R&D SPENDING AMONG SHORT-HORIZON CEOS: A REEXAMINATION

by

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ABSTRACT

Prior literature argues that compensation based on short-term earnings induces CEOs near retirement to forego projects with positive net present value. However, empirical research on whether CEOs curtail investment in long-term projects such as R&D during their final years provides mixed evidence. This paper performs direct and powerful tests of the relationship between earnings-based compensation and abnormal R&D spending in CEOs' final years. Examining a "short-horizon" sample of 203 retiring CEOs, I find that R&D spending in CEOs' pre-retirement years is neither statistically nor economically different from R&D spending by those firms during other years. In addition, I find no evidence that abnormal R&D spending in CEOs' pre-retirement years is associated with whether CEOs' retirement benefits are contingent on bonuses received in CEOs' final years. These results hold after controlling for other factors expected to affect the horizon problem, such as the relay process of CEO succession, CEO post-retirement board service, and CEO equity holdings. Finally, I provide evidence that opportunistic R&D curtailment among short-horizon CEOs documented by prior literature is likely overstated.

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CHAPTER 1. INTRODUCTION

CEOs typically participate in annual bonus plans that reward them for both accounting and stock price performance. Prior research argues that accounting-based performance measures provide CEOs nearing retirement with incentives to focus on short-term projects, because the benefits of long-term investments will not be fully realized until after their departure. In a seminal study on managerial "horizon problems", Dechow and Sloan (1991) provide evidence that CEOs near the end of their careers boost short-term accounting performance by cutting research and development (R&D) expenditures. They conclude that R&D curtailment around CEO departures is a manifestation of agency problems leading to opportunistic managerial behavior among "short-horizon" CEOs.

A contrasting interpretation of Dechow and Sloan's (1991) findings is offered by Murphy and Zimmerman (1993). They contend that R&D curtailment around CEO departures stems from poor performance leading to both CEO turnover and reductions in R&D expenditures. Examining a large sample of CEO departures, Murphy and Zimmerman (1993) find no evidence of R&D curtailment among CEOs departing the firm at normal retirement age. Murphy and Zimmerman (1993) conclude there is no evidence of a horizon problem among departing CEOs after properly controlling for firm performance.

Although Murphy and Zimmerman (1993) argue that R&D curtailment around CEO departures documented in prior work is a function of poor performance, limitations of their own design decrease the likelihood of finding evidence of a horizon problem if it exists. For instance, Dechow and Sloan (1991) focus on R&D-intensive firms, whereas

Murphy and Zimmerman's (1993) results are based on a broad sample of departing CEOs with varying incentives to curtail R&D. Thus, it remains unclear whether Murphy and Zimmerman's (1993) inability to document discretionary R&D curtailment among short-horizon CEOs is due to the absence of an agency problem or to their failure to isolate the conditions under which this phenomenon is most likely to exist. The inconclusive evidence on the horizon problem arising from the Dechow and Sloan (1991) and Murphy and Zimmerman (1993) papers has generated a stream of subsequent research that continues to provide conflicting evidence on whether CEOs curtail R&D expenditures as they approach retirement (e.g., Barker and Mueller 2002; Cheng 2004; Naveen 2006).

The purpose of this paper is to help reconcile conflicting evidence regarding the horizon problem reported in prior literature and to test for opportunistic R&D curtailment among departing CEOs for whom the horizon problem is expected to be most severe. In contrast to prior research, this paper directly tests for a relationship between accounting-based compensation and R&D curtailment around CEO departures. I overcome design limitations in Murphy and Zimmerman (1993) by: 1) restricting my sample to R&D-intensive firms; 2) controlling for factors expected to affect managerial myopia such as CEO succession plans; and 3) imposing minimum CEO tenure requirements in my sample selection criteria to ensure a clean partitioning of "treatment" and "control" years. I overcome the primary design limitation in Dechow and Sloan (1991) by restricting my sample to CEO departures representing normal retirement in order to mitigate the endogenous relationship between CEO departures and R&D expenditures. In addition, I control for firm performance and other determinants of R&D spending in my statistical tests.

I first reexamine the primary results in Dechow and Sloan (1991) by following their sample selection criteria to reconstruct their sample of CEO departures as closely as possible. This procedure results in a sample of 52 CEO departures between 1979 and 1989 from manufacturing firms listed on the 1989 Forbes compensation survey.[1] I partition these 52 CEOs between those for whom average R&D growth is lower in their final two years than in the immediately surrounding years ("curtailers") and those for whom R&D growth is not lower in their final two years ("non-curtailers"). I find that among R&D curtailers, sales growth is significantly lower in the CEOs' final two years than in surrounding years, whereas sales growth is not abnormally low in the final years of non-curtailers. These results support arguments by Murphy and Zimmerman (1993) that R&D curtailment around CEO departures reported by prior research is associated with poor corporate performance.

I retest for evidence of discretionary R&D curtailment in a setting in which prior literature argues the horizon problem should manifest most strongly. Specifically, I test for R&D curtailment in the final years of retiring CEOs whose pension benefits are contingent on salary and bonus awards in their final years ("bonus-contingent pensions").[2] The ability of prior research (e.g., Dechow and Sloan 1991) to infer that bonus incentives are responsible for R&D curtailment around CEO turnover is limited by the fact that nearly all CEOs participate in bonus plans. In contrast, CEOs vary greatly in their pension arrangements, making the link between R&D curtailment and accounting-

[1] By comparison, Dechow and Sloan (1991) identify 58 CEO departures using their sample selection criteria. The source of this discrepancy is unclear.

[2] Primary analyses test for R&D curtailment in retiring CEOs' final five years, though supplemental analyses also examine retiring CEOs' final two years. Inferences are the same using both time horizons.

based compensation directly testable. CEO pensions provide a post-retirement annuity equal to a percentage of the CEO's final salary and bonus, significantly amplifying the value of bonuses awarded in the CEO's final years. Under the provision of some defined-benefit plans, a one-time $1 increase in the annual bonus near retirement can increase the present value of the CEO's pension benefits by over $2, amplifying the value of the bonus award by a factor of three.[3] Thus, a CEO's incentives to boost current earnings by cutting R&D near the end of his career are likely to be strongest if his retirement benefits are a function of bonuses awarded in the years preceding retirement.

Examining a sample of 203 CEOs retiring from R&D-intensive firms between 1996 and 2005, I find no evidence of R&D curtailment in CEOs' final years. Moreover, I find no evidence of R&D curtailment among retiring CEOs whose pension benefits are contingent on bonuses received in their final years. These results persist after controlling for other factors posited to affect the horizon problem, such as the use of CEO relay succession plans. Dechow and Sloan (1991) present evidence that CEO relay succession planning mitigates R&D curtailment prior to CEO departures. I argue their results are likely confounded because firm performance affects both R&D investment and CEO succession decisions (e.g., Parrino 1997). I mitigate this problem by limiting my sample to normal CEO retirements and also by explicitly controlling for performance in my statistical tests. I also control for whether the CEO remains on the board of directors after retirement, the CEO's bonus sensitivity to earnings, and the CEO's equity holdings.

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[3] This example uses a discount rate of 5%, an annual pension annuity worth 60% of final average earnings, a retiring CEO of age 65, and final earnings for pension plan purposes averaged over three years.

In summary, my tests do not support the hypothesis that CEOs respond to accounting-based compensation incentives at the end of their careers by curtailing R&D expenditures.

I provide evidence that sample selection bias likely contributes to results in studies that conclude CEOs curtail R&D expenditures as they approach retirement based on the negative association between R&D spending and CEO age or tenure. For a broad sample of CEOs in R&D-intensive firms covered by ExecuComp, I show that results from cross-sectional regressions of R&D spending on CEO age or tenure suggest CEOs become increasingly myopic during their careers. However, this result does not hold when tracking R&D spending by the same CEOs over time. I find that firm R&D-intensity is positively associated with the probability a firm delists in future years, confounding cross-sectional comparisons of R&D spending between relatively young CEOs and CEOs who have reached retirement age.

The contribution of this paper is underscored by the magnitude of the horizon problem documented in prior literature. Dechow and Sloan (1991) estimate that R&D growth is approximately 3.5 percentage points lower in a CEO's final two years, representing a decline in R&D growth of nearly 45 percent. For the average firm in their sample, this reduction in R&D would result in a current-year increase in net income of over 2 percent, or approximately $24 million in 2008 dollars.[4] Several related studies document significant but gradual declines in R&D spending as CEOs approach retirement (Barker and Mueller 2002; Lundstrum 2002; Naveen 2006). My findings

[4] See Dechow and Sloan (1991) Table 4. These figures ignore tax effects, which would have a dampening effect on the relationship between R&D curtailment and increases in net income.

suggest that prior evidence of CEOs curtailing R&D in the years leading to retirement is likely overstated.

The remainder of this paper is structured as follows: Section 2 lays out the development of my hypotheses; Section 3 presents my empirical design; Section 4 reports my results, and Section 5 concludes.

CHAPTER 2. HYPOTHESIS DEVELOPMENT

2.1 Prior Literature on the Horizon Problem

Smith and Watts (1982) argue that bonus plans can affect firms' real investment decisions because bonuses are tied primarily to annual accounting profits. Bonus plans can induce managerial myopia because they give managers incentives to favor projects that boost current accounting earnings at the expense of long-term value creation.

CEOs in the early stages of their career are subject to influences that increase the likelihood they will select investment projects with positive net present value. First, because the greater part of their careers is ahead of them, CEOs far from retirement are more susceptible to the reputational costs and career concerns that may result from opportunistic managerial behavior (e.g., Tadelis 2002; Desai et al. 2006). Second, if younger CEOs remain with the firm after investing in projects with negative net present value, they are vulnerable to ex post settling up, whereby the board of directors may reduce future compensation to discipline the CEO for poor investment decisions (e.g., Watts, 2003). Third, younger CEOs are more likely to reap the rewards of positive net present value projects whose payoffs do not materialize until several years after the investment decision. These considerations indicate younger CEOs have incentives to choose investment strategies that are likely to maximize firm value.

As CEOs approach retirement, however, career concerns and incentives provided by ex post settling up decrease (e.g., Gibbons and Murphy, 1992), making it less costly for CEOs to manipulate short-term accounting performance to achieve bonus targets in their final years. Butler and Newman (1989) are among the first to test this hypothesis empirically. They find no evidence of R&D curtailment among a sample of CEOs in their final year of service relative to a matched sample of firms. However, they suggest that their failure to document the horizon problem could be due to the low power of their tests.

Dechow and Sloan (1991) focus on firms in R&D-intensive industries and demonstrate that growth rates in R&D are significantly lower in a CEO's final full year and year of departure, indicating that CEOs with short horizons make potentially value-destroying decisions in order to boost current earnings. In similar studies, however, Gibbons and Murphy (1992) find no decline in R&D expenditures or growth in the final years of the CEO's tenure, and Murphy and Zimmerman (1993) find that after controlling for firm performance, there is little evidence that CEOs reduce R&D prior to retirement. Murphy and Zimmerman (1993) conclude that the results in Dechow and Sloan (1991) are likely due to poor performance contributing to both CEO turnover and reductions in R&D.

Subsequent evidence regarding the horizon problem is mixed. I summarize the findings of prior empirical papers that test for evidence of R&D curtailment associated with short CEO career horizons in Table 1. Among the studies displayed in Table 1 are several that provide evidence consistent with a horizon problem. Barker and Mueller (2002) and Lundstrum (2002) find a negative association between CEO age and R&D expenditures and conclude that CEOs invest increasingly myopically as they approach retirement. Naveen (2006) finds that R&D spending is negatively associated with CEO tenure and reports that CEOs approaching retirement face significant agency problems.

Conversely, Cheng (2004) tests for a horizon problem and reports no differences in R&D investment between CEOs older and younger than age 63. Moreover, he reports results consistent with compensation committees providing CEOs with offsetting incentives to invest in R&D as they get older. Conyon and Florou (2006) examine a sample of U.K. firms and report no evidence that retiring CEOs in their last 2 years of service are more likely to cut R&D or plant, property, and equipment.

This paper investigates whether inconclusive evidence regarding the horizon problem reported in prior literature stems from overlooking the differential incentives CEOs have to invest myopically based on the structure of their retirement benefits. Kalyta (2007) reports that CEOs are more likely to manipulate accruals prior to retirement when their pension benefits are contingent on their final bonus awards. To the extent that retiring CEOs respond to accounting-based compensation incentives by curtailing R&D, I posit this effect will be strongest among CEOs whose pension benefits are bonus-contingent.

Gerakos (2005) studies a sample of CEOs in their final four years of service and finds that R&D growth is negatively associated with CEO pension incentives. This finding is consistent with the notion that pension incentives contribute to R&D curtailment as CEOs approach retirement. However, this finding is also consistent with unmodeled determinants of R&D growth varying between firms that do and do not provide the CEO with a bonus-contingent pension. I extend Gerakos (2005) in several important ways. Most notably, I mitigate the correlated omitted variable problem by controlling for differences in firm characteristics between firms that do and do not provide the CEO with a bonus-contingent pension. I further mitigate the correlated omitted variable problem by testing whether CEO pensions are associated with intertemporal changes in R&D as CEOs approach retirement. I find that CEO pensions are negatively associated with R&D spending in the cross section, but not with intertemporal R&D curtailment as CEOs approach retirement.

2.2 Institutional Background on Executive Pensions

Most CEO pension plans are defined-benefit plans (Sundaram and Yermack 2007; Bebchuk and Fried, 2004). CEOs may also participate in other retirement plans such as deferred compensation or defined-contribution plans. However, only defined-benefit plans use formulas that significantly inflate the value of CEO bonuses in the CEO's final years. For that reason, this paper ignores other types of post-retirement pay. In addition, Sundaram and Yermack (2007) indicate that the value of defined-benefit pensions is far greater than deferred compensation for most CEOs. In subsequent references in this paper, I use "pension" to refer strictly to defined-benefit plans.

The Employee Retirement Income Security Act (ERISA) imposes limits on compensation considered pensionable under companies' tax-qualified pension plans. Because CEOs earn compensation well in excess of these limits, CEOs typically participate in supplemental or restoration plans that provide for benefits that would have been allowed under the company's pension plan except for the limits imposed by ERISA. Thus, the vast majority of CEO pension benefits are from unqualified plans that are not eligible for the favorable tax treatment received by qualified pension plans.

Pension plans obligate a company to pay a life annuity to participating executives following retirement, though CEOs often have the option to receive the value of their annuity as a lump sum upon retirement (Gerakos 2007). The annual pension benefit payable upon retirement is typically based on the executive's credited years of service, an annual multiplier, and final compensation, usually averaged over 3 to 5 years.[5] Most CEO pension plans consider the CEO's bonus as well as salary as compensation for pension plan purposes (Sundaram and Yermack, 2007; Kalyta, 2007). The annual pension benefit that a CEO receives is usually calculated according to the following formula:

$$\text{Annual Pension Benefit} = \sum_{i=1}^{N} \frac{\text{Pensionable pay}}{N} \times \text{Accrual Rate} \times \text{Years of Service} \quad (1)$$

where pensionable pay always includes annual salary and most often annual bonuses, N is the number of years over which final earnings is averaged (typically 5 or 3), the accrual rate is an annual multiplier (usually between 0.01 and 0.025), and years of service is the CEO's tenure with the company, though occasionally firms will credit CEOs with years of service not actually worked in order to attract mid-career hires or to reward past performance. Thus, a CEO with final average pensionable compensation of $1 million, an annual accrual rate of 0.017, and 35 years of credited service will be entitled to an annual pension of $595,000 ($1 million x 0.017 x 35 = $595,000). The product of the accrual rate and years of service is called the replacement ratio, and represents the percentage of final average compensation that the CEO will receive annually upon retirement. This replacement ratio is sometimes capped at around 50 to 60 percent.[6] The

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[5] Some firms compute final average compensation as compensation received over the final n years of employment; others instead use the highest n consecutive years of compensation out of the last 10 years of employment; still others use the highest n years over the last 10, whether the n years are consecutive or not. Sundaram and Yermack (2007) report that the almost monotonic increase in cash compensation over an executive's career results in these formulas yielding the same value for most executives.

[6] When CEOs reach the replacement ratio cap, pension benefits no longer increase with additional years of service, but do increase with increases in the underlying pensionable compensation. Thus, CEOs who have reached a cap on their pension's replacement ratio still have every incentive to maximize pensionable compensation in their final years of service.

above formula illustrates that the impact a one-time dollar increase in pensionable compensation has on the annual pension benefit increases with the replacement ratio and decreases with the number of years of service over which compensation is averaged. Because pension benefits are payable at the end of the CEO's career, the discounted present value of annual pension benefits increases as the CEO approaches retirement age.

Sundaram and Yermack (2007) examine a sample of 237 firms from the Fortune 500 and report that in 94% of the cases where the CEO participated in a pension plan, the CEO's bonus was considered pensionable compensation. In my study, a small percentage of CEO pension plans that deem bonuses to be pensionable are not based on final-pay-and-service formulas and are not expected to significantly affect CEO incentives to curtail R&D in his final years.[7] I classify as "bonus-contingent" only those CEO pensions that provide a post-retirement annuity set at a percentage of the CEO's final salary and bonus over his final years of service. Approximately 82% of CEOs' defined-benefit pensions in my study meet these criteria.

2.3 Illustrating the Impact of R&D Curtailment on CEO Pension Values

To illustrate the effect that R&D curtailment can have on annual salary and bonus awards and thus on pension values, I first estimate the average cash compensation sensitivity to accounting earnings for the retiring CEOs in my sample. Building on prior literature (e.g., Jensen and Murphy 1990), I regress changes in the CEO's annual cash

[7] Some defined-benefit pensions are based on a "cash-balance" formula in which a small percentage (often between 6 and 12 percent) of the CEO's salary and bonus is credited to a hypothetical retirement account. This account is credited with a predetermined rate of interest during each year of the executive's participation in the plan. At retirement, the CEO receives a pension annuity equal in present value to the accrued value of this hypothetical account. The amplification effect these plans have on CEO bonus awards during CEOs' final years of service is relatively minor.

compensation on changes in the firm's net income and the firm's annual stock return. I depart from Jensen and Murphy's (1990) method in that I scale net income by total assets, because descriptions of CEO bonus plans in proxy statements indicate bonuses are awarded on the basis of return on capital rather than on the absolute dollar amount of net income. The untabulated results indicate that, in my sample, a $1000 increase in net income leads to an average increase in the CEO's cash compensation of $2.55.[8]

The average standard deviation of annual R&D spending among retiring CEOs with bonus-contingent pensions in my sample is approximately $64 million. To put this in perspective, a one-time decrease in R&D spending by one standard deviation would lead—based on the estimated compensation-sensitivity parameters—to an increase in the average CEO's cash compensation of $163,200 (=$64 million x 0.00255). Under a reasonable set of assumptions, the effect of this one-time cut in R&D expense on the present value of pension benefits for a 60 year-old CEO who will retire at age 65 ranges between approximately $155,000 and $259,000.[9] However, the impact of a $1 increase in compensation on the discounted value of the CEO's pension benefits increases as the CEO draws closer to normal retirement age. At age 65, a one-standard deviation decrease in R&D spending would lead to an increase in pension benefits ranging from approximately $212,000 to $353,000. If the 60-year old CEO in the above example

[8] An important caveat when estimating bonus-earnings sensitivities in a linear framework is that bonus plans always have a floor and almost always have a ceiling (e.g., Murphy 1999), inducing nonlinearity in the bonus-earnings relation. Thus, the actual sensitivity of the CEO's bonus to annual earnings is a function of whether reported earnings are below the bonus plan floor or above its ceiling. Firms do not disclose the parameters of the CEO's bonus plan, and research on the managerial horizon problem does not condition on whether the CEO is near either of these thresholds.

[9] These assumptions include a replacement ratio of 60 percent, a 5 percent discount rate, and mortality assumptions based on the 2003 Social Security Period Life Table. The estimate of $155,000 assumes the CEO's pay is averaged over 5 years for pension purposes; the $259,000 estimate assumes the CEO's pay is averaged over 3 years for pension purposes.

could maintain this reduction in R&D levels every year without adversely impacting sales during his remaining tenure, the present value of his pension benefits received at age 65 would increase by just over $1 million. The actual increase in pension benefits a CEO receives from curtailing R&D five years prior to retirement varies directly with the expected payback period of the foregone R&D projects.

2.4 The Impact of R&D Curtailment on Equity Values

The actual monetary gain a CEO receives from cutting R&D at the end of his career depends on the impact of this curtailment on his equity holdings as well as on his pension entitlement. Prior literature suggests that in the short term, CEOs who curtail R&D may not bear significant costs in the form of reduced stock prices. One reason for this is that R&D projects are associated with greater information asymmetry between management and external shareholders compared to other investments (e.g., Kothari et al 2002; Chan et al 2001; Lev and Sougiannis 1996). This information asymmetry makes R&D investment relatively difficult for the market to price in the short term. Several studies find that the market undervalues current R&D expenditures (Ali, Ciftci, and Cready 2007; Chambers, Jennings, and Thompson 2002; Eberhart, Maxwell, and Siddique 2006). Lev, Sarath and Sougiannis (2004) and Penman and Zhang (2002) provide additional evidence that the market fixates on earnings without fully understanding the impact of R&D accounting on earnings quality.[10]

[10] The market's fixation on earnings may explain why Graham, Harvey, and Rajgopal (2005) find that 80 percent of the executives in their survey are willing to cut discretionary expenditures such as R&D to achieve current earnings targets, and 55 percent are willing to postpone the start of a new project even if it entails a small sacrifice in value.

Murphy (1999) notes that even CEOs with wealth sensitivity tied primarily to the firm's stock price can be driven by short-term accounting performance. He argues that many CEOs understand how their actions affect accounting profits, but not necessarily how their actions affect share prices. He concludes that "rational managers will naturally focus on increasing accounting bonuses and devote less attention to stock prices if they know how to affect the former but not the latter" (Murphy 1999).

2.5 Hypotheses

This paper examines two primary hypotheses. The first is that CEOs approaching retirement tend to curtail investment in long-term projects such as R&D. The second is that R&D curtailment around CEO retirements is exacerbated among CEOs with pensions linked to earnings-based bonuses in their final years. Before proceeding with an examination of whether CEO pensions are associated with R&D curtailment in CEOs' pre-retirement years, I first test for evidence of a horizon problem across all CEOs near retirement age in my sample. My first hypothesis, stated in null form, is:

H1: There is no association between R&D expenditures and the proximity of the CEO to retirement.

To the extent that CEOs maximize accounting-based compensation by curtailing R&D expenditures in their final years, I predict this effect will be greatest among CEOs with bonus-contingent pensions. This leads to my second hypothesis, stated in null form:

H2: A firm's abnormal R&D spending in the CEO's final pre-retirement years is not associated with whether the firm provides bonus-contingent pension benefits to the CEO.

CHAPTER 3. RESEARCH DESIGN

3.1 Reconstruction of Dechow and Sloan's (1991) Data

I begin by reexamining the evidence of discretionary R&D curtailment around CEO departures presented in Dechow and Sloan (1991). Dechow and Sloan (1991) construct a sample of 58 CEO departures from firms in 14 different R&D-intensive manufacturing industries (defined at the 3-digit SIC level) that are listed in the 1989 Forbes executive compensation survey.[11] Following their sample selection procedure, I identify 52 CEO departures from 52 unique firms.[12] Comparing descriptive statistics between the firms in my sample and the firms in Dechow and Sloan's (1991) sample (see Table 2, Panel A) confirms that my sample is quite similar to that used in Dechow and Sloan (1991).

An explicitly stated assumption of Dechow and Sloan's (1991) study is that CEO departures in their sample represent predetermined events, such that in the absence of managerial manipulation R&D growth immediately prior to CEO

[11] The fourteen 3-digit SIC code industries examined in Dechow and Sloan (1991) are the following: 280, 281, 282, 283, 284, 285, 289, 357, 360, 366, 367, 382, 384, and 386.

[12] I am unable to ascertain the source of the differences between Dechow and Sloan's (1991) sample and my reconstruction of their sample. Email communication with the authors reveals the original data from that study no longer exists. Thus, the analyses contained herein cannot fully determine the extent to which managerial opportunism versus economic determinants explain the declines in R&D spending captured by Dechow and Sloan (1991). In attempting to replicate their results, I identify firms in Dechow and Sloan's (1991) 14 R&D-intensive industries using historical SIC codes (Compustat data item #324) as of 1989 rather than the variable DNUM because some firms have been reassigned SIC codes by COMPUSTAT since 1989. For five firms in my reconstructed sample, I find two instances of CEO turnover meeting Dechow and Sloan's (1991) selection criteria (i.e., a 5-year minimum tenure requirement for each departing CEO) during the sample period. In these cases, I include only a single CEO turnover per firm because there is some indication that Dechow and Sloan (1991) retain only one CEO turnover per firm. I use the descriptive statistics outlined in Table 1 of Dechow and Sloan (1991) to determine which CEO turnover to exclude in these instances. In addition, a minor source of the discrepancy between our two samples may be that among the 58 departures in Dechow and Sloan's (1991) sample, two did not meet the 5-year minimum tenure requirement. However, Dechow and Sloan (1991) indicate the inclusion of these two observations has no material effect on their results.

departures should be the same as in adjacent years. An alternative hypothesis is that the timing of CEO departures is often influenced by poor performance, which induces either voluntary or forced removal of the CEO from office. In this case, R&D growth around CEO departures may be low as a result of poor corporate performance rather than managerial opportunism.

To shed light on whether R&D curtailment documented in Dechow and Sloan (1991) is explained by poor performance, I partition the 52 CEOs in my reconstructed sample between "Curtailers" and "Non-curtailers". Curtailers are CEOs for whom average R&D growth is lower in the CEO's final two years than in the other years in the 11-year window centered on the year of the CEO transition. Non-curtailers are CEOs for whom average R&D growth is not lower in the CEO's final two years than in the other years in this 11-year window. Following Dechow and Sloan (1991), I measure R&D growth as $\ln(R\&D_t) - \ln(R\&D_{t-1})$. If R&D curtailment around CEO departures is driven by managerial opportunism rather than by poor performance, then R&D curtailers should not exhibit significant reductions in nondiscretionary financial variables such as sales growth in their final two years. In addition, if R&D curtailment around CEO departures represents managerial opportunism, then R&D curtailers should exhibit abnormally high net income growth in their final two years.

Figure 1 displays trends in sales growth around CEO departures for R&D curtailers versus non-curtailers. Figure 1 indicates that R&D curtailers exhibit abnormal decreases in sales growth around the time of their departure, consistent with R&D curtailment around CEO departures being driven by poor performance.

Panel C of Table 2 indicates that the decrease in sales growth for curtailers is statistically significant (t-value = -2.26). In addition, sales growth for non-curtailers is not significantly different from zero. The difference in sales growth for curtailers and non-curtailers is statistically significant (two-tailed p-value = 0.07). Panel C of Table 2 indicates net income growth is also negative in curtailers' final two years, though not significant at conventional significance levels (t-statistic = -1.36). If R&D curtailment around CEO departures were symptomatic of managerial opportunism, net income growth should be abnormally high in the CEO's final years. Together, these results suggest that poor performance is at least partially responsible for the R&D curtailment documented in Dechow and Sloan (1991), consistent with concerns expressed by Murphy and Zimmerman (1993).[13]

3.2 Retesting for Managerial Horizon Problems in Stronger Settings

I next retest for evidence of opportunistic R&D curtailment around CEO departures after focusing on conditions in which prior literature argues the horizon problem should be most strongly manifest. First, I explore whether R&D curtailment is strongest among CEOs with bonus-contingent pensions, because prior literature argues bonus compensation drives R&D curtailment among CEOs with short career horizons. These arguments suggest that R&D curtailment should be

[13] An important limitation of this analysis is that I am unable to replicate Dechow and Sloan's initial results of significant average R&D curtailment around CEO departures with my reconstructed sample. In a simple regression of R&D growth on an intercept term and FINAL (where FINAL = 1 in a CEO's last 2 years and 0 otherwise), I find a 1.63 percentage cut in R&D growth in departing CEOs' final 2 years (t-stat = -.91), compared to the estimate of 3.4 percentage cut (t-stat = 2.06) reported in Table 4 of Dechow and Sloan (1991). This suggests that a significant proportion of Dechow and Sloan's (1991) results is concentrated in the few firms in their sample I am unable to identify. However, this limitation of my replication prevents me from making stronger statements about precisely what factors are driving R&D curtailment in Dechow and Sloan's (1991) paper. Data limitations prevent me from replicating Dechow and Sloan's (1991) additional analyses, which rely on proxy statement data for years between 1974 and 1989.

most pervasive among CEOs whose pension benefits amplify the effect of bonuses awarded in the CEOs' final years.

Second, I strengthen tests for R&D curtailment by restricting my sample to CEO departures representing normal retirement. Prior literature argues R&D curtailment should be strongest among these CEOs because they are best able to anticipate the timing of their departure in advance. In addition, restricting the sample to normal retirements mitigates the endogenous relationship between CEO turnover and firm performance that may manifest in low R&D expenditures prior to CEO departures.

Third, I strengthen tests for opportunistic R&D curtailment around CEO departures by controlling for other factors expected to influence the horizon problem. The first factor is whether the firm employs a "relay process" of CEO succession planning. Vancil (1987) characterizes the "relay process" of CEO-succession as one in which an "heir apparent" is chosen a few years prior to the retirement of the incumbent CEO and given the title of President or Chief Operating Officer. The heir apparent gradually takes over decision rights within the firm prior to the CEO change. In firms employing the relay process of CEO succession, incumbent CEOs have less ability to manipulate R&D expenditures near retirement because their successor is either more closely monitoring the investment decisions of the incumbent CEO or else making those decisions himself.[14]

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[14] A news article reporting the retirement of long-time CEO Chuck Hayes from Guilford Mills in 1999 provides anecdotal support for the view that outgoing CEOs relinquish operational control to the heir apparent prior to their retirement: "Monday's announcement that (former COO John Emrich) is ascending to CEO struck textile analyst Kay Norwood as slightly puzzling. 'You know, I'm sitting here thinking, "I thought he already was,"' said Norwood of Wachovia Securities in Charlotte. '... I haven't had that much interaction with Chuck lately'" (Krouse 1999).

Another factor prior research suggests may affect R&D curtailment around CEO retirement is the CEO's plans for post-retirement board service. CEOs commonly remain on the board of directors for a few months (e.g., until the end of the fiscal year or until the next annual shareholder meeting) after stepping down as part of the management transition. However, some CEOs remain on the board of directors for a period beyond the normal transition phase. Brickley, Linck, and Coles (1999) argue that even CEOs near retirement retain career and reputational concerns to the extent that they care about opportunities to serve on their own company's board or other boards after retirement. I control for whether the CEO remains on his own board of directors for an extended period of time after retirement because these CEOs may be less likely to make value-destroying R&D cuts at the end of their careers.

Because variation exists in the performance standards and parameters embedded in CEO bonus formulas (e.g., Murphy 2001), I also control for the sensitivity of the CEO's bonus to accounting earnings in tests of R&D curtailment around CEO departures.

3.3 Sample Selection Procedure

Data limitations necessitate that my subsequent tests be conducted on a more recent sample of CEO departures than those examined by Dechow and Sloan (1991). Using ExecuComp to identify CEO turnover and Compustat to determine firm R&D-intensity, I construct a sample of CEO retirements from ExecuComp firms between the years 1996 to 2005. I restrict my sample to firms for which R&D expenditures average at least 10 percent of net income over the sample period to ensure discretionary changes in R&D can have a meaningful impact on reported income.[15] I further restrict the sample to CEOs with at least 5 years in office prior to their departure. This procedure ensures that R&D expenditures during the CEO's final years are a reflection of the current CEO's policy rather than that of his predecessor's.

To ensure that the departures of CEOs in my sample represent planned retirement rather than unexpected management changes, I use information from Factiva and firm proxy statements to impose the following additional criteria on departing CEOs in my sample. First, the CEO's departure cannot be in conjunction with a merger or acquisition. Second, the CEO's departure cannot be an involuntary termination or a performance-induced turnover. Third, the CEO cannot leave to work for another company as a full-time executive or remain with his current company as an employee. Fourth, the CEO's departure cannot be due to the CEO's death or illness. Finally, if the CEO retires at an age younger than 60, there must be explicit evidence that his departure was planned several years in advance.[16]

I examine executive compensation disclosures in firms' proxy statements to determine which CEOs are provided with bonus-contingent pensions. SEC disclosure requirements during my sample period ensure that information sufficient for this purpose is reported in the proxy statement. However, my sample selection

[15] In supplemental analyses, I replicate tests using R&D/sales as my sample selection criterion (R&D/sales >=.01). Results are qualitatively similar.

[16] An example of a CEO I retain in my sample who retired prior to age 60 is William W. George, who retired from Medtronic at age 58 in 2001. A contemporaneous Wall Street Journal article reports that, in 1991, George "took the rare step of notifying the board he would retire after 10 years in the top job" (Burton, 2000).

criteria do not require proxy statements to explicitly state the CEO's bonus to be a function of accounting earnings, because firms during my sample period were not required to (and often did not) reveal this information. Consistent with prior literature, I find a strong statistical relationship between accounting earnings and CEO bonus awards in my sample, indicating that CEOs in my sample are able to boost annual bonus awards by inflating earnings.

Univariate statistics reveal that a few firms in my sample are outliers in terms of their R&D intensity (R&D investment is greater than sales revenue). An examination of 10-K reports reveals that the primary source of revenue for the most R&D-intensive firms tends to be from licensing their intellectual property rather than from sales of their own manufactured products. In addition, much of the research in these firms is done by contract with third-party manufacturers who pay for research regardless of the eventual commercial success of the product. I delete the most R&D-intensive firms from the sample because I expect their business model to make them less susceptible to horizon problems.[17]

I first test for R&D curtailment in retiring CEOs' final five years of service because five is the most common number of years over which CEOs' final compensation is averaged for determining pension benefits. To the extent that CEOs curtail R&D in order to inflate pension benefits, I expect this curtailment to manifest most strongly during CEOs' final five years. In addition, prior literature suggests five years is approximately equal to the average payback period for R&D

[17] Specifically, I delete observations for which R&D is greater than 40 percent of sales. A histogram suggests observations for which R&D/Sales > .4 can reasonably be considered outliers. In a related study, Gibbons and Murphy (1992) eliminate observations where R&D/sales > 0.25.

investments (Lev and Sougiannis 1996). This finding indicates that CEOs five or fewer years away from expected retirement may maximize cumulative accounting earnings over their remaining tenure by cutting back on investments in R&D.[18]

I partition CEO-years in my sample between a "short-horizon" subsample consisting of the last 5 years of service of the retiring CEO, and a "control" subsample consisting of other years in the same firms for which the horizon problem is expected to be less severe. To ensure that the horizon problem is negligible for CEO-years in the "control" sample, I exclude all observations in this sample in which a CEO is over age 55 unless the CEO is at least 3 years away from departure. I also exclude new CEOs' first year of service from the control sample because R&D expenditures for a new CEO may be abnormally low as a consequence of R&D cuts made at the end of his predecessor's career. I also exclude the last 2 years of service of CEOs younger than 55 who departed the firm for reasons other than normal retirement during this period to ensure horizon problems in this sample are minimal.

My final "short-horizon" sample contains 969 CEO-years representing the final 5 years of service for 203 CEOs between the years 1993 and 2005 (46 CEO-years are discarded due to lack of necessary data). The "control" sample contains 728 CEO-years from the same firms represented in the "short-horizon" sample during 1993 and 2005. Panel A of Table 1 displays the effect of my sample selection criteria on my sample of firms.

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[18] This estimate of the payback period for R&D comes from parameter estimates provided in Table 3 of Lev and Sougiannis (1996), and is generally robust to reasonable assumptions about discount rates.

3.4 Descriptive Statistics and Means Tests

Panel B of Table 3 presents descriptive statistics regarding the type of CEO pension plans observed in my short-horizon sample of CEOs. In the short-horizon sample, 120 CEOs (59%) have pension arrangements that pay benefits proportional to the CEO's final average salary and bonus. Panel C indicates that the average retirement age of CEOs in my short-horizon sample does not vary with the structure of their pension benefits. However, executives without defined-benefit pensions become CEOs at a younger age on average and have longer tenure as CEO (p-value < 0.01).

Panel A of Table 4 indicates that firms providing the CEO with a bonus-contingent pension tend to be older and larger in market value than other firms in the sample. Firms that provide the CEO with a defined-benefit pension are less R&D-intensive than firms that do not provide the CEO with a defined-benefit pension. These univariate analyses also indicate that among CEOs with defined-benefit pensions, R&D intensity is marginally higher for CEOs whose pensions are not bonus-contingent. Also among CEOs with defined-benefit pensions, total CEO compensation is similar regardless of whether the pension is bonus-contingent. However, total compensation is significantly lower for CEOs who have no defined-benefit pension. This is consistent with other results in Panel A that indicate CEOs without pensions manage relatively smaller companies, on average.

Before proceeding to multivariate tests, I first conduct simple means tests of my data to examine whether CEOs near retirement tend to invest less in R&D relative to their younger counterparts. Panel A of Table 5 indicates that across all CEOs in my two samples, R&D as a percentage of sales is not statistically different among CEOs near retirement relative to CEOs in my control sample (0.0468 vs. 0.0471, p-value < .962).

I next test for a difference in R&D intensity among CEOs near versus far from retirement separately for CEOs without pensions, CEOs with bonus-contingent pensions, and CEOs with pensions not contingent on bonuses. Panel B of Table 3 reveals that among CEOs without pensions, R&D as a percentage of sales does not significantly vary economically or statistically with the CEO's proximity to retirement (0.0765 vs. 0.0744, p-value = 0.876). Similarly, R&D intensity is invariant to CEO proximity to retirement among all CEOs with pensions (0.0340 vs. 0.0348, p-value = 0.646) and CEOs whose pensions are bonus-contingent (0.0329 vs. 0.0322, p-value = 0.837). Together, these analyses do not support the notion that CEOs curtail R&D expenditures as they approach retirement.

An additional observation from Table 5 is that among CEOs far from retirement, R&D spending is lower among firms providing CEO pensions than among CEOs without pensions. This is consistent with the descriptive statistics in Table 4 showing CEO pensions to be most common in older, lower-growth firms.

I next proceed to a multivariate regression model to account for other determinants of R&D spending. Multivariate analysis provides at least two additional benefits over the preceding univariate analyses. First, controlling for other determinants of R&D spending increases the power of my statistical tests by removing variance in the error term, thereby lowering the standard errors of my coefficient estimates. Second, multivariate analysis controls for the possibility that the true effect of a horizon problem is obfuscated by other determinants of R&D spending (e.g., CEO equity incentives) that may be systematically different around CEO retirements.

3.5 R&D Expectation Model

In order to isolate the effect of bonus-contingent pension incentives on R&D expenditures as CEOs approach retirement, I construct a model of expected R&D expenditures in the absence of a horizon problem. My dependent variable in this regression, $FIRM\_R\&D_t$, is measured as $R\&D_t/Sales_t$. I choose to examine R&D levels rather than R&D growth for several reasons. First, most prior work on the determinants of R&D has focused on levels rather than growth. Second, because net income is ultimately a function of R&D levels and not R&D growth, R&D levels more precisely capture the variable of interest. Third, examination of R&D growth may obscure the effect of the horizon problem on R&D investment. For instance, R&D growth two years prior to the CEO's retirement will not appear abnormal if the CEO cuts R&D levels significantly in year t-3 and retained that level of R&D spending in subsequent years.

I model expected R&D expenditures as a function of several determinants suggested by prior literature as described below. Table 6 contains a description of the construction of variables used in the paper.

Because prior research indicates that industry R&D is an important determinant of firm R&D expenditures (e.g., Hansen and Hill 1991, Jarrell and Lehn 1985, Barker and Mueller 2002), I include as an explanatory variable the median R&D expenditure among all firms in the same 2-digit SIC code and year.[19] I control for firms' growth options

[19] The extreme skewness of R&D as a percentage of sales suggests the median is a better measure of central tendency than the mean for this variable.

(TOBINS_Q) because I expect firms with better investment opportunities to invest more in R&D. I control for one-year lagged stock returns (LAG_RET), because Bhagat and Welch (1995) argue that positive lagged returns indicate the firm has strong growth opportunities. They find lagged stock returns are positively associated with current R&D expenditures.

Agency theory argues firms prefer internally-generated funds to finance R&D projects because information asymmetry between insiders and outsiders regarding R&D investments makes external financing costly. Prior research consistently finds a positive association between internally generated funds and firm investment (e.g., Himmelberg and Petersen 1994). I control for the level of the firm's free cash flows (FCF), measured as cash flow from operations less capital expenditures and R&D expense, scaled by sales. Based on prior research, I expect free cash flows to be positively associated with R&D expenditures.

Because prior research suggests R&D is a discretionary expense in the minds of managers (Wang and D'Souza 2006), I expect CEOs to spend less on R&D when accounting performance is expected to be poor. Another reason accounting earnings and R&D may be positively correlated is that firms receive a tax credit for R&D expenditures (e.g., Berger 1993).[20] Because only firms with positive income tax liability benefit from this tax credit, a positive relation between accounting performance and R&D expense may be induced by tax incentives. I calculate return on assets (ROA) after subtracting the effect of R&D expenditures and use this as my measure of accounting performance.

[20] The R&D tax credit gives firms a tax credit as a percentage of their total R&D expenditures and was in effect each year of my sample period except from July 1995 to June 1996.

A stream of literature in economics argues that firm size should be positively associated with R&D intensity (Schumpeter's Hypothesis). However, empirical research is inconclusive regarding the relationship between firm size and R&D intensity. Cohen and Klepper (1996) review prior studies and conclude that in general R&D spending tends to be proportional to firm size. Due to the lack of consistent evidence in prior literature, I control for firm size (SIZE) without making a prediction regarding the sign of the coefficient on this variable.

I control for firm age because prior literature finds a negative association between innovative output and firm age (e.g., Huergo and Jaumandreu 2004; see also Caves 1998). To control for differences in R&D expenditures associated with firm age, I include FIRM_AGE, which is the natural logarithm of the number of years since the firm first listed on COMPUSTAT.

Prior research argues that CEOs with greater equity incentives will invest more in risky projects that are rewarded by the capital markets (e.g., Barker and Mueller 2002). I measure CEO equity incentives (EQUITY_INCENTIVES) as the dollar change in CEO wealth stemming from a 1% change in the firm's market value. EQUITY_INCENTIVES is computed following the procedures outlined in Core and Guay (2002). See Table 6 for a more complete explanation of the construction of EQUITY_INCENTIVES and other variables. I expect EQUITY_INCENTIVES to be positively associated with FIRM_R&D.

My model of expected R&D expenditures in the absence of a horizon problem is provided below in equation (2):

$$FIRM\_R\&D_i = \alpha_0 + \alpha_1 INDUSTRY\_R\&D_i + \alpha_2 TOBINS\_Q_i + \alpha_3 LAG\_RET_i$$
$$+ \alpha_4 FCF_i + \alpha_5 ROA_i + \alpha_6 SIZE_i + \alpha_7 FIRM\_AGE_i + \alpha_8 EQUITY\_INCENTIVES + \varepsilon_t \quad (2)$$

I am not aware of any empirical study that addresses the relationship between CEO pensions and R&D investment decisions of CEOs far from retirement. Prior research on how CEO compensation affects long-term investment decisions has focused on the CEO's equity rather than inside-debt holdings such as pensions. Due to the lack of existing empirical evidence, I have no prior expectation that CEO pensions are correlated with levels of R&D investment among CEOs far from retirement after controlling for firm characteristics such as age, growth opportunities, industry R&D, and equity holdings. However, determining whether bonus-contingent pensions exacerbate the horizon problem requires establishing the baseline relationship between CEO pensions and R&D spending among CEOs far from retirement.

I test whether CEO pensions are associated with R&D spending among CEOs in my control sample by creating an indicator variable, DB_PENSION, and including this variable in equation (2). In untabulated analyses, I find the coefficient estimate on DB_PENSION to be negative (parameter estimate = -0.025) and highly significant (p-value <0.001).[21] This finding complements the results in Gerakos (2005) by showing that the negative association between R&D and CEO pensions is not limited to firms with CEOs near retirement.

It is not immediately obvious why CEO pensions are associated with R&D spending among CEOs far from retirement after controlling for firm age, industry R&D, growth

[21] Among CEOs with pensions who are far from retirement, I find R&D spending is not associated with whether the CEO's pension is bonus-contingent in multivariate analyses (parameter estimate = -0.008, p-value =0.33). Accordingly, I do not control for whether the CEO's pension is bonus-contingent in regression (2).

options, operating cash flow and equity incentives. One explanation is proposed by Sundaram and Yermack (2007). They suggest (but do not test) that CEOs holding large pensions are expected to pursue strategies that reduce overall firm risk because pensions align CEOs' incentives with those of debt-holders rather than with equity-holders. Thus, risk avoidance may partially explain the negative association between CEO pensions and R&D investment among CEOs far from retirement because long-term R&D projects are associated with greater uncertainty than other investments (e.g., Kothari et al 2002).[22]

An F-test indicates that intercept and slope coefficients in equation (2) vary between CEOs with and without pensions (p-value < 0.001). Accordingly, I allow the intercept and slope coefficients in equation (2) to vary by interacting DB_PENSION with each economic determinant of R&D and inserting DB_PENSION and these interaction terms back into equation (2).

Because my control sample contains multiple CEO-years for most CEOs in the sample, I also control for within-CEO autocorrelation across years. Controlling for within-CEO autocorrelation through the use of clustered standard errors is unfeasible due to the lack of an adequate time-series for many of the CEOs in the sample. I account for within-CEO autocorrelation by averaging data across years for each CEO and retaining one observation per CEO for the regression in equation (2).

3.6 Measuring R&D Curtailment

To estimate the impact of the horizon problem on R&D expenditures, I use the estimated coefficients from equation (2) to compute predicted R&D expenditures for the

[22] An alternative explanation is that my controls for firm age, growth options, etc., contain measurement error and do not fully capture the underlying constructs. In this case, correlated omitted variables may induce a spurious relationship between CEO pensions and R&D spending.

CEO-years in my "short-horizon" sample. I measure abnormal R&D for each CEO in the short-horizon sample as actual R&D minus this predicted value. Thus, ABNORMAL_R&D takes on negative values for short-horizon CEOs who invest less than the predicted value of R&D. I test whether CEOs approaching retirement invest less in R&D on average than their younger counterparts (Hypothesis 1) by examining whether ABNORMAL_R&D for CEOs in my short-horizon sample is significantly less than zero.

3.7 Determinants of R&D Curtailment as CEOs Approach Retirement

To test Hypothesis 2, I model ABNORMAL_R&D as a function of CEO bonus-contingent pensions after controlling for other factors that I expect to either mitigate or exacerbate CEO incentives to curtail R&D. Hypothesis 2 predicts bonus-contingent pensions are negatively associated with abnormal R&D near the end of CEOs' careers. The bonus-amplification effects of bonus-contingent pensions vary with factors such as the CEO's replacement ratio (the percentage of pensionable compensation the CEO will receive as an annuity after retirement), the firm's discount rate, and the number of years the CEO must wait to receive unreduced retirement benefits. Constructing a precise measure of pension incentives is difficult because firms do not clearly disclose important terms of the pension contract, such as provisions for early retirement or the use of favorable discount rates in calculating lump sum pension payouts. I avoid these measurement problems by using a dichotomous variable (BONUS_PENSION) that captures the average effect of CEO pension incentives on R&D curtailment. BONUS_PENSION is equal to one for CEOs with bonus-contingent pensions, and zero otherwise. Hypothesis 2 will be supported if the coefficient on BONUS_PENSION is significantly negative.

I proxy for the other factors expected to influence the CEO horizon problem as follows:

RELAY – Prior literature predicts R&D curtailment in response to accounting-based compensation incentives will be attenuated in firms that employ the relay process of CEO succession. Vancil (1987) indicates that the relay process of CEO succession is characterized by an "heir apparent" being appointed to the office of President or Chief Operating Officer (COO) prior to assuming the responsibilities of CEO. Naveen (2006) finds that declines in R&D investment over CEOs' tenure are mitigated in firms that employ the relay process of CEO succession. Dechow and Sloan (1991) also report marginally significant evidence that the horizon problem is attenuated among firms appointing the COO or President as the successor to the departing CEO, though this result is confounded by the fact firm performance affects both R&D expenditures (Murphy and Zimmerman 1993) and internal succession decisions (Parrino 1997). To control for whether firms employ a relay process of succession in my tests for opportunistic R&D curtailment, I create an indicator variable (RELAY) which is equal to 1 in a firm-year if the current President or COO becomes the company's next CEO, and zero otherwise.

Some firms likely have designated a different executive to be the successor without appointing him first as COO or President. It is also possible that some current COOs or Presidents who do not become the next CEO were heir apparents that did not make the final cut. However, I use this measure because it is similar to the measure employed by Dechow and Sloan (1991).

BOARD_SERVICE – Prior literature (e.g., Brickley, Linck, and Coles 1999) proposes that managerial horizon problems are attenuated among CEOs who remain on the board of directors after retirement. I create an indicator variable, BOARD_SERVICE, which is equal to one if the CEO remains on the board of directors for at least one year after retirement, and zero otherwise.[23] A significantly positive coefficient estimate on BOARD_SERVICE will be consistent with the notion that post-retirement board service opportunities mitigate CEO incentives to curtail R&D expenditures prior to retirement.

BONUS_SENSITIVE –Arguments made in prior literature (Dechow and Sloan 1991) suggest that the horizon problem will be attenuated among CEOs whose bonus formulas are less sensitive to accounting earnings. However, firms do not publicly disclose the parameters of the CEO's annual incentive plan. Prior research does not suggest a CEO-year specific proxy for the sensitivity of the CEO's bonus to accounting earnings. I proxy for CEOs' bonus-earnings sensitivity by dividing the annual change in the CEO's bonus (scaled by lagged salary) by the annual change in the firm's ROA. I compute the median value of this ratio across all short-horizon CEOs and set BONUS_SENSITIVE equal to 1 in CEO-years for which this ratio is above the median and 0 otherwise.[24] I

[23] A weakness of the BOARD_SERVICE measure is that it is an ex post rather than an ex ante measure of the CEO's intention to remain on the board of directors after retirement. Although the structure of my model suggests that the R&D curtailment choice is determined by whether the CEO intends to stay on the board of directors, a negative coefficient on this variable could alternatively suggest that CEOs who choose to curtail R&D at the end of their careers are less successful at retaining board seats.

[24] Alternatively, I regress changes in CEO bonus on changes in ROA and the annual stock return by industry and year and set BONUS_SENSITIVE equal to 1 for firms in industry-years where the estimated coefficient on ROA is greater than the sample median. Inferences are unaffected by the choice of proxy for CEO bonus sensitivity.

include BONUS_SENSITIVE as a control for sensitivity of the CEO's bonus to accounting earnings.

My model of abnormal R&D associated with the horizon problem is as follows:

$$ABNORMAL\_R\&D_i = \beta_0 + \beta_1 BONUS\_PENSION_i + \beta_2 BONUS\_SENSITIVITY_i + \beta_3 RELAY_i + \beta_4 BOARD\_SERVICE_i + \mu_i \quad (3)$$

CHAPTER 4. REGRESSION RESULTS

4.1 Determinants of R&D Spending

The results from estimating equation (2) for my control sample of CEOs are displayed in Columns A and B of Table 7. Column A contains coefficient estimates for CEOs without defined-benefit pension plans. Column B contains coefficient estimates for CEOs with defined-benefit pensions.[25] Cells in the right-most column of Table 7 indicate the probability that the coefficient on each economic determinant is the same for CEOs with and without defined-benefit pensions.

In general, the signs of the coefficient estimates in Table 7 are consistent with their predicted direction, although for CEOs without pensions the coefficients on LAG_RET and ROA are opposite from the predicted direction and significant. The coefficient estimate on free cash flows comes through as the most significant explanatory variable both for CEOs with and without defined-benefit plans. The coefficient estimate on INDUSTRY_R&D is also positive for both groups of CEOs. The coefficient estimates on EQUITY_INCENTIVES and FIRM_AGE are insignificant for both groups of CEOs. The coefficient estimates on the intercept term, FCF, ROA, TOBINS_Q, and ROA are significantly different between CEOs with and without pensions, highlighting the importance of estimating coefficients separately for these two groups of CEOs.

I use the coefficient estimates from Table 7 to construct predicted R&D for the CEOs in my short-horizon sample. Predicted R&D is computed by multiplying each

[25] Column B coefficient estimates are computed by adding the main effect coefficient estimates in Column A to the coefficient estimates on the corresponding interaction terms (economic determinant x DB_PENSION). The coefficient estimates on the interaction terms are suppressed in order to simplify the exposition; however, they are equal to the difference between coefficient estimates in Column A and Column B.

coefficient estimate in Table 7 by the actual realization of the corresponding variable, using coefficient estimates in Column B and Column A for CEOs with and without defined-benefit plans, respectively. ABNORMAL_R&D is measured for CEOs in the short-horizon sample as the actual R&D expenditure minus the predicted R&D expenditure. If CEOs curtail R&D as they approach retirement (Hypothesis 1), then ABNORMAL_R&D should be significantly negative. Table 8 displays distribution statistics for actual, predicted, and ABNORMAL_ R&D for CEOs in the short-horizon sample, as well as results from a t-test of whether mean ABNORMAL_R&D is significantly different from zero.

Panel A of Table 8 indicates that mean ABNORMAL_R&D across all CEOs in my short-horizon sample is not significantly different from zero (mean = 0.0008, p-value = 0.784). Panel A of Table 8 shows ABNORMAL_R&D spending by CEO pension type. ABNORMAL_R&D is slightly more negative among CEOs without pensions, who exhibit average abnormal R&D of 0.4 percent of sales, though this estimate is not significantly different from zero. To put this estimate of abnormal R&D in perspective, predicted R&D for the average CEO without a pension is 7.8 percent of sales, providing a point estimate of percent curtailment for these CEOs of just over 5 percent (-0.4/7.8 = -0.051) . For CEOs with bonus-contingent pensions, ABNORMAL_R&D averages only -0.06 percent of sales and is statistically insignificant. Mean sales for CEOs with bonus-contingent pensions in my sample is $10.6 billion; curtailing R&D expenditures by 0.06 percent would lead to a $6.4 million increase in pre-tax net income ($10.6 billion x

0.0006), corresponding to an average increase of just over $16,000 in the CEO's bonus.[26] Table 4 indicates that mean total compensation for retiring CEOs with bonus-contingent pensions is just over $6 million. A $16,000 increase in bonus from curtailing R&D is less than 0.3 percent of the total compensation these CEOs receive, suggesting opportunistic reductions in R&D spending for bonus purposes is minimal.

4.2 Controlling for Other Potential Determinants of R&D Curtailment

I test Hypothesis 2 after controlling for other factors posited to influence opportunistic R&D curtailment prior to CEO retirements. I again control for within-CEO autocorrelation by averaging data across years for each CEO in the short-horizon sample and retain one observation per CEO.

Column A of Panel B in Table 8 reports the results from estimating equation (3). Column A reveals that the coefficients on BONUS_PENSION, RELAY, BOARD_SERVICE, and BONUS_SENSITIVE are all insignificantly different from zero, providing no support for the view that accounting-based compensation is associated with opportunistic R&D curtailment among retiring CEOs. However, results reported earlier in the paper indicate that CEOs with pensions invest less in R&D even for those CEOs far from retirement. The lack of association between absolute measures of R&D curtailment and bonus-contingent pensions may be due to CEOs with bonus-contingent pensions having less R&D spending in the first place. To investigate this possibility, I

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[26] This estimate relies on the CEO bonus-earnings sensitivity estimates computed in the first half of the paper: 0.00255 x $6.4 million = $16,320).

test whether BONUS_PENSION is associated with abnormal R&D as a percentage of the absolute value of predicted R&D.[27]

Column B of Panel B in Table 8 reports the regression results from equation (3) after substituting ABNORMAL_R&D/ (|predicted R&D|) as the dependent variable. Once again, the coefficient estimates on BONUS_PENSION and other variables expected to affect the horizon problem are all insignificant at conventional levels. These results provide no support for arguments made in prior literature that CEOs with greater accounting-based compensation are more likely to reduce investment in projects such as R&D as they approach the end of their careers.

Given the lack of evidence of a horizon problem among CEOs approaching retirement, a natural question arises regarding the power of the statistical tests employed. The 95 percent confidence interval for ABNORMAL_R&D across all short-horizon CEOs is -0.005 to 0.006. This indicates a very small probability (2.5 percent) that mean R&D curtailment among retiring CEOs is greater in magnitude than 0.5 percent of sales (less than 11 percent of the predicted value of R&D). For CEOs with bonus-contingent pensions, the lower bound on the 95 percent confidence interval for ABNORMAL_R&D is -0.004. This result indicates a very small probability (2.5 percent) that even CEOs with the greatest amount of accounting-based compensation (bonus-contingent pensions) curtail R&D spending in excess of 0.4 percent of sales prior to retirement.

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[27] I use the absolute value of predicted R&D in the denominator because predicted R&D is negative for a few observations. A second issue arising from scaling by predicted R&D is the small denominator effect. When predicted R&D is close to zero, ABNORMAL_R&D/predicted R&D can be very large. To control for the effect of outliers of this ratio, I winsorize this ratio at positive 1.

4.3 Shortening the Horizon

Prior research varies in the time period over which tests of a horizon problem are conducted (see Table 1). The design of studies regressing R&D expenditures on CEO age or tenure are based on the view that the horizon problem takes effect gradually over several years. Other studies posit that the horizon problem manifests most strongly in the CEO's final one or two years prior to retirement (e.g., Dechow and Sloan 1991; Murphy and Zimmerman 1993). I investigate whether my findings of no R&D curtailment stems from measuring the short-horizon period over too long of a window by comparing R&D expenditures in the retiring CEO's final one or two years to R&D expenditures by the same firm in the surrounding years.

Shortening the period over which the horizon problem is anticipated to manifest allows me to consider other real earnings management techniques CEOs may use to boost earnings very near to retirement but which they are less likely to employ several years prior to retirement. In another setting, Roychowdhury (2006) finds that managers engage in earnings manipulations through real transactions such as overproducing inventory to lower cost-of-goods sold expense and cutting discretionary expenditures such as SG&A and advertising. I test for managerial myopia in the final two years prior to CEO retirement in my short-horizon sample by examining whether these two years are associated with an increased probability of cuts in R&D as well as other discretionary expenses or increases in production designed to lower costs of goods sold.

I use firm-years that are more than two years prior to or one year after a CEO departure as my control sample. Control sample CEO-years are restricted to those from the same firms comprising my short-horizon sample over the period 1993 to 2005. I use logit regression to model the probability of an annual decrease in other discretionary expenditures (SG&A + advertising) and R&D, and the probability of an increase in production. I do not develop a separate expectation model to predict changes in each of these variables. Rather, I assume that in the absence of manipulation, the probability of a decrease in each variable is uncorrelated with whether a CEO is within 2 years of normal retirement. I set FINAL equal to 1 if a CEO from my short-horizon sample is in his last 2 years of service, and 0 otherwise. If CEOs engage in real transaction management in order to boost earnings in their final years, then the coefficient estimate on FINAL should be significantly positive. A positive and significant coefficient estimate on FINAL x BONUS_PENSION will indicate that the horizon problem is worst for CEOs with bonus-contingent pensions. If CEOs with bonus-contingent pensions are more likely to curtail R&D in their last 2 years than in prior years, then the sum of the coefficients on FINAL and FINAL x BONUS_PENSION should be significantly positive. Table 9 displays the results from these logit regressions.

The coefficient on FINAL is not significantly different from zero in any of the three regressions in Table 9, providing no support for the view that retiring CEOs artificially inflate earnings through real transaction management. The coefficient on FINAL x BONUS_PENSION is marginally significantly negative in Column C, indicating that any propensity to curtail R&D in CEOs' final years is *less* pronounced for CEOs with bonus-contingent pensions. Finally, the coefficient estimates on the interaction terms are not significantly different from zero in any of the three regressions. Thus, I find no evidence of myopic investment decisions among CEOs approaching retirement.

4.4 Reconciling Contradictory Findings in Prior Research

A notable feature of prior studies is that findings in support of or against the horizon problem are correlated with the empirical design employed. Of the four studies documenting an intertemporal decline in R&D spending consistent with a horizon problem (Dechow and Sloan 1991; Barker and Mueller 2002; Lundstrum 2002; Naveen 2006), all but one (Dechow and Sloan 1991) allow short-horizon and long-horizon CEO years to come from different firms. Conversely, studies finding no evidence of R&D curtailment tend to compare R&D spending immediately prior to a CEO's departure to R&D spending in other years of the same firm (two exceptions being Butler and Newman (1989) and Cheng (2004)).

Comparing R&D spending between CEOs relatively close to retirement and CEOs relatively far from retirement in different firms may result in spurious inferences of a horizon problem due to sample selection problems. There are reasons to expect that firm R&D intensity is associated with the likelihood that a young CEO remains in office until normal retirement age. One reason is that R&D-intensive firms make attractive acquisition targets. Heeley, King, and Covin (2006) find that the likelihood a firm is acquired increases in R&D-intensity. A second reason is that R&D-intensive firms tend to have high growth strategies and significant operating risk, making them more likely to delist due to business failure.

The following scenario illustrates how survivorship bias can confound a regression of R&D on CEO age or tenure. A new set of firms begins operations every year, each with a CEO relatively far from retirement. Some firms are high-growth firms with high R&D spending, and other firms are low-growth firms with low R&D spending. R&D-

intensive firms are more likely to delist in subsequent years either due to business failure or to being acquired by larger entities. Eventually, the sample of CEOs who have arrived at retirement age will be disproportionately populated by relatively low-R&D spending firms. A regression of R&D spending on CEO age or CEO tenure (as in Lundstrum (2002), Barker and Mueller (2002), and Naveen (2006)) will produce a finding that CEOs closer to retirement spend less in R&D.

I shed light on the descriptive validity of the above scenario by examining the extent to which industry-adjusted R&D intensity is correlated with the probability of delisting in subsequent years. I begin with all firms in R&D-intensive industries that begin ExecuComp coverage prior to 1997, where R&D-intensive industries are defined as 2-digit SIC codes in which over half of all firms invest in R&D. I compute the percentile rank of each firm's R&D as a percentage of sales relative to other firms in the same industry-year.[28] I limit the sample to firms in industries with a total of at least 30 firms listed on ExecuComp in order to obtain a reliable measure of a firm's ranking within its industry. This results in a sample of 654 firms in R&D-intensive industries beginning coverage in ExecuComp prior to 1997.

I next determine the number of these firms that are still covered in ExecuComp in 2006 (the last full year of ExecuComp data). Of the 654 firms in R&D-intensive industries that commence ExecuComp coverage prior to 1997, 304 are no longer covered in ExecuComp by 2006. Delisting codes from CRSP (available for only 273 of the 304 firms) indicate that most of these firms have been acquired by other entities, though over

[28] Percentile ranks are computed as (numerical rank/number of firms in industry), which allows comparability of rankings across industries containing different numbers of firms.

ten percent of these firms delist for reasons associated with business failure. Consistent with the argument that R&D intensity is positively correlated with the probability of delisting in subsequent years, I find firms that fall out of the sample have significantly greater mean percentile rank of R&D (scaled by sales) than the 350 firms that are still active in 2006 (t-stat = -2.63, p-value = 0.009).

To illustrate how regressing R&D on CEO age in a cross-section of firms results in different inferences than does tracking R&D spending by the same CEOs over time, I build on results from a prior paper finding evidence that older CEOs are associated with lower R&D spending. Lundstrum (2002) examines a sample of 1,076 firm-years in R&D-intensive industries between 1991 and 1993 and reports that industry-adjusted R&D spending is negatively associated with CEO age. He finds that the negative relationship between R&D spending and CEO age persists across the range of CEO age and concludes that CEOs' R&D investments become increasingly myopic as CEOs approach retirement.

Using sample selection procedures similar to those described in Lundstrum (2002), I identify a sample of firm-years from 1996 to 2006 in industries with mean firm R&D spending equal to at least 3 percent of sales. I replicate Lundstrum's main result by regressing industry-adjusted R&D/sales on CEO age, total assets, and market-to-book ratio of equity, reporting the results in Column A of Table 10. I repeat the procedure using each firm's within-industry percentile rank (between 0 and 1) of R&D/sales as the dependent variable to account for the influence of outliers.

Columns A and B of Table 10 reveal that CEO age is negatively related to both industry-adjusted R&D/sales and within-industry percentile rankings of R&D/sales. In untabulated analyses, I also find that cross-sectional regressions run by year result in a negative coefficient on CEO age significant at the 5% level or lower every year from 1996 to 2006 using industry-ranks as the dependent variable.[29] These regression results are consistent with CEOs gradually reducing R&D investments over the course of their tenure. The coefficient estimate on CEO_AGE in Column B of Table 10 suggests that after ten years, industry-adjusted R&D spending by the same CEO over time is expected to decline by approximately 2 percent of sales (0.002 x 10). The coefficient estimate on CEO_AGE in Column C suggests that during the same period, the CEO's industry rank of R&D/sales is expected to decline by approximately 0.06.

I next investigate whether the negative association between CEO age and R&D spending suggested by the coefficient estimates in Table 6 are actually descriptive of trends in R&D spending exhibited when tracking the same CEOs over time. Out of 480 CEOs in R&D-intensive industries who are in office in 1996, 54 CEOs are still in office ten years later in 2006. I rerun the same regressions from Columns A and B of Table 6 on these 54 CEOs after replacing the CEO_AGE variable with a time trend (TIME_TREND) equal to 0 in 1996 and increasing by one integer for each succeeding year. This sample consists of 580 CEO-years from 1996 to 2006. If CEOs actually decrease their R&D spending relative to their industry-peers as they approach retirement, the coefficient on TIME_TREND should be significantly negative. I report the results from these regressions in Columns C and D of Table 10.

[29] Using industry-adjusted R&D/sales as the dependent variable results in a negative and significant coefficient on CEO_AGE for every year except for 2005 and 2006, when the coefficient is still negative but no longer significant at the 5% level.

Columns C and D of Table 10 show that the coefficient on TIME_TREND is positive and insignificant, providing no support for the view that that CEOs reduce their R&D spending as they approach retirement. To assess whether this result is due to inadequate statistical power, I note that the 95 percent confidence interval for the coefficient on TIME_TREND in Column D has a lower bound of -0.00052. Based on these parameter estimates, the probability that aging ten additional years leads to a decrease in CEOs' percentile rank of R&D intensity of more than 0.0052 is only 2.5 percent. This evidence suggests that the strong negative association between R&D spending and CEO age or tenure documented in prior literature (Barker and Mueller 2002; Lundstrum 2002; Naveen 2006) stems from sample selection bias rather than from the same CEOs decreasing R&D expenditures over time.

4.5 Rerunning Analyses for CEOs with Low Equity Holdings

Dechow and Sloan (1991) report that CEO equity holdings mitigate the horizon problem in their sample. It may be that retiring CEOs in my sample don't exhibit R&D curtailment on average because their equity-based incentives properly align their interests with the interests of shareholders. I investigate whether my results differ among retiring CEOs conditional on the level of their equity holdings by partitioning the short-horizon sample between CEOs whose wealth sensitivity to a dollar change in stock price is above or below the sample median. Mean ABNORMAL_R&D among CEOs with relatively low wealth sensitivity to a dollar change in stock price is -0.001 (0.1 percent of sales), but statistically indistinguishable from zero (p-value = 0.75). Among short-horizon CEOs who have both bonus-contingent pensions and relatively low wealth sensitivity to changes in stock price, mean ABNORMAL_R&D is -0.002 (0.2 percent of sales) and is again statistically insignificant (p-value = 0.36). Focusing on CEOs whose wealth sensitivity to changes in stock price is below the 25^{th} percentile yields similar results. Thus, I find no evidence of R&D curtailment among CEOs with relatively low CEO equity holdings.

4.6 Caveats and Limitations

The inferences drawn from this paper are subject to certain limitations. First, by focusing on retiring CEOs, this paper ignores the agency problems of short-horizon CEOs who are fired. If CEOs who anticipate a significant probability of being involuntarily terminated in the near future are those most likely to ignore the interests of shareholders, then this paper potentially ignores a subset of CEOs for whom agency problems are the most severe. However, many prior papers argue that the horizon problem should be greatest among retiring CEOs because they are best able to anticipate the timing of their departure.

In addition, this paper relies on imperfect surrogates for unobserved constructs such as firms' relay succession plans and CEOs' plans for post-retirement board service. To the extent that the variables used in this paper do not adequately proxy for firms' succession plans or CEOs' post-retirement career concerns, the power of my statistical tests are limited. However, the variables used in this paper are consistent with those used in prior research.

CHAPTER 5. DISCUSSION AND CONCLUSION

I perform a battery of tests for opportunistic R&D curtailment associated with the horizon problem by focusing on CEO departures representing normal retirement, examining CEOs whose pension arrangements amplify the effect of bonuses awarded in their final years, and controlling for other factors expected to affect managerial horizon problems. I find no support for the view that retiring CEOs curtail R&D expenditures in the years immediately prior to their retirement. In addition, I find no evidence that accounting-based compensation is associated with abnormal R&D spending in retiring CEOs' final years. I identify an important limitation of prior research that infers a managerial horizon problem from the negative association between R&D spending and CEO age or tenure.

One explanation for finding no evidence of R&D curtailment as CEOs approach retirement may be that agency problems are mitigated through control mechanisms not explicitly considered in this paper. For instance, boards of directors may increase monitoring of the CEO during his final years. Additionally, boards of directors may alter the compensation of CEOs near retirement in order to better align their wealth with the long-term financial health of the firm (e.g., Baber, Kang, and Kumar 1998).

Gibbons and Murphy (1992) discuss other explanations for researchers' failure to document evidence of a horizon problem. They suggest that retiring CEOs switch to R&D projects with shorter payoffs without decreasing the total investment in R&D. Retiring CEOs may invest more towards the development of products they can push to the market quickly while investing less on basic research that will pay off far in the future. In addition, Gibbons and Murphy (1992) argue that myopic investment policies are likely to face opposition from younger members of the management team whose careers and wealth are still tied to the long-term health of the corporation.

This paper leaves many important questions to future research. Do CEO horizon problems manifest in myopic behavior besides R&D curtailment? Do bonus-contingent pensions create agency problems in CEOs' final years of service in ways not examined in this paper? Do factors besides survivorship bias induce the negative relationship between CEO age and R&D spending documented in prior literature? In addition, future research should further examine retiring CEOs' explicit and implicit incentives to better understand why empirical evidence of a horizon problem is so limited.

APPENDIX A: TABLES AND FIGURES

Table A1. Summary of Prior Empirical Evidence on R&D Curtailment among Short-horizon CEOs

Author(s) (Year)	Sample of short-horizon CEOs	Dependent Variable	Proxy for CEO proximity to retirement	Results Consistent with a Horizon Problem?
Butler and Newman (1989)	54 CEO departures including non-retirements	$(R\&D_t - R\&D_{t-1})/R\&D_{t-1}$	CEO's final year	No
Dechow and Sloan (1991)	58 CEO departures including non-retirements	$(R\&D_{it} - R\&D_{it-1})/Sales_{it-1}$ and $Ln(R\&D_{it}) - ln(R\&D_{it-1})$	CEO's last full year and year of departure	Yes
Gibbons and Murphy (1992)	304 CEO departures from 184 firms, including non-retirements	$\frac{R\&D_{it}}{(\text{Average R\&D over CEO's career})}$	CEO's last full year and year of departure	No
Murphy and Zimmerman (1993)	1,063 CEO departures from 599 firms, including non-retirements[a]	$Ln(R\&D_{it}) - ln(R\&D_{it-1})$	CEO's last full year and year of departure	No
Barker and Mueller (2002)	CEOs of 172 firms, test based on CEO age	$R\&D_{it}/(\text{\# of Employees})$	CEO age	Yes
Lundstrum (2002)	Average of 359 firms per year over 3-year period, test based on CEO age	$R\&D_{it}/Sales_{it}$	CEO age	Yes
Cheng (2004)	CEOs in 160 firms, tests based on CEO age exceeding 63	$(R\&D_{it}/\text{BV of Equity}_{it}) - (R\&D_{it-1}/\text{BV of Equity}_{it-1})$	CEO age > 63	No
Gerakos (2005)	118 CEO departures including non-retirements	$(R\&D_t - R\&D_{t-1})/R\&D_{t-1}$	CEO's final 4 years	Yes
Conyon and Florou (2006)	90 CEO retirements	$Pr(RD_{it} - RD_{it-1} < 0)$	CEO's last full year and year of departure	No
Naveen (2006)	Average of 614 firms per year over 10-year period, test based on CEO tenure	$R\&D_{it}/Assets_{it}$	CEO tenure	Yes

Table A2. Reconstruction of Dechow and Sloan's (1991) Sample

Panel A: Sample Selection Procedure for Identifying "Clean" CEO Departures	**Dechow and Sloan (1991)**	**Re-constructed sample**
Manufacturing firms in R&D-intensive industries identified by Dechow and Sloan (1991)	405	1,272
Firms that are also listed on the 1989 Forbes executive compensation survey	91	87
CEO turnovers from 1979-89 in which no other CEO turnover occurs in prior 5 years	58	52

Panel B: Distribution Data from Dechow and Sloan's (1991) Sample. Reconstructed Sample Reported below in Parentheses.

Variables	**Mean**	**Standard deviation**	**Median**	**Lower Quartile**	**Upper Quartile**
Sales ($MM)	6,300.21 (6,139.79)	9,896.32 (9,585.17)	2,642.99 (2,787.78)	1,491,58 (1,481.00)	6,018.17 (5,989.91)
R&D ($MM)	329.72 (311.76)	610.39 (556.41)	148.69 (149.21)	59.58 (45.48)	315.45 (335.7)
R&D/Sales	0.059 (0.061)	0.034 (0.035)	0.055 (0.053)	0.029 (0.027)	0.078 (0.077)

Panel C: Financial Performance of R&D Curtailers vs. Non-curtailers around CEO Departures

$$\Delta(\text{Financial variable})_{it} = \alpha + \beta^{*}\text{FINAL}_{it} + \varepsilon_{it}$$

Dependent variable = Sales Growth = $\ln(sales_t) - \ln(sales_{t-1})$

	α	**β**
Non-curtailers (240 CEO-years from 25 unique CEOs)	0.059 (3.35)***	-0.004 (-0.10)
Curtailers (250 CEO-years from 27 unique CEOs)	0.040 (4.66)***	-0.048 (-2.62)**

Dependent variable = Net Income Growth = $\ln(NI_t) - \ln(NI_{t-1})$

	α	**β**
Non-curtailers (239 CEO-years from 25 unique CEOs)	0.040 (1.36)	0.037 (0.49)
Curtailers (250 CEO-years from 27 unique CEOs)	0.044 (3.09)***	-0.041 (-1.32)

Note: In Panel A, reconstructed sample is based on industry classification using firms' historical SIC codes (Compustat data item #324) as of 1989, which is the year of the Forbes executive compensation survey Dechow and Sloan (1991) use to identify their sample.

Table A2. Continued

Note: Compustat backfills prior years' data for firms when they begin coverage on Compustat. This explains why, as seen in Panel A, the number of firms with year 1989 data available on Compustat is much higher today than it was in 1991.

Note: Descriptive statistics in Panel B are stated in 1988 dollars using a CPI adjustment.

Note: In Panel C, R&D Curtailers are CEOs for whom average R&D growth is lower in their final two years of office than in other years during the 11-year window centered on the CEO transition. Non-curtailers are CEOs for whom average R&D growth is not lower in their final 2 years. R&D growth is measured as $\ln(R\&D_t) - \ln(R\&D_{t-1})$, following Dechow and Sloan (1991). Sales is Compustat data item #12, Net Income is measured as operating income (Compustat data item #13). FINAL is a dichotomous variable equal to 1 if a departing CEO is in his departure year or the immediately previous year, and 0 otherwise. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 alpha level, using a two-tailed test.

Table A3. Sample Selection and Descriptive Statistics Regarding CEO Retirements

Panel A: Sample Selection Procedure for Retiring CEOs (short-horizon sample)	**Number of CEOs**	**Number of CEO-years**
CEO departures with at least 5 years of ExecuComp data prior to departure (1996-2005)	942	4,710
CEOs of firms with average R&D > 10% of net income over sample period	414	2,070
CEOs with sufficient pension data	390	1,950
CEOs who participate in annual bonus plans	373	1,865
Deleting CEO departures not corresponding to planned retirement:		
CEO departures due to death or illness	<13>	<65>
CEOs who are terminated involuntarily or who resign due to poor performance	<65>	<325>
CEOs who remain as an executive of their own or another firm after leaving office	<37>	<185>
CEOs who depart prior to age 60 for undisclosed reasons	<37>	<185>
CEO departures in conjunction with a merger or spinoff	<10>	<50>
CEOs departures deleted for other miscellaneous reasons	<10>	<50>
CEOs with necessary data & average R&D/Sales <0.4	203	969

Panel B: Descriptive Statistics on Short Horizon CEO Pension Plans	
Pension contingent on bonuses in final years	120
Pension not contingent on bonuses in final years	20
No defined-benefit pension plan	63
Total	**203**

Panel C: CEO Age at Retirement (Short-Horizon CEOs) and Tenure as CEO			
	Pension contingent on bonuses in final years	Pension not contingent on bonuses in final years	No defined-benefit plan
Age at Retirement	63.4 (63.5)	64.0 (65.0)	64.9 (64.0)
CEO Tenure	8.9 (7.9)	9.7 (7.8)	14.4 (11.2)

Note: In Panel A, average R&D as a percentage of net income over the sample period is based on a minimum of 3 years of positive R&D spending for each firm in the control and short-horizon samples. Firms with fewer than 3 years of positive R&D spending during the sample period were excluded from the sample.

Note: In Panel A, CEOs eliminated from the sample for miscellaneous reasons include CEOs who are appointed to government positions (three), CEOs whose pensionable compensation includes stock-based awards (four), a CEO whose pension was changed in his final year to include bonuses as pensionable compensation, a CEO who departs while his firm is in bankruptcy, and a CEO who is only a Co-CEO. The classification of CEO

Table A3. Continued

departures for reasons other than planned retirement is based on proxy statements and contemporary news articles from Factiva. Note: In Panel B, CEO pensions that are not contingent on performance in final years primarily consist of pensions for which only salary is pensionable or pensions based on a cash-balance plan (rather than a final-pay-and-service formula). However, this category also includes pensions that are set at fixed dollar amounts, pensions based on target rather than actual bonuses, and pensions based on compensation capped below the CEO's current salary level.

Note: In Panel C, means are reported in the top part of the cell and medians are reported below in parentheses. CEO tenure is significantly longer among CEOs with no defined-benefit plan than for CEOs with defined-benefit plans in my sample at the 0.01 significance level.

Table A4. Descriptive Statistics Regarding Financial Variables and Industry Distribution

Panel A: Distribution Data by CEO Pension Type						
Variables	**Bonus-Contingent Pension (A)**	**Pension not Contingent on Bonus (B)**	**No Defined-benefit Pension (C)**	**Pr (A=B)**	**Pr (A=C)**	**Pr (B=C)**
Market value ($BB)	15.33 (5.03)	14.91 (2.02)	8.73 (1.57)	0.95	**0.09**	0.36
Market-to-book ratio	3.12 2.80	3.07 (2.72)	4.33 (3.24)	0.90	**0.05**	**0.03**
R&D/Sales	0.033 (0.023)	0.046 (0.031)	0.075 (0.056)	**0.08**	**<0.01**	**<0.01**
Firm age (Years listed on Compustat)	40.60 (44.50)	27.64 (28.50)	21.46 (21.25)	**<0.01**	**<0.01**	**0.02**
CEO bonus/salary	1.15 (1.03)	1.01 (0.72)	1.18 (0.99)	0.50	0.83	0.47
CEO total compensation ($MM)	6.04 (4.46)	6.42 (3.13)	4.06 (2.61)	0.75	**<0.01**	**0.06**
CEO equity holdings ($MM)	43.65 (26.46)	46.02 (14.70)	36.73 (13.27)	0.90	0.26	0.63

Panel B: Breakdown of Sample Firms by Industry		
2-Digit SIC Code	**Industry Description**	**Number of firms**
28	CHEMICALS AND ALLIED PRODUCTS MFRS	32
38	MEASURING & ANALYZING INSTRUMENTS MFRS	27
36	ELECTRONIC, ELCTRCL EQPMNT & CMPNTS, EXCPT CMPTRS	26
37	TRANSPORTATION EQUIPMENT MFRS	24
35	INDUSTRIAL & CMMRCL MACHINERY & COMPUTER EQUPMNT	22
33	PRIMARY METAL INDUSTRIES MFRS	10
34	FABRICATED MTL PRDCTS, EXCPT MCHNRY & TRNSPRT EQPMNT	10
Other	MISCELLANEOUS	44

Table A4. Continued

Panel C: Pearson Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) BONUS_ PENSION	1.00												
(2) EQUITY_ INCENTIVES	(0.03)	1.00											
(3) FCF	**(0.22)**	**0.38**	1.00										
(4) INDUSTRY _R&D	(0.07)	**0.17**	**0.37**	1.00									
(5) TOBIN'S_Q	**(0.22)**	**0.40**	**0.64**	**0.25**	1.00								
(6) LAG_RET	**(0.22)**	0.08	**0.14**	0.05	**0.24**	1.00							
(7) ROA	**(0.17)**	**0.32**	**0.69**	**0.27**	**0.75**	**0.27**	1.00						
(8) SIZE	**0.31**	**0.60**	**0.31**	0.10	**0.31**	(0.01)	**0.21**	1.00					
(9) FIRM_AGE	**0.45**	(0.01)	**(0.09)**	(0.11)	**(0.20)**	**(0.16)**	**(0.17)**	**0.35**	1.00				
(10) FIRM_R&D	**(0.35)**	**0.20**	**0.65**	**0.41**	**0.49**	**0.13**	**0.49**	0.09	**(0.21)**	1.00			
(11) BOARD_ SERVICE	-0.06	**0.14**	0.04	(0.02)	0.06	0.02	0.04	(0.02)	0.01	0.01	1.00		
(12) RELAY	(0.07)	0.11	0.03	0.02	0.07	0.02	0.05	(0.01)	0.00	0.03	**0.41**	1.00	
(13) BONUS _SENSITIVE	**0.12**	(0.01)	**(0.15)**	(0.04)	**(0.15)**	(0.08)	(0.11)	0.04	**0.14**	(0.12)	(0.06)	(0.02)	1.00

Table A4. Continued

Note: In Panel A, means are reported in the top part of the cell and medians are reported below in parentheses. The right-most 3 columns contain p-values from tests of equality of means. All dollar amounts are adjusted for inflation and stated in 2005 dollars. P-values less than 0.10 are in bold.

Note: In Panel C, **bold** (underline) indicates correlations significant at the 1 (5) percent significance level.

Table A5. Simple Means Tests for Reduced R&D Spending as CEOs Approach Retirement

A: Mean R&D/Sales for Control Sample CEOs	B: Mean R&D/Sales for "Short-horizon" CEOs	(A-B)	Pr(A=B)
Panel A: Pooling Across All CEOs (n=445)			
A: Mean R&D/Sales for Control Sample CEOs	B: Mean R&D/Sales for "Short-horizon" CEOs	(A-B)	Pr(A=B)
0.0468	0.0471	-0.0002	0.962
Panel B: Examining CEOs without pensions (n=136)			
A: Mean R&D/Sales for Control Sample CEOs	B: Mean R&D/Sales for "Short-horizon" CEOs	(A-B)	Pr(A=B)
0.0765	0.0744	0.002	0.876
Panel C: Examining all CEOs with pensions (n=309)			
A: Mean R&D/Sales for Control Sample CEOs	B: Mean R&D/Sales for "Short-horizon" CEOs	(A-B)	Pr(A=B)
0.0340	0.0348	-0.0007	0.849
Panel D: Examining only CEOs whose pensions are bonus-contingent (n=229)			
A: Mean R&D/Sales for Control Sample CEOs	B: Mean R&D/Sales for "Short-horizon" CEOs	(A-B)	Pr(A=B)
0.0329	0.0322	0.0008	0.837

Note: Panel A shows the results from testing for a difference in mean R&D between CEOs near retirement (last 5 years) versus CEOs further from retirement for all CEOs in my short-horizon and control samples. Panel B displays results of these tests on CEOs with no defined-benefit pension. Panel C displays results of these tests on only CEOs with pensions that are not bonus-contingent. Panel D displays results of these tests on only CEOs with bonus-contingent pensions. R&D data are averaged across all CEO-years for each CEO in the sample to avoid the effects of autocorrelation.

Table A6. Construction of Dependent and Independent Variables

Variable Name	Description
BONUS _SENSITIVE	Computed by dividing the annual change in the CEO's bonus (scaled by lagged salary) by the annual change in the firm's ROA. I compute the median value of this ratio across all short-horizon CEOs and set BONUS_SENSITIVE equal to 1 in CEO-years for which this ratio is above the median and 0 otherwise.
ABNORMAL_R&D	Actual R&D of CEOs near retirement minus predicted R&D. Predicted R&D is computed using coefficients on economic determinants of R&D spending estimated over a control sample of CEOs far from retirement.
BOARD_SERVICE	Equal to 1 if the CEO serves on the board of directors for at least one year following retirement as a full-time employee, and 0 otherwise. Measurable only for CEOs in the short-horizon sample.
BONUS_ PENSION	Equal to 1 if the CEO has a non-qualified defined benefit plan contingent on final average salary and bonus, and 0 otherwise. Data hand-collected from proxy statements (DEF 14A) for each CEO-year.
DB_ PENSION	Equal to 1 if the CEO has a non-qualified defined benefit plan, and 0 otherwise. Data hand-collected from proxy statements (DEF 14A) for each CEO-year.
EQUITY_ INCENTIVES	The natural logarithm of the CEO's dollar wealth increase from a 1% change in stock price. Measured as in Core and Guay (2002). The dollar wealth increase from a 1% change in stock price is based on the Black Scholes (1973) option pricing model and measured as: (δ(option value) /δ(price)) * (price/100) = e^{-dT} N (Z) * (price/100), where d = the firm's dividend yield, T = the time to option maturity, N(Z) = the cumulative probability function for the normal distribution, and the first term (δ / δ) denotes the partial derivative of the option value with respect to stock price.
FCF	Free cash flows in year t. Measured as operating cash flows plus R&D expense minus capital expenditures, all scaled by sales ((Compustat data item #308+data item #46 – data item #128)/data item #12).
FIRM_AGE	The natural logarithm of the number of years between year t and the first year the company listed on Compustat.
FIRM_R&D	R&D expense scaled by sales (Compustat data item #46/data item #12).
INDUSTRY _R&D	The 2-digit SIC industry median of FIRM_R&D.
INST_ HOLDINGS	The percent of outstanding shares owned by institutional shareholders. Collected from S&P's Security Owners' Stock Guide.
LAG_RET	Lagged 1-year total return to shareholders (TRS1YR from ExecuComp)
RELAY	Equal to 1 in year t if the current President or Chief Operating Officer becomes the CEO after the incumbent's retirement, and zero otherwise.
ROA	Return on Assets, measured as operating net income before R&D expense scaled by assets (Compustat data item #13 – data item #14+data46)/data item # 6.
SIZE	The natural logarithm of the firm's market value at the beginning of fiscal year t. Measured as common shares outstanding multiplied by stock price.
TOBIN'S_Q	The market value of the firm's equity plus the book value of the firm's debt, all scaled by the book value of assets. Measured as of the beginning of fiscal year t.

Table A7. Determinants of R&D Spending Estimated on Control Sample

$$FIRM\_R\&D_i = \alpha_0 + \alpha_1 \times INDUSTRY\_R\&D_i + \alpha_2 \times TOBINS\_Q_i + \alpha_3 \times LAG\_RET_i + \alpha_4 \times FCF_i + \alpha_5 \times ROA_i + \alpha_6 \times SIZE_i + \alpha_7 \times FIRM\_AGE_i + \alpha_8 \times EQUITY\_INCENTIVES_i + \alpha_9 \times DB\_PENSION_i + \sum DB\_PENSION \times \text{economic determinants}_i + \varepsilon_t \quad (2)$$

Independent Variable	Expected Sign	Parameter Est *Two-tailed p-value* CEOs without DB Pensions (A)	CEOs with DB Pensions (B)	Pr (A=B) (C)
Intercept	?	**0.065** *0.031*	**-0.025** *0.250*	0.016
INDUSTRY_R&D	+	**0.204** *0.062*	**0.147** *0.003*	0.632
TOBINS_Q	+	**0.020** *<0.001*	**-0.012** *0.026*	<0.001
LAG_RET	+	**-0.029** *0.013*	**-0.008** *0.471*	0.186
FCF	+	**0.304** *<0.001*	**0.185** *<0.001*	0.113
ROA	+	**-0.135** *0.050*	**0.208** *0.002*	<0.001
SIZE	?	**-0.009** *0.019*	**0.003** *0.233*	0.009
FIRM_AGE	-	**0.000** *0.947*	**0.004** *0.310*	0.635
EQUITY_INCENTIVES	+	**0.000** *0.961*	**-0.001** *0.666*	0.732
R-square	0.61			
Number of observations (CEOs)	257			

Note: Coefficient estimates from regressing FIRM_R&D (measured as R&D/sales) on the economic determinants displayed in equation (2) on my control sample of CEOs. Data are averaged across years for each CEO to control for within-firm autocorrelation (control sample represents a total of 728 CEO-years from 1993 to 2005). All CEO-years in the control sample represent CEOs who are age 55 or younger and at least 3 years away from departing the firm. Column A contains coefficient estimates from regression (2) for CEOs without defined-benefit plans. Column B contains coefficient estimates from regression (2) for CEOs with defined-benefit (DB) pensions. Column B coefficient estimates are measured as the main effect plus the coefficient estimate on the corresponding interaction term. Coefficient estimates are in bold; corresponding p-values appear below in italics. Regressions are OLS; running a Tobit regression has a negligible effect on all parameter estimates and leaves inferences unchanged. The right-most column contains p-values indicating the probability that the coefficient in column A is the same as the corresponding coefficient in column B. All variables are defined in Table 6.

Table A8. Determinants of ABNORMAL_R&D among Short-Horizon CEOs

Panel A: Descriptive Statistics for actual, predicted, and abnormal R&D for CEOs in short-horizon sample

Variable	All short-horizon CEOs	CEOs without pensions	CEOs with pensions not contingent on bonus	CEOs with bonus-contingent pensions
Actual R&D	**0.047**	**0.074**	**0.050**	**0.032**
	0.028	*0.057*	*0.031*	*0.023*
Predicted R&D	**0.044**	**0.078**	**0.026**	**0.033**
	0.034	*0.065*	*0.024*	*0.031*
Abnormal R&D	**0.0008**	**-0.004**	**0.023**	**-0.0006**
	-0.004	*-0.016*	*0.007*	*-0.003*
Pr(Abnormal R&D = 0)	0.784	0.591	0.069	0.748

Panel B: Results from Regressing ABNORMAL_R&D on Factors Expected to Affect Horizon Problem

$$\text{ABNORMAL\_R\&D}_i = \beta_0 + \beta_1 \times \text{BONUS\_PENSION}_i + \beta_2 \times \text{BONUS\_SENSITIVITY}_i + \beta_3 \times \text{RELAY}_i + \beta_4 \times \text{BOARD\_SERVICE}_i + \mu_i$$

Independent Variable	Expected Sign	Parameter Est *Two-tailed p-value* (A)	(B)
Intercept	?	**0.005**	**-0.028**
		0.533	*0.818*
BONUS_PENSION	-	**-0.004**	**0.022**
		0.474	*0.799*
RELAY	+	**-0.004**	**-0.127**
		0.627	*0.299*
BOARD_SERVICE	+	**-0.004**	**-0.051**
		0.457	*0.559*
BONUS_SENSITIVE	-	**0.005**	**0.100**
		0.641	*0.525*
R-square		0.00	0.01
Number of Obs		203	203

Note: ABNORMAL_R&D is computed for short-horizon CEOs as actual R&D expenditures minus predicted R&D (all scaled by annual sales). Predicted R&D is based on parameters estimated from a control sample of CEOs relatively far from retirement (displayed in Table 4). ABNORMAL_R&D for each short-horizon CEO is averaged over his last 5 years of service to control for autocorrelation. The short-horizon sample consists of 203 unique CEOs over the period from 1993 to 2005. In Panel A, means are reported in bold and medians are reported below in italics.

Table A8. Continued

Note: Panel B displays coefficient estimates from regressing ABNORMAL_R&D on the factors posited to affect R&D curtailment among CEOs close to retirement. All measures of R&D are scaled by sales. The dependent variable in Column B of Panel B is ABNORMAL_R&D scaled by the absolute value of predicted R&D. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 significance level.

Table A9: Changes in R&D, Other Discretionary Expenses, and Production Costs in CEOs' Final 2 Years

$$Pr(\text{Expense Manipulation})_{i,t} = \beta_0 + \beta_1 \times FINAL_{i,t} + \beta_2 \times FINAL \times BONUS\_PENSION_{i,t} + \beta_3 \times FINAL \times RELAY_{i,t} + \beta_4 \times FINAL \times BOARD\_SERVICE_{i,t} + \beta_5 x\ FINAL \times BONUS\_SENSITIVITY_{i,t} + \mu_i$$

	Parameter Est *Two-tailed p-value*		
Independent Variable	INCREASE_PROD (A)	DECREASE_OTH (B)	DECREASE_R&D (C)
Intercept	**0.019**	**0.119**	**0.055**
	0.66	*0.03***	*0.31*
FINAL	**-0.011**	**0.047**	**0.211**
	0.96	*0.87*	*0.47*
FINAL x BONUS_PENSION	**0.034**	**-0.310**	**-0.35**
	0.85	*0.179*	*0.10**
FINAL x RELAY	**0.208**	**0.294**	**0.162**
	0.26	*0.18*	*0.46*
FINAL x BOARD_SERVICE	**-0.204**	**-0.052**	**-0.066**
	0.26	*0.83*	*0.77*
FINAL x BONUS_SENSITIVE	**0.178**	**0.193**	**-0.063**
	0.42	*0.42*	*0.77*
$Pr(\beta_1 + \beta_2 = 0)$	0.91	0.31	0.58
Number of Obs	2,000	1,823	1,969

Note: Coefficient estimates from a logit regression of the probability of a decrease (increase) in R&D and other discretionary expenses (production costs) in a CEO's final 2 years. Model consists of the same variables expected to moderate the horizon problem as specified in Panel B of Table 5. FINAL = 1 if a CEO from the short-horizon sample is in his last 2 years of service, and 0 otherwise. Control years (FINAL = 0) are derived from the same firms represented in the short-horizon CEO sample. Control years are retained if they are at least 2 years prior to or one year after a CEO's departure. INCREASE_PROD = 1 if production costs as a percentage of sales is higher in the current year than in the prior year, and 0 otherwise. Production costs are computed as cost of goods sold plus annual change in inventory. DECREASE_OTH = 1 if the sum of SG&A and advertising expense as a percentage of sales is lower in the current year than in the prior year, and 0 otherwise. DECREASE_R&D is equal to 1 if R&D as a percentage of sales is lower in the current year than in the prior year, and 0 otherwise. P-values are reported below coefficient estimates and are based on standard errors clustered by firm. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 significance level.

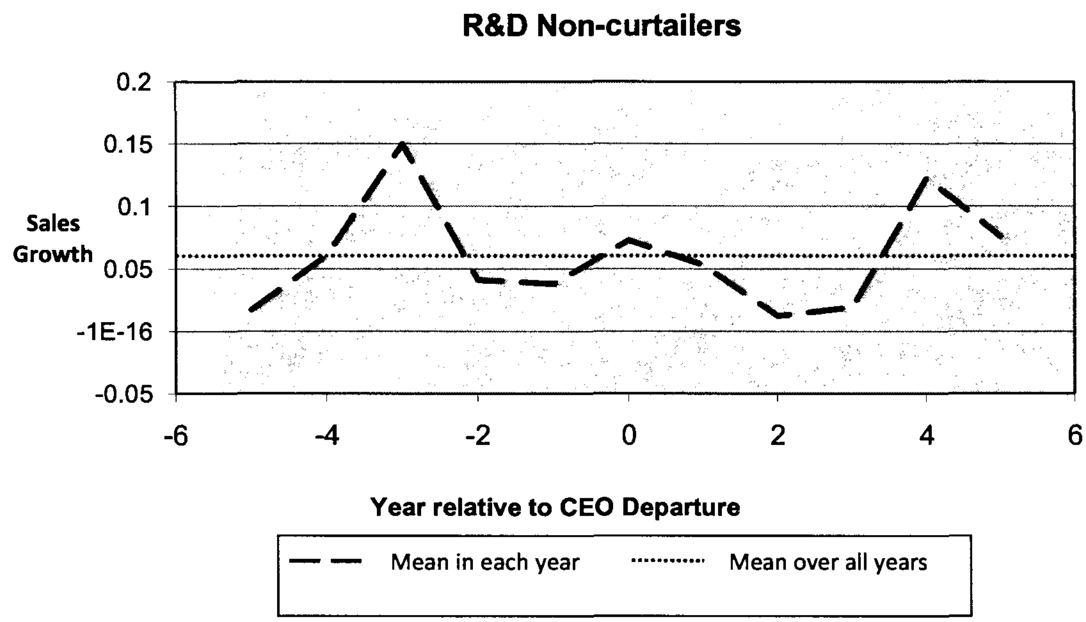
Table A10: Results from a Regression of Industry-adjusted R&D/Sales on CEO Age and a Time Trend Variable

Measure of industry-adjusted $R\&D_{i,t}=\theta_0+\theta_1\times CEO\_AGE_{i,t-1}+\theta_2\times ASSETS_{i,t-1}+\theta_3\times MTB_{i,t-1}+\epsilon$

	Dependent Variable			
Independent Variable	Industry-Adjusted R&D/Sales (A)	Industry Rank of R&D/sales (B)	Industry-Adjusted R&D/Sales (C)	Industry Rank of R&D/sales (D)
Intercept	**0.14**	**0.797**	**0.046**	**0.481**
	*<0.001******	*<0.001******	*0.106*	*<0.001******
CEO_AGE	**-0.002**	**-0.006**		
	*<0.001******	*<0.001******		
TIME_TREND			**0.002**	**0.002**
			0.211	*0.154*
ASSETS ($000)	**-0.003**	**-0.004**	**-0.004**	**-0.000**
	*<0.001******	0.067*	*0.261*	*0.969*
MTB	**0.003**	**0.010**	**0.003**	**0.016**
	*<0.001******	*<0.001******	*0.494*	*0.089**
R^2	0.04	0.05	0.01	0.04
Number of CEO-years	6,273	6,273	584	584

Note: This table reports coefficient estimates from a regression of industry-adjusted R&D/sales on the CEO's age, MTB, and total assets for a sample firms years from 1996 to 2006. Firms were chosen from industries with mean firm R&D greater than 3 percent of sales. The dependent variable in Column A is industry-median adjusted R&D/sales, where industries are defined at the 2-digit SIC level. The dependent variable in Column B is the firm's percentile rank of R&D/sales within its industry, ranging from 0 to 1. Column C reports coefficients from rerunning the model in Column A on a sample of 54 CEOs who remained in office from 1996 to 2006, after replacing CEO_AGE with a time trend variable equal to 0 in 1996 and increasing by 1 for every year until 2006. Column D reports coefficients from rerunning the model in Column B on those 54 CEOs, again replacing CEO age with the time trend variable. Two-tailed p-values are reported in italics below parameter estimates and are based on standard errors clustered by firm. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 significance level, using a two-tailed test.

Figure A1. Sales Growth around CEO Departures for R&D Curtailers versus R&D Non-curtailers



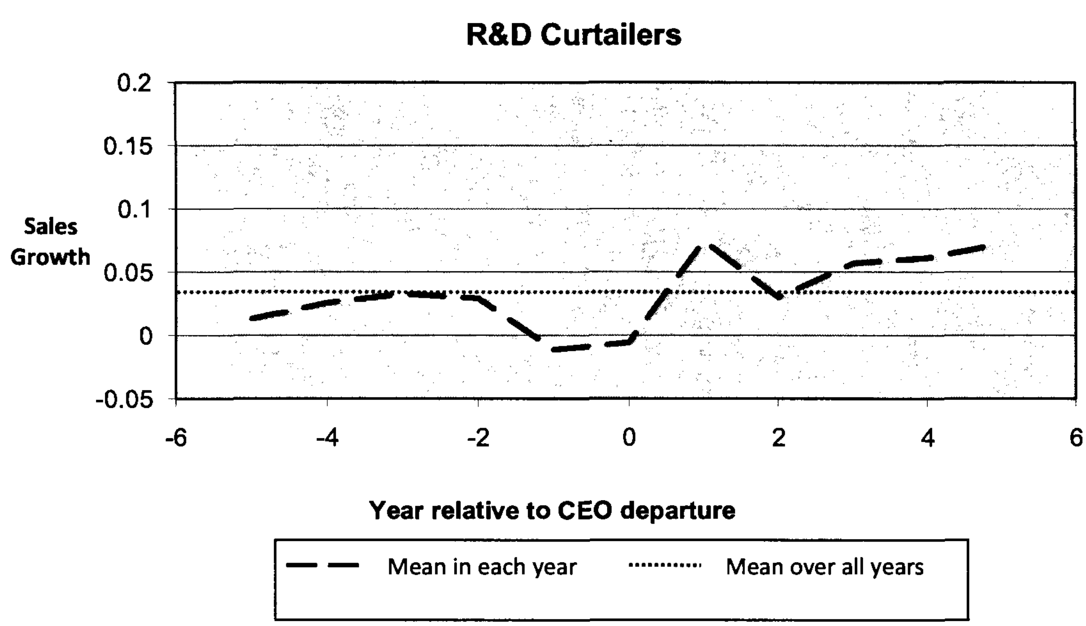
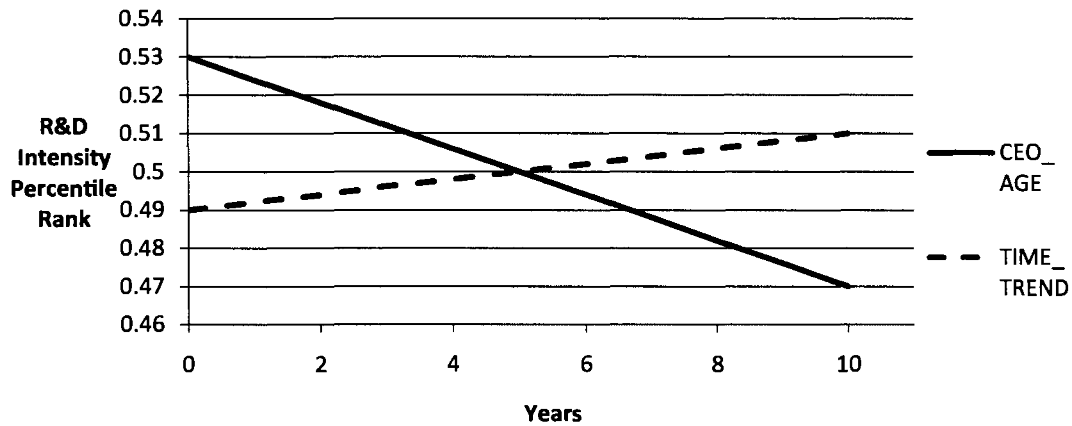


Figure A1. Continued

Note: These figures are based on a reconstruction of a sample of CEO departures identified following Dechow and Sloan's (1991) sample selection criteria. Sales growth is measured as $\ln(Sales_t) - \ln(Sales_{t-1})$. R&D Curtailers are CEOs for whom average R&D growth is lower in the CEO's departure year and the immediately preceding year than in other years in the 11-year window surrounding the CEO departure. R&D growth is measured as $\ln(R\&D_t) - \ln(R\&D_{t-1})$, following Dechow and Sloan (1991). Dollar amounts are adjusted for inflation and stated in 1988 dollars.

Figure A2. Trend in Within-Industry Percentile Rank of R&D Intensity during a CEO's Time in Office.



Note: This figure illustrates the different trends in R&D spending during a CEO's tenure estimated using CEO age in pooled regressions versus tracking the same CEOs over time. Both trend lines represent the slope coefficient estimates from a regression of industry-adjusted percentile rank of R&D/Sales on market-to-book, total assets, and a variable capturing the CEO's proximity to retirement (CEO_AGE or TIME_TREND). The trend line represented by CEO_ AGE is from a pooled sample of CEOs in R&D-intensive industries from 1996 to 2006. The trend line represented by TIME_TREND is estimated by tracking R&D/sales for the same CEOs over time for those CEOs who remained in office from 1996 to 2006. The slope coefficient on CEO_AGE is significantly negative (p-value < 0.001), whereas the slope coefficient on TIME_TREND is positive and statistically insignificant.

APPENDIX B: ADDITIONAL ANALYSES

Alternative Measures of R&D Intensity

This study focuses on firms for which R&D expenditures average at least 10 percent of net income during the sample period. For some firms, net income may be relatively small during the sample period such that even R&D expenditures averaging 10 percent of net income are not economically large relative to the size of the firm. Alternatively, I examine firms for which R&D expenditures average at least 1 percent of sales during the sample period. This procedure reduces my sample of "short-horizon" CEOs by nearly 20 percent (from 203 to 165). Analyses restricted to firms for which R&D expenditures average at least 1 percent of sales during the sample period are qualitatively similar to the analyses reported in this paper (abnormal R&D among short-horizon CEOs with bonus-contingent pensions = -0.001, p-value = 0.643).

Institutional Holdings

Jiambalvo, Rajgopal, and Venkatachalam (2002) report evidence suggesting that stock prices reflect future earnings more quickly among firms with high institutional ownership due to their ability to decipher the value-relevance of current R&D expenditures. Similarly, Bushee (1998) finds that institutional investors have a moderating effect on managers' myopic R&D investments. This literature suggests that to the extent that CEOs have incentives to cut R&D expenditures prior to their retirement, these incentives may be kept in check in the presence of large institutional holdings. I control for institutional holdings by including the percentage of common shares held by institutions (INST_HOLDINGS) in equation 3. The inclusion of INST_HOLDINGS has almost no effect on the coefficient estimates or t-statistics reported in Table 8. In addition, the coefficient on INST_HOLDINGS is -0.00005 (p-value = 0.998).

Excluding R&D from Earnings for CEO Bonus Purposes

Cheng (2004) argues that compensation committees exclude R&D from earnings when evaluating CEO performance for compensation purposes. If compensation committees exclude R&D from earnings when assessing CEO performance, this could explain the lack of evidence of R&D curtailment prior to CEO retirements. From a theoretical perspective, however, it is unclear that excluding R&D expense for CEO performance evaluation leads to better alignment of CEO and shareholder interests. Prior literature documents that CEOs often tend to empire build and over-invest (e.g., Jensen 1986; Richardson 2006). By charging R&D expenditures to net income for performance evaluation purposes, boards of directors are able to maintain accountability from CEOs for their R&D investment decisions.

I empirically test whether R&D expense is excluded from earnings in determining CEO cash compensation for CEOs in my sample by regressing changes in CEO salary plus bonus on changes in sales, changes in R&D, and changes in other components of operating income.[30] The dependent and independent variables in this regression are all scaled by lagged sales. If compensation committees exclude R&D expense from earnings when awarding CEO bonuses, then the coefficient on changes in R&D should be zero. If R&D expense is not backed out of earnings in assessing CEO performance, then the coefficient on changes in R&D should be negative, indicating that increases in R&D lead to lower bonus awards. In untabulated analyses, I find that for all CEOs in my sample, R&D expense is negatively associated with CEO bonuses. However, an F-test

[30] Tests of pay sensitivities in prior research commonly use a changes rather than a levels specification (e.g., Cheng 2004). Change analyses mitigate the effects of correlated omitted variables on coefficient estimates.

indicates that this relationship is marginally weaker than for other operating expenses (p-value = 0.14), consistent with at least some compensation committees backing out R&D from earnings for bonus purposes. Rerunning this regression only on CEOs with bonus-contingent pensions indicates that for these CEOs, R&D expense is negatively associated with CEO bonuses to the same degree as other operating expenses. This evidence is consistent with CEOs in my sample being able to increase their bonus-contingent pension benefits by decreasing current R&D expense.

CEO Pension Provisions as Exogenous Variables

My study treats CEO pension arrangements as exogenous to the CEO's investment decisions at the end of his career. I argue that this is appropriate because unlike salary, bonuses, and stock-based awards which fluctuate on an annual basis, the structure of an executive's pension benefits are generally set early in his career. In examining firms' proxy statements, I do find some instances in which a CEO's pension formula is modified during his tenure as CEO. However, I maintain that the infrequency of these modifications allows me to treat CEO pension arrangements as exogenous variables in my study.

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