D spending are more strongly positively associated with changes in CEO compensation when the horizon and/or myopia problems are present.

I test these hypotheses by regressing changes in CEO compensation on changes in R&D spending and its interactions with horizon and myopia indicators, controlling for earnings before R&D expenditures and stock returns. The data are from 160 Forbes 500 firms in R&D-intensive industries over the period 1984–1997. Consistent with the hypotheses, the results indicate a significant increase in the association between changes in R&D spending and changes in the value of CEO annual option grants in the presence of the horizon and myopia problems. This association is significantly positive when the horizon or myopia problem is present, and insignificant otherwise. For an average firm, the results imply that a $1,000 increase in R&D spending is associated with a $2.48 ($4.32) increase in the value of CEO annual option grants in the presence of the horizon (myopia) problem, and a $7.08 increase in the value of CEO annual option grants in the presence of both problems. These results are robust to the inclusion of various controls such as CEO equity portfolios and block holdings. Similar results also hold for changes in CEO total annual compensation (i.e., the sum of salary, annual bonus, stock options, and other long-term incentives), but do not hold for changes in CEO cash compensation (i.e., the sum of salary and annual bonus).1

I also test whether increasing the association between changes in R&D spending and changes in the value of CEO annual option grants is effective in mitigating opportunistic reductions in R&D expenditures. The results indicate that the horizon and myopia problems are not significantly associated with reductions in R&D spending, even after controlling for factors such as CEO equity portfolios and block holdings.2 Overall, the findings of this study suggest that compensation committees prevent potential opportunistic reductions in R&D expenditures by adjusting the relation between changes in R&D spending and changes in the value of CEO annual option grants, and this adjustment is effective in mitigating such opportunistic reductions.

This study makes two contributions to the literature. First, it shows how firms, acting through compensation committees, address situations where opportunistic reductions in R&D spending are more likely. Prior studies focus on documenting managerial opportunism in such situations, but do not examine whether compensation committees prevent the opportunism. Dechow and Sloan (1991) identify CEO stock ownership as a mechanism to mitigate the problem of cutting R&D spending, but do not examine whether compensation committees actually use this mechanism. Baber et al. (1991) find that firms cut R&D spending when facing small earnings declines, but do not examine mechanisms to mitigate such cuts.

Second, this study advances our understanding of the relation between R&D spending and CEO compensation. Although R&D spending is generally desirable to shareholders

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1 The arrangements of the compensation committee in the current period do not have a direct effect on the value of CEO stock and option holdings from the prior periods. Thus, this study focuses on CEO annual compensation, the direct compensation of the CEO, controlling for CEO equity portfolios. In Section V, I discuss the reasons why I obtain different results for the value of CEO annual option grants versus CEO cash compensation.

2 This finding is consistent with Butler and Newman (1989) and Murphy and Zimmerman (1993), but is inconsistent with Baber et al. (1991) and Dechow and Sloan (1991). Section V presents discussions about these different results.

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(Lev and Sougiannis 1996), Bizjak et al. (1993) find that R&D spending is negatively associated with CEO cash and total compensation. Matsunaga (1995) finds no association between R&D spending and the value of employee stock option grants. One possible reason for these mixed findings is that in general settings, it is unclear whether compensation committees should motivate more R&D spending, because of the possibility of over-investment in R&D. By focusing on situations where opportunistic reductions in R&D expenditures are more likely, this study sharpens predictions about the relation between R&D expenditures and CEO compensation.

The next section develops the hypotheses. Section III discusses research design. Section IV describes the sample and data. Section V reports the results, followed by conclusions in Section VI.

II. HYPOTHESIS DEVELOPMENT

CEO Incentives to Cut R&D Spending

CEOs consider the benefits and costs of R&D spending, and they invest in R&D only when the expected personal benefits dominate the expected personal costs. Their expected costs of R&D spending include the negative impact of R&D spending on short-term accounting and stock performance, since these measures affect CEO compensation and job security (Dechow and Skinner 2000; Murphy 1999). The negative impact of R&D spending on current accounting earnings is due to the fact that R&D spending is typically immediately expensed under U.S. GAAP. Therefore, CEOs who want to boost current accounting earnings have incentives to reduce R&D spending (e.g., Baber et al. 1991; Dechow and Sloan 1991).

In addition, CEOs may consider R&D investments as less desirable than other investments in terms of the impact of the investments on short-term stock prices. Relative to other investments, R&D projects often are associated with higher information asymmetry between managers and shareholders (e.g., Clinch 1991) and greater uncertainty of the future benefits (e.g., Chan et al. 2001; Kothari et al. 2002). As a result, current stock prices likely do not fully reflect the future benefits of R&D spending (Lev and Sougiannis 1996). Therefore, CEOs concerned with short-term stock prices may reduce R&D spending to increase investments with benefits fully (or better) reflected in current stock prices.

Furthermore, CEOs may believe that stock markets may temporarily undervalue their firms based on current earnings, and hence perceive R&D spending to have a negative impact on short-term stock prices. During the 1980s, CEOs of major U.S. corporations blamed the equity market’s excessive focus on short-term accounting earnings for declines in long-term investment (Drucker 1986). This belief is seemingly consistent with empirical findings that stock markets reward firms for meeting or beating short-term earnings targets, despite the possibility of earnings management or expectations management (Bartov et al. 2002; Skinner and Sloan 2002). Because a temporary undervalueation can negatively affect current CEO compensation, attract takeover bids, and threaten CEO job security, CEOs

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3 These studies use R&D intensity as a proxy for growth opportunities or information asymmetry, and predict positive associations between R&D spending and compensation.

4 This study does not focus on the CEO’s incentive to reduce R&D spending in order to benefit from insider trading, because insider trading is not uniquely or more seriously related to R&D spending or the horizon and myopia problems. I consider the effect of insider trading incentives by controlling for CEO equity portfolios and find that the results of this study are robust to the inclusion of CEO equity portfolios. In addition, earnings-based compensation is not the only source of CEO incentives to cut R&D spending. Consistent with this notion, Baber et al. (1991, 828) find that R&D reductions documented in their study are not related to the use of earnings-based compensation.
with this belief are likely to sacrifice R&D and other long-term spending to inflate current earnings. Indeed, when earnings are used to forecast firm value, Stein (1989) shows that “even a fully efficient market can lead managers who care about stock prices to behave myopically.”

The discussions above suggest that CEOs are concerned with short-term accounting and stock performance, and these concerns generate incentives for CEOs to reduce R&D spending. Such incentives become stronger when CEOs approach retirement or face earnings shortfalls (Baber et al. 1991; Dechow and Sloan 1991). As the CEO approaches retirement, it is less likely for the CEO to benefit from current R&D investments. Meanwhile, the CEO’s career concern diminishes, and the CEO becomes more short-term oriented (Gibbons and Murphy 1992) due to weakened concern about the discipline from the managerial labor markets. Likewise, when facing deteriorating economic performance, the CEO is more concerned with the expected personal costs of R&D spending, since poor performance may trigger such results as job termination and corporate takeover, which may disentitle the CEO to the future benefits of current R&D spending. Thus, CEOs have incentives to reduce R&D spending in order to reverse a poor performance, especially if an expected shortfall is small and thus more easily reversed (Burgstahler and Dichev 1997; Bushee 1998).5

Adjustments to CEO Compensation

When CEO incentives to reduce R&D spending become stronger, compensation committees may adjust CEO compensation arrangements to mitigate such incentives (e.g., Gibbons and Murphy 1992; Lewellen et al. 1987). This adjustment should affect CEOs’ considerations of the expected personal benefits and the expected personal costs of R&D spending in favor of R&D expenditures. One possible adjustment is to establish a greater positive association between changes in R&D spending and changes in CEO compensation. Such a greater association makes increasing R&D spending more beneficial to the CEO, and reducing R&D spending more costly to the CEO. Therefore, whether CEOs want to reduce R&D spending to increase their annual compensation, the temporary value of their stock holdings, or their job security, such an increase motivates more R&D spending. For this reason, I focus on the association between changes in R&D spending and changes in CEO compensation.

Following prior studies (e.g., Baber et al. 1996; Lambert and Larcker et al. 1987; Sloan 1993), I focus on the contemporaneous association between changes in R&D spending and changes in CEO compensation.6 Compensation committees could intensify such contemporaneous association through ex ante contracts or ex post discretion. Ex post discretion is

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5 When the earnings decline or loss is large, CEOs may have incentives to take a “big bath” by opportunistically increasing R&D spending. In analyses not reported in this paper, I find that the big bath problem does not significantly affect R&D spending or the relation between R&D spending and CEO compensation, probably because overinvestment in R&D decreases both earnings and stock returns, and is thus less likely to be a serious issue.

6 An association between changes in R&D spending in the current period and changes in CEO compensation in the prior period may exist. For example, stock options granted in the prior period may have such an effect. However, stock options are usually granted independent of future R&D spending. If in the prior period the compensation committee anticipated the current period’s CEO incentives to reduce R&D and hence granted stock options accordingly in the prior period, it is reasonable to expect the compensation committee to be better able to tie the current period’s stock options to current R&D spending, which should be reflected in the contemporaneous association between changes in R&D spending and changes in CEO compensation. Furthermore, the lagged changes in R&D spending may be associated with the current changes in CEO compensation. When the lagged changes in R&D spending are included in the analyses, the results about the contemporaneous association between changes in R&D spending and changes in CEO compensation remain unchanged.

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possible, because contracts on compensation components other than salary are usually incomplete. Although performance measures and standards for annual bonus plans are normally specified at the beginning of the year, some performance measures may be subjective (e.g., Murphy 1999). Even for objective measures such as earnings, the measurement may not be precisely specified in the bonus plans (Dechow et al. 1994). Likewise, equity-based incentive plans often do not specify the size and timing of the awards (Aboody and Kasznik 2000). For example, according to Lockheed Martin’s proxy statements filed with the SEC in March 1998, the determination of the number of options awarded is “within the complete discretion” of the Stock Option Subcommittee of the Compensation Committee.

Meeting several times a year (e.g., six to eight times according to Murphy [1999]), compensation committees are likely to be able to evaluate R&D activities based on R&D budgets and actual spending. When they anticipate opportunistic reductions in R&D spending at the beginning of the year (e.g., the CEO is retiring), compensation committees could specify the relation between R&D spending and CEO compensation in bonus contracts and equity incentive plans. Such ex ante arrangements induce desired R&D spending in the year. For situations unforeseen before bonus contracts and incentive plans are made (e.g., the firm faces an earnings decline late in the year), compensation committees may exercise discretion in bonus contracts or equity incentive plans to establish an ex post relation between R&D spending and CEO compensation. To the extent CEOs anticipate such ex post “settling up,” their incentives to cut R&D spending are mitigated. This logic leads to the following two hypotheses.

H1 (Mitigating the horizon problem): Ceteris paribus, changes in R&D expenditures and changes in CEO compensation are more strongly positively associated when the CEO is approaching retirement than when the CEO is not.

H2 (Mitigating the myopia problem): Ceteris paribus, changes in R&D expenditures and changes in CEO compensation are more strongly positively associated when the firm faces a small earnings decline or a small loss than when the firm does not.7

III. RESEARCH DESIGN

Measurement of the Main Variables

CEO Compensation

Consistent with prior studies (e.g., Baber et al. 1996; Bizjak et al. 1993; Clinch 1991), this study focuses on CEO annual compensation, which is directly influenced by the compensation committee. I use three measures of CEO annual compensation: cash, option, and total compensation. CEO cash compensation is the sum of CEO salary and annual bonus. CEO option compensation is the value of stock options granted in the fiscal year (valued at the end of the fiscal year using the Black and Scholes (1973) model adjusted for dividends).8 CEO total compensation is the sum of CEO cash compensation, option compensation, fringe benefits, and other long-term incentives.

7 Dikolli (2001) shows that when the horizon problem is more severe, greater emphasis should be placed on “forward-looking” measures. His prediction is consistent with H1 if R&D-related “forward-looking” measures (e.g., innovations, new products, and patents) are used in CEO compensation contracts.

8 Because I am unable to obtain the grant dates of the options granted before 1992, I do not estimate the value of stock options at the grant date.
The Horizon Problem

Horizon, a proxy for the horizon problem, equals 1 if the CEO is at least 63 years old, and 0 otherwise. This definition reflects the fact that CEOs typically retire between the ages of 64 and 66 (Murphy 1999).9

The Myopia Problem

Myopia, a proxy for the myopia problem, equals 1 if a firm faces a small earnings decline or a small loss in a given year, and 0 otherwise. Following Baber et al. (1991) and Bushee (1998), I assume that the CEO holds unbiased expectations of other components of pre-tax earnings prior to decisions on R&D spending. Specifically, firm i in year t faces a small earnings decline if it satisfies two conditions (Bushee 1998, 311): (1) pretax income$_{it}$ + R&D expenditures$_{it}$ < pretax income$_{it-1}$ + R&D expenditures$_{it-1}$, and (2) pretax income$_{it}$ + R&D expenditures$_{it}$ > pretax income$_{it-1}$. Condition (2) simply means that the decrease in pretax earnings is “small” or less than R&D expenditures$_{it}$. Firm i in year t has a small loss if $-1$ percent $\leq$ pretax income$_{it}$/market value of equity$_{it-1} < 0$. This definition of a small loss is similar to the one used in Burgstahler and Dichev (1997).10

R&D Expenditures

I use Compustat item #46 to measure R&D expenditures. This item includes internal R&D spending plus acquired in-progress R&D, both of which are typically expensed under the U.S. GAAP (SFAS No. 2, FASB 1974).11

Empirical Specification

To examine whether compensation committees arrange CEO compensation so as to mitigate potential opportunistic reductions in R&D spending, I focus on the contemporaneous association between changes in R&D spending and changes in CEO compensation. This focus is consistent with agency theory that suggests an association between a change in compensation and unexpected components of the performance measures (Lambert and Larcker 1987). Following Baber et al. (1996) and Larcker and Lambert (1997), I use changes in R&D spending relative to the prior year to measure unexpected R&D spending. As such, I use changes in R&D spending as a proxy for CEO actions, rather than a proxy

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9 The results are not sensitive to this choice. For example, using either 60 or 62 as the cut-off yields similar results. Furthermore, following Dechow and Sloan (1991) and Murphy and Zimmerman (1993), I use the two years preceding the CEO retirement as an alternative measure of the horizon problem. A CEO turnover is considered as a normal retirement if the CEO was 64 or older at turnover (e.g., Murphy 1999). The main results remain unchanged.

10 Managers also may use analysts’ forecasts as earnings targets, reducing R&D spending when earnings vary from analysts’ expectations (Perry and Grinaker 1994). I do not use analysts’ forecasts as CEOs’ earnings targets, because this would require data on analysts’ expectations of R&D expenditures to estimate expected pre-R&D earnings (Bushee 1998). Further, I define a “small earnings decline” as a decrease in pretax earnings that is less than 50 percent or 80 percent of R&D expenditures$_{it}$, and a “small loss” as $-3$ percent or $-5$ percent $\leq$ pretax income$_{it}$/market value of equity$_{it-1} < 0$. The results remain qualitatively unchanged under these alternative definitions.

11 Expenditures from acquiring completed R&D outputs are recognized as intangible assets and amortized. Thus, the CEO’s incentive to cut such expenditures is weaker than the incentive to cut expenditures from developing internal R&D or acquiring in-progress R&D, which are typically expensed. Thirty-one firm-years of the sample of this study reported acquired in-progress R&D expense, and 20 of the firm-years had the required data. The main results of this study remain unchanged after excluding these firm-years.
for changes in information asymmetry or growth opportunities. The empirical model, which controls for firm-specific fixed effects, is specified below:

\[
\Delta \text{COMP}_{it} = \beta_0 + \beta_1 \text{RET}_{it} + \beta_2 \Delta \text{ROE}_{it} + \beta_3 \Delta \text{RD}_{it} + \beta_4 \text{Horizon}_{it} + \beta_5 \text{Myopia}_{it} + \beta_6 \text{Horizon}_{it} \times \text{RET}_{it} + \beta_7 \text{Horizon}_{it} \times \Delta \text{ROE}_{it} + \beta_8 \text{Myopia}_{it} \times \Delta \text{RD}_{it} + \beta_9 \text{Myopia}_{it} \times \Delta \text{ROE}_{it} + \beta_{10} \text{Myopia}_{it} \times \Delta \text{RD}_{it} + \epsilon_{it}
\]

(1)

where, for each firm \(i\) and year \(t\):

\[
\Delta \text{COMP}_{it} = \ln(\text{CEO compensation})_{it} - \ln(\text{CEO compensation})_{it-1};
\]

\[
\text{RET}_{it} = \text{annual stock return};
\]

\[
\Delta \text{ROE}_{it} = \text{ROE}_{it} - \text{ROE}_{it-1}, \text{ where } \text{ROE} \text{ is earnings before R&D expenses and taxes (Compustat #170 + #46) divided by average book value of common equity (Compustat #60)};
\]

\[
\Delta \text{RD}_{it} = \text{RD}_{it} - \text{RD}_{it-1}, \text{ where } \text{RD} \text{ is R&D expenditures (Compustat #46) scaled by average book value of common equity};\]

\[
\text{Myopia}_{it} \text{ and } \text{Horizon}_{it} \text{ are defined as before.}
\]

Following prior studies (e.g., Sloan 1993), I use a natural logarithmic transformation to control for skewness in CEO compensation, although the results are similar when this transformation is not used. I apply the model to CEO cash and option compensation separately to examine whether the two components are subject to differential adjustments. Because R&D spending depends on the effect of such spending on CEO total compensation, I use CEO total compensation as a dependent variable as well. Following Baber et al. (1996), Clinch (1991), and Jensen and Murphy (1990), I use the same model to examine the effect of R&D expenditures on changes in CEO cash, option, and total compensation.

In this model, I control for accounting and stock performance measures, because prior studies document that these measures have positive effects on CEO compensation (e.g., Baber et al. 1996; Lambert and Larcker 1987). Following these studies, I use \(\text{RET}\) and \(\Delta \text{ROE}\) to control for stock and accounting performance and expect the coefficients on these two variables to be positive. Similarly, I use \(\Delta \text{RD}\) to estimate the association between changes in R&D spending and changes in CEO compensation in the absence of the horizon and myopia problems. I expect the coefficient on \(\Delta \text{RD}\) to be positive, because R&D spending is generally desirable to shareholders. In Equation (1), a significant positive coefficient on \(\Delta \text{RD}\) indicates that CEO compensation increases with an increase in R&D spending. An insignificant coefficient on \(\Delta \text{RD}\) means that compensation committees determine CEO compensation based on earnings before R&D spending, shielding CEO compensation from R&D expenses.

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12 Prior studies use R&D spending to proxy for information asymmetry or growth opportunities in level models of CEO compensation (e.g., Bizjak et al. 1993) and option grants (e.g., Hanlon et al. 2003; Ittner et al. 2003; Yermack 1995). The hypotheses and the empirical results of this study would be difficult to interpret if R&D spending is considered as a proxy for information asymmetry between managers and shareholders or the firm’s growth opportunities. For example, the results would suggest that changes in information asymmetry or growth opportunities are positively associated with changes in CEO option and total compensation when and only when the horizon and myopia problems are present.

13 I use pretax earnings to avoid introducing errors in the process of estimating marginal tax rates to obtain after-tax R&D expenditures (Bushee 1998). Scaling R&D expenditures by the average book value of common equity allows consistency with the measure of \(\text{ROE}\). Using industry-adjusted \(\Delta \text{RD}\) yields similar results.
Hypotheses 1 and 2 predict that the coefficients on $\text{Horizon} \times \Delta RD$ and $\text{Myopia} \times \Delta RD$, respectively, should be positive, reflecting increased association between changes in R&D spending and changes in CEO compensation in the presence of the horizon and myopia problems. Compensation committees also may adjust the amount of CEO annual compensation in the presence of these problems, so the regressions include $\text{Horizon}$ and $\text{Myopia}$ to capture such adjustments. The sign of $\text{Horizon}$ should be positive, because older CEOs are likely to receive greater compensation. The sign of $\text{Myopia}$ should be negative, because the presence of the myopia problem may indicate a performance decline beyond current accounting earnings and stock returns.

Compensation committees also are likely to adjust the relative importance of stock-based versus earnings-based incentives (e.g., Baber et al. 1996; Clinch 1991; Lewellen et al. 1987). Thus, the regressions include $\text{Horizon} \times \text{RET}$, $\text{Horizon} \times \Delta \text{ROE}$, $\text{Myopia} \times \text{RET}$, and $\text{Myopia} \times \Delta \text{ROE}$. The findings by Lewellen et al. (1987) suggest that the coefficient on $\text{Horizon} \times \text{RET}$ should be positive and that on $\text{Horizon} \times \Delta \text{ROE}$ negative, reflecting the shift of weight from accounting earnings to stock returns in the presence of the horizon problem. For similar reasons, the coefficients on $\text{Myopia} \times \text{RET}$ and $\text{Myopia} \times \Delta \text{ROE}$ should be positive and negative, respectively. Finally, in the subsequent analyses, the regressions include an indicator variable for each year from 1986 to 1997 to control for time-specific factors that may affect CEO compensation.

**IV. DATA**

**Sample and Data**

Similar to prior studies (Dechow and Sloan 1991; Gaver and Gaver 1998; Murphy and Zimmerman 1993), this study examines *Forbes 500* firms for two reasons. First, agency problems with innovation are more severe in larger firms (Holmstrom 1989). Second, *Forbes* annual surveys of CEO compensation provide relatively complete data on CEO age.\(^{14}\) To qualify as a sample firm, a firm must be listed at least four times between 1984 and 1997 in the *Forbes 500* ranking based on sales, assets, net income, or market capitalization and publicly traded for four consecutive fiscal years. The four-year criterion represents a trade-off between the data requirements for panel data analysis and potential survivorship bias (Yermack 1995).

Because this study focuses on the relationship between R&D spending and CEO compensation, I further restrict the sample to R&D-intensive industries. An industry is R&D-intensive if it is identified as R&D-intensive, intangible-intensive, or high-tech by any of the following four studies: Collins et al. (1997), Dechow and Sloan (1991), Francis and Schipper (1999), and Lev and Sougiannis (1996).

Data on CEO compensation, turnover, age, and tenure, as well as on ownership structures, are drawn from firm proxy statements, 10-Ks, *Forbes* annual surveys of CEO compensation, and EXECUCOMP 1998. Stock data are from CRSP 1998 and financial items from Compustat 1998. I exclude firms for which the required data are not available from the sources identified above. This process generates 160 firms in 39 three-digit and eight two-digit SIC code industries. Industries with more than ten sample firms each include telephone communication (17 firms, SIC 481), drugs (16 firms, SIC 283), computer and office equipment (12 firms, SIC 357), and aircraft and parts (11 firms, SIC 372). R&D

\(^{14}\) The EXECUCOMP dataset covers only 1992 and later years, and its information about executive age is not as complete as the *Forbes* data. For the 2,142 firms covered in EXECUCOMP over 1992–1997, only 19.31 percent of the observations have valid data on CEO age, and only 52.49 percent have valid data on CEO total compensation.

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intensity (defined as R&D expenditures scaled by sales) is about 4 percent higher for the 160 sample firms than for the remaining Forbes 500 firms (p = 0.00), validating the classification of industries. Between 1984 and 1997, 137 of the 160 sample firms experienced the horizon or myopia problem. During the same period, 192 CEO turnovers occurred. I exclude firm-years in which CEO turnover occurred from all analyses, because in these firm-years the measurement of CEO compensation is noisier, and it is unclear whether the outgoing or the incoming CEO is the more influential (Murphy and Zimmerman 1993). As a result, the change in compensation is calculated only for the same CEO, and Equation (1) actually controls for CEO-specific fixed effects as well. Finally, all monetary items are restated to constant 1997 dollars using the fiscal year-end Consumer Price Index. Note that the findings of this paper still hold when CEO turnovers are included and when the monetary items are not restated.

**Descriptive Statistics**

Table 1 summarizes the descriptive statistics of the sample. The statistics in this table show that the mean ratio of R&D spending to average book value of common equity for the sample firms is 11.1 percent. The horizon and myopia problems occur in 258 (or 15 percent) and 298 (or 17 percent) of the firm-years, respectively. These results indicate that R&D spending in the sample firms is important, and that the horizon and myopia problems are reasonably frequent. The results also indicate that ARD is stable (about −1 percent for the lower quartile and 1 percent for the upper quartile). The mean of ARD is 0.001676, representing $5.82 million for a firm with a mean book value of equity of $3,474 million. The CEO cash, option, and total compensation means are each larger than their corresponding medians, indicating skewness in the data and justifying the use of the logarithmic transformation of CEO compensation. For example, the mean of CEO total compensation is $3,279 thousand, while the median is $2,034 thousand.

The last four columns of Table 1 report the results of several t-tests. These tests compare groups of firm-years with the horizon or myopia problem versus the remaining firm-year observations. The results indicate no significant difference in CEO total compensation changes across groups. The myopia problem, with or without the horizon problem, significantly reduces CEO cash compensation changes. However, CEO option compensation changes are significantly greater when the myopia problem is present and the horizon problem is not than in the other situation. Accounting and stock performance are generally lower for firms with either the horizon or myopia problem. Finally, there is no significant difference in R&D spending changes across the groups.

**Pearson Correlations**

Table 2 presents Pearson correlations among the main variables in Equation (1). RET and AROE are significantly positively associated with CEO cash and total compensation, but not with option compensation. ARD is not significantly associated with CEO cash (correlation coefficient = 0.00, p = 0.89), option (correlation coefficient = 0.03, p = 0.30), or total compensation (correlation coefficient = 0.03, p = 0.33). Horizon (correlation coefficient = −0.04, p = 0.09) and Myopia (correlation coefficient = −0.13, p = 0.00) are significantly negatively associated with CEO cash compensation, but not with CEO option or total compensation.

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15 These t-tests, as well as other tests in this study, are two-tailed.
### TABLE 1

<table>
<thead>
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<th>Variables</th>
<th>Number of Observations</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>25th Percentile</th>
<th>Median</th>
<th>75th Percentile</th>
<th>Mean Difference (p-value, two-tailed)</th>
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<tbody>
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<td>9731.35</td>
<td>17664.13</td>
<td>1809.42</td>
<td>3418.44</td>
<td>10264.47</td>
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<td>1.87</td>
<td>1.63</td>
<td>1.23</td>
<td>1.52</td>
<td>2.13</td>
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<td>1436.77</td>
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i = index for firms;
\( t = \) index for fiscal years;
MVEQi = market value of equity of firm \( i \) at the end of fiscal year \( t \) (in millions);
\( MTB_i = \) the ratio of market-to-book value of assets of firm \( i \) at the end of fiscal year \( t \);
Incomei, = earnings before R&D expenditures and tax of firm \( i \) in fiscal year \( t \);
C_PAYi = CEO cash compensation (in thousands) of firm \( i \) in fiscal year \( t \), defined as the sum of CEO salary and annual bonus;
\( \Delta C_PAY_i = CPAY_{it} - C_PAY_{it-1}; \)
OP_Vi = value of CEO annual stock option grants (in thousands) of firm \( i \) in fiscal year \( t \), valued at the end of the fiscal year using Black and Scholes (1973) model adjusted for dividends;
\( \Delta OP_Vi = OP_Vi - OP_V_{i-1}; \)
T_PAYi = CEO total compensation (in thousands) of firm \( i \) in fiscal year \( t \), defined as the sum of CEO cash compensation, value of stock annual option grants (valued at the end of the fiscal year using Black and Scholes (1973) model adjusted for dividends), fringe benefits, and other long-term incentives;
\( \Delta T_PAYi = T_PAYi - T_PAY_{i-1}; \)
RETi = annual stock return of firm \( i \) in fiscal year \( t \);
ROEi = accounting return on equity of firm \( i \) in fiscal year \( t \), defined as earnings before R&D expenditures and tax divided by average book value of common equity;
\( \Delta ROE_i = ROE_i - ROE_{i-1}; \)
RDi = R&D expenditures of firm \( i \) in fiscal year \( t \), scaled by the average book value of common equity;
\( \Delta RD_i = RD_i - RD_{i-1}; \)
Horizoni = 1 if the CEO of firm \( i \) in year \( t \) is 63 or older, and 0 otherwise; and
Myopiai = 1 if firm \( i \) faces a small earnings decline or a small loss in year \( t \), and 0 otherwise, where: (i) Firm \( i \) in year \( t \) has a "small earnings decline" if (1) pretax income, + R&D expenditures, < pretax income,_{i-1}, + R&D expenditures,_{i-1}, and (2) pretax income, + R&D expenditures, > pretax income,_{i-1}, (ii) Firm \( i \) in year \( t \) has a "small loss" if \( -1 \) percent \( \leq \) pretax income, / market value of equity,_{i-1} < 0.
TABLE 2

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TABLE 2 (continued)

\[ i = \text{index for firms}; \]
\[ t = \text{index for fiscal years}; \]
\[ \Delta \ln C\_PAY_i = \ln(\text{CEO cash compensation})_i - \ln(\text{CEO cash compensation})_{i-1}, \text{ where CEO cash compensation (in thousands) is defined as the sum of CEO salary and annual bonus;} \]
\[ \Delta \ln OP\_V_i = \ln(\text{Value of CEO annual option grants})_i - \ln(\text{Value of CEO annual option grants})_{i-1}, \text{ where the annual option grants are valued at the end of the fiscal year using Black and Scholes (1973) model adjusted for dividends;} \]
\[ \Delta \ln T\_PAY_i = \ln(\text{CEO total compensation})_i - \ln(\text{CEO total compensation})_{i-1}, \text{ where CEO total compensation (in thousands) is defined as the sum of CEO cash compensation, value of annual stock option grants (valued at the end of the fiscal year using Black and Scholes (1973) model adjusted for dividends), fringe benefits, and other long-term incentives;} \]
\[ RET_i = \text{annual stock return}; \]
\[ \Delta \text{ROE}_i = \text{ROE}_i - \text{ROE}_{i-1}, \text{ where ROE is earnings before R&D expenditures and tax divided by average book value of common equity;} \]
\[ \Delta RD_i = RD_i - RD_{i-1}, \text{ where RD is R&D expenditures scaled by the average book value of common equity;} \]
\[ \text{Horizon}_i = \begin{cases} 1 & \text{if the CEO of firm } i \text{ in year } t \text{ is 63 or older, and 0 otherwise;} \\ \end{cases} \]
\[ \text{Myopia}_i = \begin{cases} 1 & \text{if firm } i \text{ faces a small earnings decline or a small loss in year } t, \text{ and 0 otherwise, where: (i) Firm } i \text{ in year } t \text{ has a “small earnings decline” if (1) pretax income}_i + \text{R&D expenditures}_i < \text{pretax income}_{i-1} + \text{R&D expenditures}_{i-1}, \text{ and (2) pretax income}_i + \text{R&D expenditures}_i > \text{pretax income}_{i-1}. \text{ (ii) Firm } i \text{ in year } t \text{ has a “small loss” if } -1 \% \leq \text{pretax income}_i / \text{market value of equity}_{i-1} < 0. \end{cases} \]
Consistent with the hypotheses, the results in Table 2 indicate that Horizon × ΔRD (correlation coefficient = 0.08, p = 0.00) and Myopia × ΔRD (correlation coefficient = 0.08, p = 0.00) are significantly positively associated with changes in CEO option compensation. Similarly, Horizon × ΔRD (correlation coefficient = 0.11, p = 0.00) and Myopia × ΔRD (correlation coefficient = 0.04, p = 0.08) are significantly positively related to changes in CEO total compensation. There is no significant association between Horizon and ΔRD or between Myopia and ΔRD. These results suggest that R&D spending is not reduced in the presence of the horizon and myopia problems. In addition, the results of Table 2 suggest that multicollinearity is unlikely to be a serious issue for Equation (1), since the only correlation with an absolute value exceeding 50 percent is that between Myopia × ΔROE and Myopia × ΔRD (0.58, p = 0.00). The variance inflation factors (VIF) confirm this assertion.

V. RESULTS

CEO Compensation
CEO Option Compensation

The results of the OLS estimation of Equation (1) for CEO option compensation, reported in Column (1) of Table 3, Panel A, provide evidence consistent with the hypotheses. Specifically, the results indicate that Horizon × ΔRD (7.796, p = 0.051) and Myopia × ΔRD (13.015, p = 0.000) are both significantly positively associated with changes in the value of CEO annual stock option grants. The coefficient on ΔRD is insignificant, indicating that CEO option compensation is shielded from R&D expenses in the absence of the horizon and myopia problems. The insignificance of ΔRD is consistent with Matsunaga (1995) and Yermack (1995), who find that R&D intensity is not associated with the value of employee stock options or the sensitivity of the value of CEO stock options to performance. In addition, consistent with prior studies (e.g., Baber et al. 1996), the coefficient on RET (0.336, p = 0.030) is significantly positive. While the coefficient on Myopia × RET (0.150, p = 0.720) is insignificant, that on Myopia × ΔROE (−3.029, p = 0.015) is significantly negative, suggesting that compensation committees reduce the weight on accounting performance in the presence of the myopia problem.

CEO Cash Compensation

The results for CEO cash compensation, reported in Column (2) of Table 3, Panel A, are inconsistent with the hypotheses. The estimated coefficient on Horizon × ΔRD (0.017, p = 0.979) is insignificant, while that on Myopia × ΔRD (−1.102, p = 0.034) is significantly negative. The coefficient on ΔRD is insignificant, suggesting that CEO cash compensation is also shielded from R&D expenses, consistent with Dechow et al. (1994), who find CEO cash compensation is shielded from restructuring expenditures. Similar to findings of prior studies (e.g., Baber et al. 1996, Lambert and Larcker 1987), RET and ΔROE are both significantly positive.

\(^{16}\) After using heteroscedasticity- and autocorrelation-robust standard errors, the coefficients on Horizon × ΔRD (p = 0.037) and Myopia × ΔRD (p = 0.002) remain significant. The results also hold when Equation (1) is estimated using a median regression, suggesting that it is unlikely that the results are driven by outliers. In addition, R&D spending likely signals better R&D projects and, hence, generates higher stock returns and higher value of CEO annual option grants. However, since the models control for stock returns, such project signaling cannot explain the association between R&D expenditures and CEO option compensation. Furthermore, tax is another variable that may affect the relation between R&D expenditures and CEO compensation (e.g., Clinch 1991). However, this paper focuses on the interactions of R&D expenditures with the horizon and myopia problems. Thus, it is unlikely that these results are driven by tax.
TABLE 3

Panel A: Results of the Regressions

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<th>Dependent Variable</th>
<th>Expected Sign</th>
<th>$\Delta \ln OP_V_i$ (1) Estimated Coefficients (p-value, two-tailed)</th>
<th>$\Delta \ln C_PAY_i$ (2) Estimated Coefficients (p-value, two-tailed)</th>
<th>$\Delta \ln T_PAY_i$ (2) Estimated Coefficients (p-value, two-tailed)</th>
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<td>$RET_{it}$</td>
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<td>0.336 (0.030)</td>
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<tr>
<td>$\Delta ROE_{it}$</td>
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<td>0.337 (0.000)</td>
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<td>$\Delta RD_{it}$</td>
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<td>Myopia_{it}</td>
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<td>Horizon_{it} $\times$ $RET_{it}$</td>
<td>+</td>
<td>-0.048 (0.903)</td>
<td>-0.017 (0.770)</td>
<td>-0.091 (0.514)</td>
</tr>
<tr>
<td>Horizon_{it} $\times$ $\Delta ROE_{it}$</td>
<td>-</td>
<td>-0.027 (0.976)</td>
<td>-0.131 (0.357)</td>
<td>-0.019 (0.954)</td>
</tr>
<tr>
<td>Horizon_{it} $\times$ $\Delta RD_{it}$</td>
<td>+</td>
<td>7.796 (0.051)</td>
<td>0.017 (0.979)</td>
<td>5.264 (0.000)</td>
</tr>
<tr>
<td>Myopia_{it} $\times$ $RET_{it}$</td>
<td>+</td>
<td>0.150 (0.720)</td>
<td>-0.158 (0.007)</td>
<td>0.125 (0.391)</td>
</tr>
<tr>
<td>Myopia_{it} $\times$ $\Delta ROE_{it}$</td>
<td>-</td>
<td>-3.029 (0.015)</td>
<td>0.246 (0.147)</td>
<td>-0.671 (0.115)</td>
</tr>
<tr>
<td>Myopia_{it} $\times$ $\Delta RD_{it}$</td>
<td>+</td>
<td>13.015 (0.000)</td>
<td>-1.102 (0.034)</td>
<td>2.537 (0.045)</td>
</tr>
</tbody>
</table>

Sample Size 1265
Adjusted R² 2.44%

(continued on next page)
Panel B: Estimated Changes in CEO Compensation Associated with a $1,000 Change in R&D Expenditures

<table>
<thead>
<tr>
<th></th>
<th>(1) Horizon = 0 Myopia = 0</th>
<th>(2) Horizon = 1 Myopia = 0</th>
<th>(3) Horizon = 0 Myopia = 1</th>
<th>(4) Horizon = 1 Myopia = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td>-0.796</td>
<td>7.000</td>
<td>12.219</td>
<td>20.015</td>
</tr>
<tr>
<td></td>
<td>(0.514)</td>
<td>(0.074)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Cash</td>
<td>-0.145</td>
<td>-0.128</td>
<td>-1.247</td>
<td>-1.230</td>
</tr>
<tr>
<td></td>
<td>(0.440)</td>
<td>(0.838)</td>
<td>(0.012)</td>
<td>(0.067)</td>
</tr>
<tr>
<td>Total</td>
<td>-0.258</td>
<td>5.006</td>
<td>2.279</td>
<td>7.543</td>
</tr>
<tr>
<td></td>
<td>(0.564)</td>
<td>(0.001)</td>
<td>(0.060)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

Estimated Combined Coefficients on $\Delta R_D$

<table>
<thead>
<tr>
<th></th>
<th>(p-value, two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td>$-$0.28</td>
</tr>
<tr>
<td>Cash</td>
<td>$-$0.06</td>
</tr>
<tr>
<td>Total</td>
<td>$-$0.24</td>
</tr>
</tbody>
</table>

Estimated Change in CEO Compensation ($)

(based on mean compensation)

Year dummies are included, but not reported.
Option versus Cash Compensation

Although theoretically compensation committees can adjust CEO cash or option compensation, the results discussed above suggest that compensation committees adjust CEO option compensation only to prevent opportunistic reductions in R&D spending. This finding may not be very intuitive, because compensation committees usually determine cash bonuses at the end of the fiscal year, while they often grant stock options before the end of the fiscal year. In what follows, I present several reasons why compensation committees may adjust option compensation, instead of cash compensation.

First, CEO stock options typically become vested over time (e.g., four years) and expire in ten years. CEO retirement normally does not forfeit the options, and firms may grant options that become exercisable one or two years after the retirement. As such, stock options direct CEOs to focus on long-term performance, and motivate long-term investments such as R&D spending. Second, it is hard to monitor the quality of R&D investments. Increasing cash compensation for R&D spending may incur the possibility of inducing or rewarding “bad” R&D projects. As deferred compensation, option grants tied to R&D spending help enhance the chance that only “good” R&D investments are induced or rewarded. Third, while compensation committees have discretion in determining CEO annual bonuses, this discretion is often in the subjectivity of evaluating CEO performance, not so much in the amount of the bonuses. On the other hand, compensation committees are likely to have more discretion in determining the size of stock option awards. Finally, as discussed in Section II, it is plausible that compensation committees have sufficient information about R&D activities when they determine stock option grants, because they meet several times a year and have discretion in the timing of option grants.

Another difference between CEO option and cash compensation shown in the results is that the adjusted R² is higher for CEO cash compensation (20.45 percent) than for CEO option compensation (2.44 percent). This finding, consistent with prior studies (e.g., Baber et al. 1996), may reflect the fact that the option value is influenced by more factors than is cash compensation. To control for additional factors such as CEO equity portfolios, block holdings, firm size, growth opportunities, and liquidity needs, I develop several change models for CEO option grants, based on prior studies (e.g., Core and Guay 1999; Hanlon et al. 2003; Ittner et al. 2003). The results of these change models are similar to those

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17 For example, according to the proxy statements of the Alliedsignal Inc. filed with the SEC in April 1998, Mr. Lawrence A. Bossidy, the CEO of the company, was scheduled to retire on April 1, 2000 at age 64. The compensation committee approved to grant 1,500,000 stock options to Mr. Bossidy in 1997 in order to “provide a stock option-based incentive to continue his contributions to the improvement of the share price through and beyond retirement,” and half the options would not become exercisable until Mr. Bossidy became 66.

18 The words “rewarding” and “rewarded” imply an ex post payment for increasing R&D spending. They also mean that as stock options become vested, more information about the quality of the R&D projects will be impounded in the stock prices and the realized value of option grants.

19 In an additional test, Equation (1) for option compensation is extended to include lagged R&D spending and its interactions with the horizon and myopia problems. The estimated coefficients on Horizon × ΔRD (8.168, p = 0.045) and Myopia × ΔRD (13.693, p = 0.000) are both significantly positive, while the lagged R&D spending and its interaction terms are insignificant. This finding is consistent with compensation committees having enough information about R&D activities during the current year when determining CEO stock options for the year. For example, the proxy statements Eastman Kodak filed with the SEC in March 1998 indicate that the compensation committee “used the CEO’s results under the management appraisal process to determine his bonus and stock option award for the year.” The criteria used to evaluate the executives of Eastman Kodak include product leadership. Furthermore, multiple option grants during the year can provide more opportunities for compensation committees to link R&D activities to CEO option compensation. Between 1992 and 1997, about one-third of the firms in the EXECUCOMP dataset had multiple option grants to their CEOs within a fiscal year. For the same period, this percentage is 35.1 for the sample firms of this study. Seagate Technology, a sample firm of this study, granted stock options to executives on a quarterly basis for the fiscal year of 1997.
reported in Column (1) of Table 3, Panel A. Moreover, although the adjusted R² is lower for CEO option compensation, the incremental adjusted R² attributed to R&D spending and its interaction terms is 1.7 percent, higher than that for CEO cash compensation (0.25 percent).

**CEO Total Compensation**

The results for CEO total compensation, reported in Column (3) of Table 3, Panel A, also provide evidence consistent with the hypotheses: The estimated coefficients on Horizon × ΔRD (5.264, p = 0.000) and Myopia × ΔRD (2.537, p = 0.045) are both significantly positive. Similar to prior studies (e.g., Baber et al. 1996; Lambert and Larcker 1987; Sloan 1993), RET (0.283, p = 0.000) and ΔROE (0.165, p = 0.029) have significantly positive effects on CEO total compensation. Once again, the coefficient on ΔRD (−0.258, p = 0.564) is insignificant, consistent with compensation committees shielding CEO total compensation from R&D expenses.

The insignificance of ΔRD indicates no direct association between changes in R&D spending and changes in CEO compensation in the absence of the horizon and myopia problems, while the significance of Horizon × ΔRD and Myopia × ΔRD indicates such a direct association in the presence of the problems. In a prior study, Clinch (1991) documents an indirect effect of R&D intensity on CEO compensation. He shows that R&D intensity affects CEO compensation by influencing the relative weights on accounting and stock returns. To control for this indirect effect, I follow Clinch (1991) to include the interactions of R&D intensity with RET and ΔROE. For CEO total compensation, the estimated coefficients on Horizon × ΔRD (5.245, p = 0.000) and Myopia × ΔRD (2.575, p = 0.041) are still significantly positive, suggesting that the direct association between changes in R&D spending and CEO total compensation in the presence of the horizon and myopia problems is incremental to the indirect effect documented by Clinch (1991).

**The Magnitude of the Association between Changes in R&D Expenditures and Changes in CEO Compensation**

Table 3, Panel B, summarizes the estimated combined association between changes in R&D spending and changes in CEO compensation for the four possible combinations of the horizon and myopia problems. For each situation, this combined association is calculated based on the coefficients on ΔRDi, Horizoni × ΔRDi, and Myopiai × ΔRDi. The results indicate that the combined association is significantly positive for CEO option and total compensation only when the horizon or myopia problem is present. In contrast, the combined association is significantly negative for CEO cash compensation when the myopia problem occurs.

Table 3, Panel B, also presents the changes in CEO compensation associated with a $1,000 increase in R&D spending. Consider a firm with a mean book value of common equity ($3,473 million), and a mean cash ($1,387 thousand), option ($1,229 thousand), and total compensation ($3,729 thousand) of the sample. In this case, a $1,000 increase in R&D expenditures will increase the firm’s ΔRD by 0.00003 percent. In the presence of the horizon (myopia) problem, a $1,000 increase in R&D expenditures is associated with a $2.48 ($4.32) increase in CEO option compensation, and a $4.73 ($2.15) increase in CEO.

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20 In addition to the independent variables in Equation (1), these change models of CEO option compensation control for the following factors: CEO equity portfolio, firm size and its interactions with R&D spending, block holdings, growth opportunities, cash flow constraints, dividend constraints, loss carry-forwards, financial leverage, and volatility of stock returns. The results of these change models are similar. The corresponding level models also yield similar results.
total compensation. When the horizon and myopia problems are both present, a $1,000 increase in R&D expenditures is associated with a $7.08 increase in CEO option compensation, and a $7.12 increase in CEO total compensation. These numbers reflect the economic significance of the adjustment made to CEO option (and hence total) compensation in the presence of the horizon and myopia problems.\footnote{The calculations are based on COMP$_i$/COMP$_{i-1} = \exp$ (the estimated combined coefficient $\times$ $\Delta$RD).}

**The Effectiveness of Adjusting CEO Option Compensation**

So far, this study has shown that compensation committees adjust CEO option compensation to prevent opportunistic reductions in R&D spending. I now test whether this adjustment is effective in mitigating such reductions by examining the association between the horizon and myopia problems and changes in the firm’s R&D investment. In this test, I estimate changes in R&D spending using Equation (2), which resembles the model of Dechow and Sloan (1991, 62):

$$\Delta RD_i = \beta_0 + \beta_1 \text{Horizon}_i + \beta_2 \text{Myopia}_i + \beta_3 \text{Ind}_\Delta RD_i + \epsilon_i$$

(2)

where $\text{Ind}_\Delta RD_i$ is the average $\Delta$RD of other firms in Compustat in the same four-digit industry as firm $i$ in year $t$.

To the degree that optimal contracting procedures do not necessarily fully eliminate managerial opportunism (Jensen and Meckling 1976), the signs of Horizon and Myopia should be negative. Because $\text{Ind}_\Delta RD$ reflects the profitability of R&D spending, its sign should be positive. In the analyses of Equation (2), the regression also includes an indicator variable for each year between 1986 and 1997.

Table 4 presents the results from estimating Equation (2). The results indicate that neither the horizon (estimated coefficient = $-0.001$, $p = 0.705$) nor the myopia problem (estimated coefficient = $0.000$, $p = 0.876$) is associated with changes in R&D spending, while $\text{Ind}_\Delta RD$ is positively associated with $\Delta$RD. This finding is consistent with Butler and Newman (1989) and Murphy and Zimmerman (1993), who also find no association between CEO turnover and R&D spending. However, the finding is inconsistent with Baber et al. (1991) and Dechow and Sloan (1991), who find, respectively, that the myopia and horizon problems are associated with reductions in R&D spending. A possible reason for these different results is that the extent to which optimal contracting mitigates agency costs varies across different firms and time periods (Jensen and Meckling 1976). This study examines 160 *Forbes 500* firms during the period 1984–1997, while Baber et al. (1991) examine 438 industrial firms during the period 1977–1987, and Dechow and Sloan (1991) examine 91 *Forbes 500* firms with explicit bonus plans tied to accounting earnings during the period 1974–1988.

Since Equation (2) controls for the profitability of R&D spending, the results in Table 4 suggest that the horizon and myopia problems are not associated with opportunistic reductions in R&D spending. However, these results do not necessarily imply that adjusting CEO option compensation is successful in mitigating such reductions for two reasons. First, as suggested by Bushee (1998) and Dechow and Sloan (1991), other governance mechanisms, such as CEO ownership or institutional investors, may motivate R&D spending. Second, it is possible that *ex ante*, R&D spending would not have been reduced.

To address these possibilities, I extend Equation (2) to control for CEO ownership portfolio, block holdings (mostly institutional holdings in this study), as well as firm size, growth opportunities, and leverage. The results of this extended model are similar to those
of Equation (2), suggesting that R&D spending is not driven by the governance mechanisms considered by Bushee (1998) and Dechow and Sloan (1991).

Next, I analyze the 137 sample firms that experienced the horizon or myopia problem during the sample period 1984–1997. To analyze opportunistic reductions in R&D spending, for every year and two-digit SIC code industry, I estimate the following model:

$$\Delta RD_{it} = \beta_0 + \beta_1 Ind_{-\Delta RD_{it}} + \varepsilon_{it}. \quad (3)$$

Equation (3) is similar to the model of Lev and Sougiannis (1996, 115), except that it is a change model and controls for firm-specific fixed effects. Equation (3) is also a simplified version of Equation (2). This simplified model allows estimation of R&D spending determined only by R&D profitability. Based on the residuals of Equation (2), the 137 firms are classified into two groups: successful and unsuccessful firms. A firm is successful if its residuals are not significantly lower when the horizon and myopia problems are present. This classification reflects the evidence that R&D spending is significantly lower in the presence of the horizon (Dechow and Sloan 1991) and myopia (Baber et al. 1991) problems. According to this classification, 113 (or 70.6 percent) of the 137 firms are successful. The other 47 (or 29.4 percent) firms are unsuccessful, indicating the existence of opportunistic reductions in R&D spending.
I then perform two separate estimates of Equation (1) for the successful and unsuccessful firms, controlling for CEO equity portfolio, block holdings, financial leverage, firm size and market to book value of assets. The estimated coefficients on $\text{Horizon} \times \Delta RD$ (8.686, $p = 0.032$) and $\text{Myopia} \times \Delta RD$ (12.884, $p = 0.000$) are significantly positive for CEO option compensation for the successful firms, but insignificant for the unsuccessful firms. Taken together, the results suggest that the adjustment of CEO option compensation successfully mitigates opportunistic reductions in R&D spending.

**Simultaneity of R&D Expenditures and CEO Option Compensation**

In the previous analyses, I assume that R&D spending is exogenous to CEO compensation. However, this assumption may not hold for at least two reasons. First, stock options granted early in a fiscal year may motivate the CEO to invest in R&D later that year. Second, R&D expenditures and CEO compensation are likely to be determined simultaneously. For example, an exogenous shock that increases the demand for the firm’s products likely increases both CEO compensation and R&D investment. A shock that suggests that the firm’s R&D projects will do better in the future also should have this effect. To mitigate this potential simultaneity, I implement a two-stage least squares analysis. In the first stage, I use Equation (3) to estimate $\Delta RD$ for every year and two-digit SIC code industry. In the second stage, I use $F_{\Delta RD}$, the fitted value of $\Delta RD$ from Equation (3), to replace $\Delta RD$ in Equation (1) and include an indicator variable for each year between 1986 and 1997.

Table 5 reports the results of the two-stage analysis of Equation (1) for CEO option compensation. Once again, the results are consistent with the hypotheses. The estimated coefficients on $\text{Horizon} \times F_{\Delta RD}$ (13.642, $p = 0.026$) and $\text{Myopia} \times F_{\Delta RD}$ (4.280, $p = 0.088$) are both significantly positive. These results indicate that my findings about the adjustment of CEO option compensation are robust to simultaneity of R&D expenditures and CEO option compensation. The two-stage results for CEO cash and total compensation, not reported, are similar to the corresponding results in Columns (2) and (3) of Table 3, Panel A.

**VI. CONCLUSIONS**

Prior studies document that CEOs have strong incentives to opportunistically cut R&D spending in two situations: (1) when the CEO approaches retirement (Dechow and Sloan 1991)—the horizon problem, and (2) when the firm faces a small earnings decline or a small loss (Baber et al. 1991)—the myopia problem. This study provides evidence that compensation committees establish a greater positive association between changes in R&D spending and changes in CEO option compensation in order to prevent opportunistic reductions in R&D spending. Specifically, the results indicate that the association between changes in R&D expenditures and changes in CEO option compensation is significantly positive in the presence of the horizon and myopia problems, and insignificant in the absence of these two problems. Similar results also hold for changes in CEO total compensation. Furthermore, the horizon and myopia problems are not associated with reduced R&D spending, suggesting that increasing the association between changes in R&D spending and changes in CEO option compensation is effective in mitigating opportunistic reductions in R&D spending.

This study contributes to the literature in two ways. First, it shows how firms prevent opportunistic reductions in R&D spending. Prior studies (e.g., Baber et al. 1991; Dechow and Sloan 1991) focus on documenting opportunistic reductions in R&D spending, but do not examine whether firms seek to mitigate such reductions. Second, this study sharpens...
TABLE 5
Regressions of CEO Option Compensation on R&D Expenditures for 160 Forbes 500 R&D-Intensive Firms over 1984–1997—Two-stage Method

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Expected Sign</th>
<th>Estimated Coefficients</th>
<th>Dependent Variable $\Delta \ln OP_V_{it}$</th>
<th>(p-value, two-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>?</td>
<td>-0.011 (0.939)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RET_{it}$</td>
<td>+</td>
<td>0.334 (0.011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta ROE_{it}$</td>
<td>+</td>
<td>0.007 (0.966)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F_\Delta RD_{it}$</td>
<td>+</td>
<td>-2.601 (0.173)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizon$_{it}$</td>
<td>+</td>
<td>0.004 (0.972)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myopia$_{it}$</td>
<td>-</td>
<td>0.118 (0.290)</td>
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<tr>
<td>Horizon$<em>{it} \times RET</em>{it}$</td>
<td>+</td>
<td>-0.154 (0.645)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizon$<em>{it} \times \Delta ROE</em>{it}$</td>
<td>-</td>
<td>0.671 (0.365)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizon$<em>{it} \times F</em>\Delta RD_{it}$</td>
<td>+</td>
<td>13.642 (0.026)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myopia$<em>{it} \times RET</em>{it}$</td>
<td>+</td>
<td>0.329 (0.352)</td>
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<td></td>
</tr>
<tr>
<td>Myopia$<em>{it} \times \Delta ROE</em>{it}$</td>
<td>-</td>
<td>0.682 (0.447)</td>
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</tr>
<tr>
<td>Myopia$<em>{it} \times F</em>\Delta RD_{it}$</td>
<td>+</td>
<td>4.280 (0.088)</td>
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</tr>
</tbody>
</table>

Sample Size 1220
Adjusted $R^2$ 1.31%

$i =$ index for firms;
$t =$ index for fiscal years;
$\Delta \ln OP_V_{it} =$ ln(Value of CEO annual option grants)$_{it}$ − ln(Value of CEO annual option grants)$_{it-1}$, where the annual option grants are valued at the end of the fiscal year using Black and Scholes (1973) model adjusted for dividends;

$RET_{it}$ = annual stock return;

$\Delta ROE_{it} =$ $ROE_{it} - ROE_{it-1}$, where $ROE$ is earnings before R&D expenditures and tax divided by average book value of common equity;

$F_\Delta RD_{it} =$ the fitted value of $\Delta RD$ of firm $i$ in fiscal year $t$, using the following regression for every year and two digit-industry: $\Delta RD_{it} = a + b Ind_\Delta RD_{it} + e_{i t}$, where $\Delta RD_{it} =$ $RD_{it} - RD_{it-1}$, and $RD_{it}$ is R&D expenditures of firm $i$ in year $t$ scaled by the average book value of common equity; $Ind_\Delta RD_{it}$ is the average of $\Delta RD_{it}$ of all other firms in Compustat in the same four-digit industry as firm $i$ in year $t$;

Horizon$_{it} =$ 1 if the CEO of firm $i$ in year $t$ is 63 or older, and 0 otherwise; and

Myopia$_{it} =$ 1 if firm $i$ faces a small earnings decline or a small loss in year $t$, and 0 otherwise, where: (i) Firm $i$ in year $t$ has a “small earnings decline” if (1) pretax income$_{it} +$ R&D expenditures$_{it} <$ pretax income$_{it-1} +$ R&D expenditures$_{it-1}$, and (2) pretax income$_{it} +$ R&D expenditures$_{it} >$ pretax income$_{it-1}$. (ii) Firm $i$ in year $t$ has a “small loss” if $-1$ percent $<\text{pretax income}_{it}/\text{market value of equity}_{it-1} < 0$.

Year dummies are included, but not reported.

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the prediction for the relation between R&D expenditures and CEO compensation by focusing on situations where opportunistic reductions in R&D spending are more likely. Prior studies find a negative effect of R&D spending on CEO compensation (Bizjak et al. 1993) and no effect of R&D spending on the value of employee option grants (Matsunaga 1995) in general settings. This study finds that changes in R&D spending and changes in CEO option and total compensation are positively associated in the presence of the horizon and myopia problems.

This study is subject to several limitations. First, like previous studies (e.g., Bizjak et al. 1993; Dechow et al. 1994; Gaver and Gaver 1998), it infers the actions of the compensation committees from the association between R&D spending and CEO compensation. This approach does not identify the precise mechanisms by which CEO compensation is tied to R&D expenditures. Second, it focuses on CEOs, without considering other executives. Finally, it focuses on the horizon and myopia problems, but does not address various other situations, such as takeover threats, where CEOs also may have strong incentives to opportunistically cut R&D expenditures. These issues present research opportunities for future study.

**REFERENCES**


