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Timing for Dollars: How Option Exercisability Influences Resource Allocation

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Stock options have been advocated to encourage managers to make long-run investments like R&D and capital expenditures (CAPX) that entail upfront costs with the potential to generate favorable long-term returns. However, the effect of options on managerial decisions depends on managerial beliefs about how the stock market reacts to firm behavior. If, consistent with empirical evidence, managers believe that stock prices increase in the short term from increased R&D, but not CAPX, then stock option exercisability—which dictates when managers can receive option payouts—should influence resource allocation. We also consider the effect of changes in the value of options over time. Results from a study of more than 6,500 observations from about 1,000 manufacturing firms over 18 years show that unexercisable stock options positively influence CAPX but not R&D, while exercisable stock options positively influence R&D but not CAPX. Both patterns are consistent with behavior that increases managerial payoffs but not necessarily firm performance. In addition, we find an expected negative association between underwater options and CAPX but no evidence of a corresponding positive relation with R&D. Finally, we find partial evidence of a house money effect that makes allocations to CAPX and R&D sensitive to recent changes in option values.

Keywords: *behavioral strategy; behavioral theory of the firm; agency theory; resource allocation/management*

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Introduction

Corporate resource allocation requires setting priorities among various investment opportunities with potential for long-term returns. Prior scholarship expresses concerns that U.S. managers tend not to allocate sufficient resources toward activities featuring high risk or long payoff horizons (Devan, Millan, & Shirke, 2005; Graham, Harvey, & Rajgopal, 2005; Hayes & Abernathy, 1980; Porter, 1992b). Many of these analyses address R&D, defined as "planned activity aimed at discovering new knowledge" or "the translation of research findings or other knowledge into new or improved products, services, or processes" (Cooper & Ijiro, 1983: s.v. "research and development"). However, such concerns also apply to capital expenditures (CAPX), defined as "expenditures that add fixed-asset units or that have the effect of increasing the capacity, efficiency, life span, or economy of an existing fixed asset" (Cooper & Ijiri, 1983: s.v. "capital expenditure"). To remedy the perceived reluctance to make long-term investments, agency theorists recommend granting stock options to align the incentives of managers and owners (e.g., Brisley, 2006; Hall & Liebman, 1998; Hoskisson, Hitt, & Hill, 1993; Jensen & Murphy, 1990; Larcker, 1983).

All agency analyses assume managers react sensibly to the incentives they face. Traditional agency theory generally assumes risk-neutral principals and risk-averse managers who react to incentives in ways that maximize their utility. Behavioral agency models assume managers react to incentives in ways that reflect loss aversion and other elements of prospect theory (Wiseman & Gomez-Mejia, 1998). Recent work highlights the need to model nuanced temporal effects to capture the influence of stock options on managerial decision making. Examples include option exercisability (Devers, McNamara, Wiseman, & Aarfelt, 2008), the "house money effect" (Lim & McCann, 2013), the distinction between current and prospective managerial wealth (Martin, Gomez-Mejia, & Wiseman, 2013; Martin, Wiseman, & Gomez-Mejia, in press), the potential for changes in reference points (Lim, 2015), and the need for realistic assumptions about time discounting and preferences about uncertain outcomes (Pepper & Gore, 2015). In this paper, we examine the influence of exercisable versus unexercisable options and in-the-money versus underwater options on resource allocation. Our arguments assume managers do not believe in fully efficient capital markets and subtly adjust the timing of allocations to CAPX and R&D in ways that they believe can increase option payouts. This approach differs from traditional agency theory but overlaps with some assumptions of behavioral agency.

Specifically, we argue that the influence of stock options on resource allocation depends on management's beliefs about how such allocations influence the firm's stock price. Research shows that managers believe capital markets react negatively to CAPX at least in the short term, in contrast to a positive reaction to R&D expenditures (e.g., Graham et al., 2005; Graham, Harvey, & Rajgopal, 2006), and evidence suggests this belief is likely justified (Chauvin & Hirschey, 1993; Eberhart, Maxwell, & Siddique, 2004). We argue that managers increase or decrease R&D and CAPX following the premise that stock markets will recognize the benefits of R&D and CAPX at different times. This reasoning leads to our expectation that managerial holdings of exercisable and unexercisable options should influence year-to-year fluctuation in firms' resource allocation to R&D and CAPX. Such a scenario reverses the original logic of agency theory; rather than aligning managers with investor interests, stock options may provide managers with a motivation to adjust firm behavior to favor themselves.

Our empirical work leads to practical recommendations for firms seeking to improve the resource allocation processes. By presenting arguments and evidence that the actual influence of stock options differs from the well-known prescriptions of agency theory, our work implies several ways to adjust these incentives to improve firm outcomes and avoid inadvertently encouraging resource allocations motivated by managers' personal wealth more than firm performance.

The remainder of the paper begins by describing the resource allocation process for R&D and CAPX. We then review some of the literature connecting stock options with resource allocation, explain managerial beliefs and empirical evidence regarding stock market valuations of R&D and CAPX, describe the assumptions underlying our model, and develop hypotheses. Then, we analyze empirical evidence using a longitudinal research design, testing our hypotheses on a sample of 6,563 firm-year observations from 1,012 U.S. manufacturing firms from 1993 through 2010.

Theory

Resource Allocation Process for R&D and CAPX

Most firms develop annual budgets for the subsequent fiscal year that anticipate revenues, operating expenses, and outlays for CAPX and R&D (Bower, 1970; Carter, 1971; Maritan, 2001). While many companies produce longer-term plans, almost all produce budgets for the upcoming fiscal year. These budgets may recognize some of the largest investments or R&D projects and generally emphasize the total funds available to different units (Bromiley, 1986b). Budgeting typically follows established routines where debates generally focus on how funding should change from current levels (Crecine, 1969). Separate routines approve allocations of funds to specific projects (Bower, 1970; Bromiley, 1986a), often using criteria such as payback period, net present value, and return on investment. As with all budgets, unanticipated factors may result in actual expenditures for these categories deviating from planned amounts (Bromiley, 1986a), but the budget strongly influences resource allocation.

R&D and CAPX allocations represent an integral aspect of the anticipatory activities inherent in planning and budgeting (Hirshleifer, 1993). While R&D and CAPX often offer long-term benefits, they also have important short-term impacts on firm performance metrics. R&D constitutes a direct cost that lowers the firm's net income in the present year. At the same time, some R&D activities—such as product line extensions—generate relatively quick outcomes by producing new revenue that partly offsets the present-year costs of R&D spending. Likewise, R&D can solve immediate customer problems in some business-to-business markets and quickly increase sales—as in the case of HB Fuller, which uses R&D funds to solve the adhesives problems of business customers. Similarly, CAPX has both immediate and longer-term impacts on performance metrics. Some CAPX spending modifies current facilities—repairing infrastructure, replacing current equipment, and so forth. While the direct costs for this work are amortized and affect current net income only partially, such modifications often require partial or even complete cessation of production that can reduce current revenue and profits. Furthermore, some CAPX investments may be quickly implemented and quickly influence costs (e.g., replacement of inefficient vehicles with more efficient ones). Finally, because R&D

directly lowers reported income, it influences the cash flows that firms often use to fund CAPX (Bromiley, 1981). Consequently, both R&D and CAPX need to be integrated into the firm's overall business planning.

There are at least two reasons why R&D and CAPX are comparable to each other but distinct from most other factors in business planning. First, compared to other spending categories, R&D and CAPX typically feature more managerial discretion than other spending categories (Finkelstein & Hambrick, 1990; Stein, 1989). For example, deviations from budgeted outcomes for cost of goods sold usually result passively from surprise events or market forces rather than actively from managerial choice—that is, costs will rise with increased demand and may rise or fall on the basis of changes in underlying factor prices. Employee costs likewise depend on market forces around prevailing wage rates and consumer demand. In contrast, for R&D and CAPX, managers get to choose whether to pursue new product development or infrastructure maintenance in the present year. Most benefits of such investments will accrue in the long term, and the modest immediate performance consequences make these budget categories the easiest to cut if the firm faces budget shortfalls elsewhere (Bromiley, 1986a).

Second, notwithstanding the short-term impacts described above, both categories are strongly associated with their long-term performance implications. Prior research has associated both R&D and CAPX with longer time horizons (e.g., Bushee, 1998; Hoskisson et al., 1993; Porter, 1992a). Such studies have not differentiated substantially in their theoretical arguments between R&D and CAPX. However, the two categories have important distinctions when it comes to managerial incentives in that stock prices, which determine the value of options held by management, react differently in the short-term to reported R&D and CAPX, even though the returns from both kinds of investment often appear in longer-term business outcomes.

Consequently, R&D and CAPX are closely linked in the budget process because they represent visible discretionary categories for expressing the firm's multiyear strategies (Antia, Pantzalis, & Park, 2010; Bushee, 1998). Even though managerial stock options have also been associated with other business activities, such as share repurchases (e.g., Hall & Murphy, 2003), we restrict the scope of our study to R&D and CAPX investments, which are linked through the budgeting process, whereas share repurchase decisions result from a different process.

Managerial Beliefs About Capital Market Valuations

Corporate decisions depend on managerial beliefs about causal mechanisms in the firm and its competitive environment (March & Simon, 1958). To some extent, this is self-evident—what else could managers use in the decision processes if not their beliefs about how the world works? However, studies also find that managerial beliefs often differ from apparent fact. The cognitive stream of research in strategic management, starting with Dearborn and Simon (1958) and continuing in cognitive work on senior management (see, for instance, Narayanan, Zane, & Kemmerer, 2011), demonstrated a wide variety of factors influencing managerial beliefs over and above objective measures of the facts.

In this paper, we analyze managerial beliefs about how the stock market reacts to firm resource allocation. Drawing from a long behavioral tradition, our theorizing assumes managers believe in *boundedly efficient* capital markets, expecting the stock market to respond to firm resource allocations in predictable ways that deviate from efficient capital markets (cf. Dietrich, Kachelmeier, Kleinmuntz, & Linsmeier, 2001). Our analysis of resource allocation behavior by managers requires only that managers generally *believe* the arguments below (Bromiley, 2004)—that is, that most managers believe capital markets respond more favorably in the short run to R&D than to CAPX. However, we address a domain where evidence on actual capital market behavior happens to align closely with reported managerial beliefs. We proceed to present evidence about both how the capital market actually reacts, as evidenced by scholarly studies, and managerial beliefs about how the market reacts.

Stock prices often exhibit patterns inconsistent with capital market efficiency, including momentum effects or the herd mentality used to explain bubbles in asset prices, in addition to the way stock prices incorporate the future value of current investments (Bromiley, 1990; Stein, 1989, 1996). Corporate managers demonstrate awareness of such bounded market efficiency by self-reporting behaviors based on short-term considerations that have clearly undesirable long-term implications. For example, 40% of chief financial officers say they would reject a long-term project with a return 4% above the firm's hurdle rate—that is, with a clearly positive net present value—if the project would cause the firm to miss an earnings target (Graham et al., 2005, 2006). This indicates that many managers believe the achievement of earnings targets materially influences a firm's stock price independent of the expected future earnings (Frankel, Johnson, & Nelson, 2002; Phillips, Pincus, & Rego, 2003).

Prior research offers evidence that managers do not believe that CAPX positively influences stock prices in the short term—a belief that aligns with studies of market reactions. Surveys show that managers expect a negative reaction of stock price to increased CAPX (e.g., Graham et al., 2005, 2006), a belief consistent with empirical findings that CAPX may influence stock prices positively in the future but not the present. Titman, Wei, and Xie conclude that "firms that increased their level of capital investment the most tend to achieve lower stock returns for five subsequent years" (2004: 698). However, they also find that the pattern reversed for a period of high takeover years (1984–1989), which they ascribed to the takeover market disciplining managers in those years. This may explain contradictory results in which, using slightly different methods, Kerstein and Kim (1995) find a small but positive valuation of CAPX.

Although prior research lacks consensus on why stock prices react negatively to CAPX, one explanation comes from uncertainty about the benefits from CAPX. CAPX includes some initiatives to increase future profits (e.g., expanding capacity or reducing production cost) but also expenses that must be incurred to maintain current operations, such as replacing worn out equipment or complying with environmental and safety regulations (Bromiley, 1986b). While observers seldom criticize R&D spending as wasteful, they may describe some types of CAPX—such as executive jets or fancy offices—as wasteful extravagance. Firms must report aggregate CAPX outlays but not the details on the projects funded. Even when management does report on specific CAPX projects, it can select projects it expects investors would value, rather than providing a thorough view of the firm's CAPX projects overall. Lacking the ability to differentiate within CAPX between growth, maintenance, or waste, stockholders may wait to observe the impact of these investments on future earnings. We do not mean to imply that the majority of CAPX represents wasteful investment but merely note that investors lack a systematic way to differentiate among CAPX spending on maintenance, growth, or waste.

The situation regarding CAPX differs from the situation regarding R&D. Evidence shows that the stock market responds quickly and positively to reported R&D spending. This may reflect a substantive difference between CAPX and R&D. R&D either creates new products and product enhancements or reduces production cost—both should increase future sales and/or profits. Shareholders appear to value R&D's growth potential and increase the firm's stock price today, even though higher R&D expenses reduce a firm's current earnings (Bushee, 1998). Observers seldom categorize R&D expenditures as wasteful as they do sometimes with CAPX. Furthermore, regulators rarely compel R&D spending, again in contrast to CAPX.

The common use of stock options to compensate managers thus provides an opportunity to study how such managerial beliefs might influence the allocation of firm resources to R&D and CAPX. We note that this is a temporal effect—in the long run, the firm's value should correspond to the actual profits earned by long-term investment, but in the short run, capital markets may lack the information necessary to assess such future value. Nonetheless, because managerial stock options also have a temporal effect—for a specified period of time, options granted are not eligible for exercise—we proceed to analyze how managers might change levels of CAPX and R&D on the basis of the current exercisability of their stock options.

Our work partially overlaps with Devers et al. (2008) but with a key difference in the dependent variable. Devers et al. offered hypotheses aimed to explain "strategic risk taking," using a measure by Miller and Bromiley (1990) that combines R&D, CAPX, and long-term debt in a single measure. As discussed above, considerable evidence suggests that capital markets treat CAPX differently from R&D. Particularly with regard to stock options, the value of which depends on capital market valuations of the firm, we see value in analyzing CAPX distinctly from R&D, even though both categories exemplify long-term investment.[1]

Unexercisable Options

Often provided by firms with the intent to help managers "think like owners" (Jensen & Murphy, 1990), stock options give managers the right to purchase the company's stock at a preset price (termed the exercise price) over a specific period. The exercise price is usually the firm's stock price on the day the firm issues the options. Firms typically grant options every 1 to 3 years, with expiration after 10 years (Heath, Huddart, & Lang, 1999). Because of the lengthy potential holding period and dependence on stock price that in theory reflects the net present value of future cash flows, experts have described stock options as "long-term incentives." Scholars show particular interest in the correlation between stock option grants and long-term investments with deferred and uncertain benefits, including both R&D and CAPX (e.g., Bizjak, Brickley, & Coles, 1993; Hoskisson et al., 1993; Sanders & Hambrick, 2007; Souder & Bromiley, 2012; Wiseman & Gomez-Mejia, 1998).

Two time-based mechanisms support the idea that stock options counteract short-term incentives like salary raises and bonuses by creating rewards for long-term investing. First, unlike reported past sales or net income that form the basis for many bonus payments, a company's stock price incorporates future expectations. Observers may debate how well stock prices incorporate such expectations, but they generally agree that stock prices do incorporate an assessment of the firm's future prospects. As described above, managers have learned to expect an increase in stock prices following increased R&D. Because the value of managers' unexercisable options will also rise with increased stock prices, we expect a positive association between unexercisable options and changes in a firm's level of R&D spending.

Second, options promote a more patient approach to resource allocation through exercisability restrictions. Managers cannot exercise options (i.e., acquire shares at the exercise price) for at least 1 year and usually for 3 to 5 years after the date granted (Hall & Murphy, 2002; Ofek & Yermack, 2000). Such *unexercisable options* only provide the opportunity for wealth delayed (Devers, Wiseman, & Holmes, 2007), and the unexercisability of such options creates a temporal consideration that goes beyond standard behavioral agency reasoning. The delays from exercisability provide time for the benefits of CAPX to become evident, potentially when the options have become exercisable. We therefore expect a positive relation between unexercisable options and changes in the level of CAPX, even though managers would not expect a short-term increase in stock price when increasing their spending on CAPX.

In short, when an option is not exercisable, it should have the incentive effect anticipated in agency theory combating the tendency toward short-termism and increasing long-term investment. Following prior research that has analyzed similar arguments (Devers et al., 2008; Souder & Shaver, 2010), we consider the accumulated value of such options as the relevant incentive:

Hypothesis 1: The accumulated value of unexercisable options associates positively with changes in CAPX and R&D expenditures.

Exercisable Options

After the waiting period described above elapses, a stock option becomes *exercisable*, and a manager can exercise the option, sell the acquired stock, and receive the corresponding proceeds at any time before expiration (with some restrictions to mitigate insider trading). On average, managers hold options for 2 to 4 years after they become exercisable (Bettis, Bizjak, & Lemmon, 2005; Carpenter, 1998; Huddart & Lang, 1996). Managers often have both exercisable options that can be immediately exercised and unexercisable options that cannot be converted into cash until a specified time in the future (Devers et al., 2007).

Short-term increases in stock price can immediately benefit managers with exercisable options who can exercise the options and then sell the resultant stock (Bebchuk & Fried, 2004; Devers et al., 2007). If managers believe the reported R&D spending gets rewarded with higher stock prices in the present, then we expect increased R&D spending after options become exercisable. On the other hand, exercisable options do not facilitate the patience that also justified spending on CAPX. Because managers believe stock prices will not react positively to increased CAPX in the short term, we expect that a relation with exercisable options will exist only for increased R&D, and not CAPX:

Hypothesis 2: The accumulated value of exercisable options associates positively with changes in R&D expenditures (but not CAPX).

Underwater Options

Out-of-the-money options, commonly known as underwater options, pose a different situation. The company's stock price has fallen since the options were granted, making them worthless to managers unless the stock price increases. Yet because managers have no gain whether the stock price is slightly below the strike price or far below it, they face asymmetric payoffs in which managers can achieve gains if risky investments prove successful but cannot suffer additional loses if those risky investments fail to bear fruit (Wowak & Hambrick, 2010).

This analysis has a parallel with theorizing from the behavioral theory of the firm regarding performance below aspiration levels (March & Simon, 1958). Performance below aspirations results in search to raise performance as quickly as possible above aspirations. Thus, a perceived failure—as implied by the decline in stock prices that puts options underwater—gives managers a sense of urgency for tangible success. We therefore expect managers with underwater options to search for ways to overcome such losses through investments with the potential to raise the stock price quickly.

Consequently, both exercisable and unexercisable underwater options discourage managers from allocating resources to investments with deferred payoffs, such as CAPX, and encourage actions with high potential to raise the stock price immediately, like R&D. Because underwater options have no dollar value, we hypothesize about the number of underwater options held:

> *Hypothesis 3:* The number of underwater options associates negatively with changes in CAPX and associates positively with changes in R&D expenditures.

The House Money Effect and Reversal of Fortune

In addition to changes in exercisability over time, the value of stock options to managers changes over time with changes in the company's stock price. Recent behavioral agency research considers how these price changes influence resource allocations through the "house money" effect where recent increases in wealth or endowments—here based on the embedded value of managerial stock options—make decision makers more willing to take on projects with uncertain or deferred outcomes (Lim & McCann, 2013).

As Lim (2015) observes, house money arguments follow the behavioral logic of reference points that evolve based on new information. In the behavioral agency and prospect theory literatures, returns above the reference point associate with risk aversion, while returns below the reference point associate with risk seeking. In contrast, the house money effect takes a position consistent with the organizational literature on slack search (Cyert & March, 1963; Nohria & Gulati, 1996), in which high returns enable risk taking and low positive returns reduce risk taking. Making house money consistent with prospect theory requires a somewhat complex prior editing of the potential outcomes considered (see Thaler & Johnson, 1990), but it fits within a broad definition of behavioral agency. For our purposes, we assume the house money effect is a distinct behavioral phenomenon that influences managers through stock options.

The house money effect applies to many sources of wealth—not just stock options. However, options offer a particularly interesting situation because managers choose whether to exercise their options after the options have become exercisable. Managers who believe their options currently reflect peak value should cash in their position by exercising the option and selling the stock. By comparison, managers who continue to hold exercisable options that have risen in value implicitly bet on the stock price increasing further. In choosing to hold on to these options instead of cashing them in, these managers indicate a calculated willingness to wait for the deferred benefits available from investments like CAPX. This argues that managers would be inclined to increase levels of CAPX if they have already experienced substantial gains in the value of their stock options and continue to hold the options.

We do not anticipate a positive influence of house money on R&D. To the extent that house money facilitates a long-run perspective, and managers believe that R&D pays off in the short run (in terms of stock price reaction), then house money has less relevance. From a stock return perspective, R&D offers a lower chance of negative immediate returns than CAPX. Consequently, we capture the house money effect in a hypothesis about a positive association between *increases* in the value of exercisable options and changes in a firm's CAPX:

Hypothesis 4a: Yearly increases in value of options—whether unexercisable or exercisable—associate positively with changes in CAPX.

The house money effect applies only to increases in value of options, but options also can decrease in value. An option's exercise price represents an initial reference point, but if stock prices rise significantly, managers will compute their embedded value and establish a new reference point based on their theoretical gains on paper. Similar to Starbuck and Milliken's (1988) explanation for the difference between managerial and archival perceptions of firm environments, a manager who watches the day-to-day changes in the firm's stock price may implicitly remove the base level of the price to focus on deviations from that base. Subsequent declines in stock price can create a scenario in which options remain in the money (i.e., above the initial reference point) but also have a value much lower than their peak (i.e., below the second reference point). Here, the house money effect no longer applies. Instead, this "reversal of fortune" scenario causes managers to perceive losses from previously available peak levels, even though the options also retain some gains above the exercise price.

Prior literature suggests that such reversals of fortune will also change managers' approach to resource allocation. Aiming to restore option values above the second reference point (i.e., their peak value), managers would search for quick ways to raise performance (Bromiley, 1991; Cyert & March, 1963).

Believing that R&D spending positively influences stock price, and faced with recent declines in stock price, managers should increase R&D. This behavior resembles much of the behavioral theory of the firm logic where performance declines positively influence risk taking and specifically R&D spending. For example, Chen and Miller (2007) argue that the risk associated with R&D causes managers to increase R&D as performance falls farther away from the reference point.

Hypothesis 4b: Yearly decreases in value of options—whether unexercisable or exercisable—associate positively with changes in R&D expenditures.

Whereas house money should increase managers' willingness to invest in CAPX, the perceived need for a turnaround in the stock price following a decline in stock price should decrease the willingness to allocate resources to CAPX—with this effect strongest when the recent declines in option value have been largest.

Hypothesis 4c: Yearly decreases in value of options—whether unexercisable or exercisable—associate negatively with changes in CAPX.

Method

Data

We use archival accounting data from Compustat to obtain repeated observations for firms. For consistency, we restrict our sample in three ways. First, to obtain common accounting and compensation standards, we include only U.S.-based manufacturing firms—as indicated by Standard Industrial Classification (SIC) codes beginning from 20 to 39—because R&D and CAPX usage and importance differs in manufacturing from service or natural resource extraction industries. Second, the data collection begins in 1992, when managerial compensation data become available in the ExecuComp database, and continues through 2011. Third, as a result of concerns about data anomalies in relatively small firms, we use only firms with both annual revenue and total assets exceeding $100 million. Our analyses capture a panel of 6,563 firm-year observations from 1,012 U.S.-based manufacturing firms.

For compensation variables, the ExecuComp database includes the top management team as reported in each firm's proxy statement, which usually names the CEO and the firm's four next highest-paid individuals. We compute per-person averages for easier interpretation. On average, CEO compensation is 3 to 4 times as high as compensation for other named executives but tends to be proportional (correlations between CEO and average compensation levels for the named executives exceed .90). Substantive interpretations would be unchanged if we used CEO compensation instead of the average levels for all named executives.

To limit the potential for extreme values to overly influence the regression output, we winsorize all variables at the 5% level. This lets us keep observations with extreme values in the data but caps those extreme values at the 5th percentile (at the low end) or the 95th percentile (at the high end). Results are robust to different levels of winsorization. We present summary statistics after winsorization in Table 1 and zero-order correlations for all variables in Table 2.

Dependent Variables

We observe the impact of incentives on firm investment behavior through year-to-year changes in CAPX and R&D, as opposed to the absolute level of each. We calculate the *change in CAPX* for each firm from year $t - 1$ to year t. Some prior research focuses on CAPX intensity (CAPX divided by assets or sales), but because this practice may induce artificial correlations (Wiseman, 2009), we measure the change in actual dollars while controlling separately for firm size. After winsorization, changes in CAPX range from a decline of $74 million to an increase of $94 million with a mean of positive $4.5 million. Similarly, we measure *change in R&D* spending for each firm from year $t - 1$ to year t. After winsorization, changes in R&D range from a decline of $16 million to an increase of $51 million with a mean of positive $5.0 million.

Table 1
Descriptive Statistics

Variables	Timing	Unit of measure	*M*	*SD*	Min	Max	VIF
1. Change in CAPX	$t-1$ to t	$ Millions	4.48	38.92	−74.00	93.90	
2. Change in R&D	$t-1$ to t	$ Millions	5.00	15.58	−16.05	51.00	
3. Unexercisable option value[a]	$t-1$	$ Millions	0.75	1.29	0.00	4.94	3.10
4. Exercisable option value[a]	$t-1$	$ Millions	1.99	3.22	0.00	11.87	3.03
5. Underwater options[a]	$t-1$	Cumulative, in thousands	15.93	40.50	0.00	151.87	1.39
6. Yearly increase in option value[a]	$t-2$ to $t-1$	$ Millions	0.63	1.20	0.00	4.43	2.33
7. Yearly decrease in option value[a]	$t-2$ to $t-1$	$ Millions	−0.51	0.91	−2.90	0.00	1.76
8. Industry CAPX intensity	$t-1$	Percentage of assets (mean)	11.15	4.12	5.88	21.44	7.33
9. Industry R&D intensity	$t-1$	Percentage of sales (mean)	6.66	7.30	0.08	22.06	2.62
10. Firm size (total assets)	$t-1$	$ Billions	2.99	4.22	0.10	15.28	4.91
11. Net income	$t-1$	$ Billions	0.14	0.27	−0.12	0.95	3.71
12. Cash and equivalent	$t-1$	$ Billions	0.27	0.39	0.00	1.39	3.81
13. Acquisitions	$t-1$	$ Millions (of sales)	24.43	62.37	0.00	213.78	1.21
14. Trading frequency	$t-1$	Shares traded / shares outstanding	1.99	1.54	0.28	5.68	4.32
15. Stock volatility	$t-1$	Price difference / average price	0.65	0.32	0.26	1.38	6.65
16. Restricted stock[a]	$t-1$	$ Millions	0.07	0.16	0.00	0.62	1.27
17. Long-term cash payments[a]	$t-1$	$ Millions	0.13	0.26	0.00	0.93	1.60
18. Inside directors	$t-1$	Count	1.64	0.86	0.00	6.00	3.92
Instrumental variables							
19. Managerial ownership[a]	$t-1$	Percentage of shares outstanding	0.49	0.97	0.00	3.74	
20. Salary[a]	$t-1$	$ Millions	0.40	0.15	0.18	0.74	
21. Bonus[a]	$t-1$	$ Millions	0.23	0.26	0.00	0.90	
22. Options granted[a]	$t-1$, $t-2$, $t-3$ (average)	Annual average, in thousands	0.19	0.20	0.00	0.80	
23. Options repriced	$t-1$	Equals 1 if options were repriced	0.01	0.09	0.00	1.00	

Note: $N = 6{,}563$. All variables winsorized at the 5% level. The mean variance inflation factor (VIF) for explanatory and control variables equals 3.31. CAPX = capital expenditures.
[a]Average for managers named in firm's proxy statement.

Explanatory Variables

Because plans generated in the year before actual outlays largely determine the levels of long-term investments (Bromiley, 1986a), all explanatory and control variables are lagged by 1 year. This also achieves temporal separation and mitigates the potential for reverse causality.

Table 2
Zero-Order Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Change in CAPX	1.00																						
2. Change in R&D	.27	1.00																					
3. Unexercisable option value	.23	.37	1.00																				
4. Exercisable option value	.21	.36	.65	1.00																			
5. Underwater options	−.10	−.08	−.14	−.22	1.00																		
6. Yearly increase in option value	.23	.22	.59	.46	−.15	1.00																	
7. Yearly decrease in option value	.13	−.03	.08	−.06	−.01	.30	1.00																
8. Industry CAPX intensity	−.03	.15	.21	.16	−.06	.06	−.12	1.00															
9. Industry R&D intensity	.00	.22	.18	.16	.03	.08	−.15	.38	1.00														
10. Firm size (total assets)	.17	.27	.29	.38	.05	.18	−.14	−.08	−.04	1.00													
11. Net income	.22	.36	.38	.48	−.12	.21	−.13	.01	−.03	.74	1.00												
12. Cash and equivalent	.17	.39	.40	.44	.04	.20	−.17	.08	.26	.67	.57	1.00											
13. Acquisitions	.08	.00	.08	.12	−.04	.05	−.05	.01	−.03	.13	.07	.02	1.00										
14. Trading frequency	−.04	.10	.15	.12	.06	.07	−.25	.15	.31	−.06	−.10	.25	−.04	1.00									
15. Stock volatility	−.12	−.07	.02	−.12	.27	.04	−.09	.12	.19	−.20	−.30	−.03	−.09	.45	1.00								
16. Restricted stock	.08	.06	.08	.08	−.01	.08	−.03	−.07	−.07	.23	.19	.13	.04	−.11	−.15	1.00							
17. Long-term cash payments	.11	.10	.12	.21	−.02	.13	−.08	−.11	−.08	.39	.38	.30	.08	.10	−.09	−.04	1.00						
18. Inside directors	.04	.03	.03	.06	−.06	.01	.03	.04	−.11	.10	.11	.00	.02	−.17	−.12	.02	−.03	1.00					
19. Managerial ownership	−.03	−.09	−.08	−.10	−.04	−.08	.07	.01	−.12	−.19	−.13	−.17	−.05	−.13	.01	−.09	−.13	.29	1.00				
20. Salary	.11	.21	.25	.35	.05	.18	−.17	−.13	−.10	.71	.58	.52	.10	.03	−.17	.22	.46	.12	−.11	1.00			
21. Bonus	.22	.24	.37	.37	−.12	.25	−.02	.03	−.08	.44	.47	.31	.12	−.13	−.24	.32	.03	.14	−.08	.42	1.00		
22. Options granted	.06	.20	.42	.35	.17	.21	−.19	.11	.25	.40	.28	.49	.04	.20	.10	.16	.07	−.02	−.15	.38	.28	1.00	
23. Options repriced	−.02	.00	.01	−.02	.01	.00	.00	.08	.01	−.04	−.03	−.02	−.02	.02	.05	−.02	−.04	−.01	.01	−.04	−.03	.04	1.00

Note: $N = 6{,}563$. Correlations with an absolute value of .03 or greater are statistically significant at the 95% confidence level. All variables winsorized at the 95% level; explanatory and control variables are lagged 1 year. CAPX = capital expenditures.

Our theoretical discussion distinguishes between exercisable and unexercisable stock options. Following prior research (Devers et al., 2008; Souder & Shaver, 2010), we measure the accumulated *unexercisable option value* for each firm-year, measured in dollars at the end of year $t - 1$, finding a postwinsorized range of $0 to $5 million with a mean value of $755,000 (see Table 1). We measure value of exercisable options (*exercisable option value)* in year $t - 1$, finding a winsorized range for this variable from $0 to $12 million with a mean of $2 million. For *underwater options*, by definition the current monetary value is $0, so we instead analyze the number of underwater options held. After winsorizing, managers hold from 0 to 152 million underwater options with an average of 16 million.

Paralleling Lim and McCann (2013), we calculate the *yearly increase in option value* by subtracting the value of options held at the end of year $t - 2$ from the same value at the end of year $t - 1$ in instances where the value had increased. This variable ranges from $0 to $4.3 million after winsorization with a mean equal to $630,000. We calculate the *yearly decrease in option value* using the same method but for instances where the value had decreased. Values range from $0 to negative $2.9 million with an average loss of $513,000.

Control Variables

We control for additional factors that may influence firm resource allocation, compensation levels, or both. Because industry trends could influence firm investment policy, we control for *industry CAPX intensity* and *industry R&D intensity*. Following prior research, we divide CAPX by total assets and divide R&D by sales for each firm-year observation and then calculate the mean for each industry as defined by the two-digit SIC. Table 1 shows industries vary from 6% to 21% of assets invested in CAPX, with a mean of 11%, and from 0.8% to 22% of sales invested in R&D, with a mean of 6.7%.

Given that our dependent variables appear as changes in dollar values rather than ratios, we control for *firm size*. We use total assets for this measure, winsorized at the 95% level; our sample has mean assets after winsorization of $3 billion with a range from $100 million to $15 billion. Other firm-level factors, such as recent performance or capital availability, may also influence resource allocation decisions. We use *net income* to measure performance. Values range from −$120 million to $946 million after winsorization with a mean of $144 million in net income. For capital availability, we control for the dollar amount of *cash and equivalents* that the firm can easily deploy in new investments, which ranges from $1 million to $1.4 billion with a mean of $269 million after winsorizing at the 95% level. A priori, we expect net income and available cash to associate positively with the dependent variables.

Firms occasionally depart significantly from their budgets, most prominently when making a major acquisition. We therefore control for the revenue change from *acquisitions* in year $t - 1$ as an indicator of the extent to which the firm's structure and capital base may have changed. After winsorizing at the 95% level, this variable ranges from $0 to $214 million in sales from acquisitions with a mean value of $24 million.

We also control for variations related to the firm's activity in the stock market by measuring two factors: trading frequency and stock volatility. *Trading frequency* is the ratio of total shares traded to total outstanding shares, as reported by Compustat. Prior literature suggests that high trading frequency may pressure managers to reduce CAPX or R&D spending as they prioritize the delivery of immediate profits to impatient investors. After winsorizing at the 95% level, values range from 28% to almost 5.7 times as many shares traded as the firm has shares outstanding with a mean close to 2. We also control for *stock volatility* measured as the spread between the high and low stock prices during the year divided by the firm's average stock price because volatility is commonly used in methods for valuing stock options. After winsorization, volatility ranges from 26% of stock price to 138% of stock price with a mean of 65%.

Because stock options have been described as long-term incentives, we control for other types of long-term incentives: *restricted stock* and *long term cash payments*. Prior research highlights the role of restricted stock on R&D in particular (Lim, 2015), making it a crucial control variable. Like options, restricted stock has a vesting period during which managers must wait to realize any tangible value. Unlike options, however, companies do not report values of restricted stock after the vesting period ends; thus, we lack the data for restricted stock that correspond to the period of exercisable stock options. The inability to compare pre- and postexercisability conditions caused us not to offer hypotheses about the effects of restricted stock on changes in CAPX or R&D. We measure each of these variables in year $t - 1$ and observe many values equal to $0. After winsorizing at the 95% level, the value of restricted stock has a mean of $69,000 and a maximum of $620,000 per manager, while long-term cash payments have a mean of $125,000 and a maximum of $930,000 per manager. Finally, we control for the number of managers named in the proxy statement who also serve on the firm's board of directors (inside directors) with values ranging from 0 to 6 with an average of 1.6.

Model Specification

Panel data are essential for this study because we hypothesize about changes in the levels of firms' CAPX and R&D. We use all available data from firms that meet the screening criteria listed above over nearly two decades. This procedure yields an unbalanced panel from a wide range of heterogeneous firms. In addition, our analysis calls for two dependent variables—change in CAPX and change in R&D—which may suffer endogeneity.[2] We proceed to describe our reasoning for analyzing a two-stage least squares (2SLS) regression that matches the research design and data collected.

Endogeneity. Regression results can be biased if error terms are correlated with explanatory variables. The construction of our dependent variables through first differencing—as implied by our theoretical arguments about yearly changes in spending levels—represents a recommended technique for negating the endogeneity caused by idiosyncratic firm-specific factors (Greene, 2003).

However, first differencing does not eliminate the potential for endogeneity arising from alternate explanations. To allay these concerns, we employed the 2SLS technique to replace potentially endogenous variables with instrumental variables to obtain consistent coefficient estimates. In our study, three explanatory variables may exhibit endogeneity because they are determined by managers along with CAPX and R&D: unexercisable options, exercisable options, and underwater options.

We employ five instrumental variables that are correlated with the endogenous regressors—and can thus be used to generate first-stage estimated values—but not included in the outcome equation. Our set of instrumental variables reflect firm-level compensation policies, which are highly correlated with option grants but not obviously correlated with changes in the level of investment for CAPX or R&D. Diagnostic tests confirm the appropriateness of this set of instruments for both dependent variables. Using the Kleibergen-Paap statistic, we reject the null of underidentification ($\chi^2 = 8.410$, $df = 3$, $p < .05$ for both equations). For overidentification, the Hansen J statistic fails to reject the null hypothesis of valid instruments (change in CAPX: $\chi^2 = 2.457$, $df = 2$, $p = .29$; change in R&D: $\chi^2 = 3.313$, $df = 2$, $p = .19$).

Our first instrumental variable is the average percent of company stock owned by the managers named in a firm's proxy statement (*managerial ownership*). After winsorizing, this measure varies from 0 to almost 4% with an average of 0.5% of shares outstanding per manager. Second, we use average salary level as an instrumental variable. This variable ranges from $181,000 per manager to $745,000 per manager after winsorization with a mean of $402,000. Likewise, we use *annual bonus* payments in year $t - 1$ as an instrument, which ranges from $0 to $903,000 after winsorizing with a mean value of $227,000 per named manager. Fourth, we include a firm's *average option grants* over a 3-year period as an instrumental variable. These range from 0 to 804,000 options with a mean value after winsorizing of 191,000 options. Our last instrumental variable is *option repricing*, a dummy variable equal to 1 when firms cancel existing stock options after a substantial decrease in stock price and issue new options with lower exercise prices, which occurred less than 1% of the time.

Cross-equation correlation. Because our theory calls for two dependent variables, cross-equation correlation remains a concern unaddressed by 2SLS. We therefore report additional results from a three-stage least squares (3SLS) model that includes all the instrumental variables listed above and gains efficiency by estimating the equations jointly. All hypothesis interpretations are consistent in the 2SLS and 3SLS results.

Table 3 presents the regression results from the 2SLS regressions. Model 1 presents the results for changes in CAPX, and Model 2 presents the results for changes in R&D spending. We present the 3SLS results in Table 4. Coefficient estimates are similar across the 2SLS and 3SLS analyses, but standard errors tend to be smaller in 3SLS.

Results

For both dependent variables and both regression procedures, we reject the joint null hypothesis that all the coefficients equal 0 for the explanatory and control variables (2SLS: $F = 16.89$, $p < .001$ for CAPX, and $F = 20.52$, $p < .001$ for R&D; 3SLS: $\chi^2 = 687.98$, $p < .001$ for CAPX, and $\chi^2 = 1{,}411.76$, $p < .001$ for R&D).

The results provide support for part of Hypothesis 1. As expected, unexercisable option values positively influence CAPX (2SLS: $b = 19.98$, $z = 2.02$, $p < .05$; 3SLS: $b = 19.98$, $z = 2.58$, $p < .01$). Substantively, for each $1 million in accumulated unexercisable option value, predicted change in CAPX increases by $20 million. Unexpectedly, however, results do not support a positive association between unexercisable options values and R&D (2SLS: $b = -3.92$, $z = -1.02$, n.s.; 3SLS: $b = -3.92$, $z = -1.42$, n.s.). These results suggest a need for analysis that goes beyond the traditional agency notion that options provide incentives for managers to allocate resources to risky, long-term investments such as CAPX and R&D.

Hypothesis 2 argues that after options become exercisable, they will have a positive association with R&D but not CAPX. We find statistical support for this hypothesis with a positive, statistically significant coefficient on unexercisable option value in the R&D equations

Table 3

Two-Stage Least Squares Regression Results With Robust Standard Errors

	Model 1				Model 2			
	Dependent variable = change in CAPX				Dependent variable = change in R&D			
	b	Robust *SE*	*z*	P > *z*	*b*	Robust *SE*	*z*	P > *z*
Unexercisable option value	19.98	9.90	2.02	0.04*	−3.92	3.85	−1.02	0.31
Exercisable option value	−1.18	5.25	−0.22	0.82	4.50	2.22	2.03	0.04*
Underwater options	−0.70	0.13	−5.50	0.00**	−0.07	0.06	−1.32	0.19
Yearly increase in option value	−8.50	2.68	−3.17	0.00**	−1.65	1.21	−1.37	0.17
Yearly decrease in option value	5.16	1.88	2.74	0.01**	1.88	0.79	2.37	0.02*
Industry CAPX intensity	−1.30	0.28	−4.70	0.00**	−0.01	0.11	−0.07	0.94
Industry R&D intensity	0.11	0.13	0.84	0.40	0.24	0.06	3.94	0.00**
Firm size (total assets)	1.66	0.54	3.10	0.00**	0.05	0.25	0.22	0.83
Net income	−20.85	12.19	−1.71	0.09†	0.12	5.89	0.02	0.98
Cash and equivalent	3.23	4.53	0.71	0.48	5.70	2.27	2.51	0.01*
Acquisitions	0.02	0.02	1.12	0.26	−0.02	0.01	−2.33	0.02*
Trading frequency	−3.33	0.79	−4.20	0.00**	−0.05	0.35	−0.15	0.88
Stock volatility	22.01	6.39	3.44	0.00**	5.67	2.86	1.98	0.05*
Restricted stock	9.57	5.91	1.62	0.11	2.80	2.27	1.23	0.22
Long-term cash payments	3.61	3.96	0.91	0.36	−2.63	1.66	−1.59	0.11
Inside directors	−0.98	0.97	−1.02	0.31	−0.47	0.43	−1.10	0.27
Number of observations	6,563 (from 1,012 firms)				6,563 (from 1,012 firms)			
F		(16 *df*)	16.89	0.00**		(16 *df*)	20.52	0.00**
Underidentification test (Kleibergen-Paap)		(3 *df*)	8.50	0.04*		(3 *df*)	8.50	0.04*
Overidentification test (Hansen J)		(2 *df*)	2.60	0.27		(2 *df*)	3.33	0.19

Note: All variables winsorized at the 5% level; all explanatory variables lagged by 1 year. Year dummies and constant term included but not shown. CAPX = capital expenditures.

†$p < .10$.

*$p < .05$.

**$p < .01$.

Table 4

Three-Stage Least Squares Regression Results

	Model 3							
	Dependent variable = change in CAPX				Dependent variable = change in R&D			
	b	Robust *SE*	*z*	P > *z*	*b*	Robust *SE*	*z*	P > *z*
Unexercisable option value	19.98	7.73	2.58	0.01*	−3.92	2.78	−1.41	0.16
Exercisable option value	−1.18	4.40	−0.27	0.79	4.50	1.58	2.85	0.00**
Underwater options	−0.70	0.10	−6.75	0.00**	−0.07	0.04	−2.00	0.05*
Yearly increase in option value	−8.50	2.13	−3.99	0.00**	−1.65	0.77	−2.16	0.03*
Yearly decrease in option value	5.16	1.59	3.25	0.00**	1.88	0.57	3.30	0.00**
Industry CAPX intensity	−1.30	0.23	−5.63	0.00**	−0.01	0.08	−0.10	0.92
Industry R&D intensity	0.11	0.12	0.98	0.33	0.24	0.04	5.83	0.00**
Firm size (total assets)	1.66	0.39	4.31	0.00**	0.05	0.14	0.39	0.70
Net income	−20.85	10.01	−2.08	0.04*	0.12	3.60	0.03	0.97
Cash and equivalent	3.23	3.32	0.97	0.33	5.70	1.19	4.79	0.00**
Acquisitions	0.02	0.01	1.35	0.18	−0.02	0.00	−3.26	0.00**
Trading frequency	−3.33	0.68	−4.87	0.00**	−0.05	0.25	−0.21	0.83
Stock volatility	22.01	5.43	4.05	0.00**	5.67	1.95	2.90	0.00**
Restricted stock	9.57	4.49	2.13	0.03*	2.80	1.62	1.73	0.08†
Long-term cash payments	3.61	3.03	1.19	0.23	−2.63	1.09	−2.42	0.02*
Inside directors	−0.98	0.85	−1.16	0.25	−0.47	0.30	−1.55	0.12
Number of observations		6,563 (from 1,012 firms)				6,563 (from 1,012 firms)		
Wald chi-squared		(31 *df*)	687.98	0.00**		(31 *df*)	1,411.76	0.00**
Underidentification test (Kleibergen-Paap)		(3 *df*)	8.41	0.04*		(3 *df*)	8.41	0.04*
Overidentification test (Hansen J)		(2 *df*)	2.46	0.29		(2 *df*)	3.31	0.19

Note: All variables winsorized at the 5% level; all explanatory variables lagged by 1 year. Year dummies and constant term included but not shown. CAPX = capital expenditures.

†$p < .10$.

*$p < .05$.

**$p < .01$.

(2SLS: $b = 4.50$, $z = 2.03$, $p < .05$; 3SLS: $b = 4.50$, $z = 2.85$, $p < .01$). For each $1 million increase in accumulated value per named executive, the model predicts $4.5 million of added R&D. This effect translates to $14 million of R&D for a 1 *SD* difference in unexercisable option value ($3.2 million; see Table 1). We do not find a significant influence of exercisable option value on CAPX (2SLS: $b = -1.18$, $z = -0.22$, n.s.; 3SLS: $b = -1.18$, $z = -0.27$, n.s.), consistent with our general theme that CAPX and R&D have important distinctions in managerial perceptions as they pertain to resource allocation.

The results provide partial support for Hypothesis 3. We find support for the first part of the argument, that underwater options have a negative association with CAPX (2SLS: $b = -0.70$, $z = -5.50$, $p < .001$; 3SLS: $b = -0.70$, $z = -6.75$, $p < .001$). Substantively, at a standard deviation of 40,000 options, a 1 *SD* increase in underwater options results in a $28 million reduction in predicted CAPX. However, the results do not support the second part of our hypothesis, that underwater options increase R&D. In fact, the coefficient estimate takes on a sign in the opposite direction from our expectation (2SLS: $b = -0.07$, $z = -1.32$, n.s.; 3SLS: $b = -0.07$, $z = -2.00$, $p < .05$) and even registers as statistically significant in the 3SLS regression. We discuss the possible implications of this finding below.

Results also contradict Hypothesis 4a, which argues a house money effect will result in increases in option value positively associating with CAPX. Instead, we find a statistically significant negative association (2SLS: $b = -8.50$, $z = -3.17$, $p < .01$; 3SLS: $b = -8.50$, $z = -3.99$, $p < .001$). A 1 *SD* increase in option values ($1.2 million per named executive; see Table 1) results in a $10 million decrease in predicted CAPX. For R&D, no effect is observed in 2SLS, consistent with our argument that the house money effect applies to the delayed recognition of the value of CAPX in the stock price as opposed to the more immediate recognition of R&D's value. However, 3SLS results suggest a negative and statistically significant relation between increased option values and changes in R&D ($b = -1.65$, $z = -2.16$, $p < .05$).

For yearly option losses, the results contradict the "reversal of fortune" effect hypothesized in Hypothesis 4b, as yearly decreases in option value appear to reduce spending on R&D (2SLS: $b = 1.88$, $z = 2.37$, $p < .05$; 3SLS: $b = 1.88$, $z = 3.30$, $p < .001$).[3] A 1 *SD* decrease in options value (−$900,000 per named executive) lowers predicted change in R&D by $1.7 million. However, the results support Hypothesis 4c, as option decreases indeed lead to lower spending on CAPX (2SLS: $b = 5.16$, $z = 2.74$, $p < .01$; 3SLS: $b = 5.16$, $z = 3.25$, $p < .001$). Substantively, a 1 *SD* decrease in options value (−$900,000 per named executive) lowers predicted change in CAPX by $4.6 million.

Among the control variables, we find that both net income and cash holdings have strong positive effects on changes in both R&D and CAPX. Holding constant these measures of financial strength, we find a negative effect associated with firm size (as measured by total assets). We also observe a positive relation between acquisitions and CAPX and a negative relation between acquisitions and R&D. Trading frequency associates positively with R&D. Managerial ownership and restricted stock had no discernible effect, but variable compensation—that is, annual bonuses and long-term cash incentive payments—exhibited positive and statistically significant relations with CAPX (and the bonus variable had a positive relation with increased R&D spending as well). Neither the existence of repriced options nor the number of inside directors showed a statistically significant effect on either dependent variable.

Discussion

Our analysis attempts to explain variation in R&D and CAPX changes as a function of managerial incentive structures that change over time and interact with new information and managerial beliefs. We do not claim such incentive structures are the primary determinant of R&D or CAPX but claim they can help explain yearly changes in these important resource allocation categories around a baseline determined by business needs and market opportunities.

We retain the assumption from traditional and behavioral agency that managers' self-interest influences firm-level decisions. Building on the bounded rationality of managers inherent to the behavioral agency model, we argue that managerial beliefs about stock market reactions to firm resource allocations influence how stock options influence changes in R&D and CAPX. If managers believe capital markets react predictably to R&D and CAPX, then they may change R&D and CAPX on the basis of their stock options.

Recent research in this vein has explicitly or implicitly incorporated temporal elements, and our work continues this pattern by distinguishing between unexercisable and exercisable stock options and mapping these elements of compensation against managerial perceptions of stock market valuations. Going beyond generic prescriptions about incentive alignment (Jensen & Murphy, 1990), we propose that the changing situations created by the interaction of stock price movements and options exercisability influence management's allocation of funds to R&D and CAPX. We find empirical support for the behavioral argument that year-to-year variations in spending on R&D and CAPX partly depends on which one offers greater benefits for managers' personal wealth through the incentives provided by their stock options.

Without tying these changes in resource allocation to subsequent changes in profits and stock price, we cannot conclude that the influence of options on R&D and CAPX negatively influence long-run performance. However, options held by management in year *t* depend on incentive decisions in many previous years, plus variation in performance over those years, along with current stock prices and management's decisions about exercising options. Even if a board knew how much R&D and CAPX it wanted in future years (something for which boards depend heavily on management's recommendations), it is difficult to imagine how the board could set incentives to result in those R&D and CAPX expenditures. In short, while we do not have direct evidence that these incentive effects result in less desirable allocations, we do not see how one could design the option award criteria to result in allocations based strictly on expected returns.

Bettis et al. (2005) report options vest after 2 years on average and are exercised another 2 to 4 years after vesting. Given that most stock options will be exercisable for more time than not, our findings suggest that after incorporating behavioral perspectives, stock options may reinforce some agency problems more than remedy them. To some agency theorists, such behavioral considerations represent nothing more than "frictions" that lie at the periphery of a powerful overarching perspective. In contrast, our analysis joins a growing stream of research that identifies such frictions and their unintended side effects on managerial behavior (Bebchuk & Stole, 1993; Harris & Bromiley, 2007; Sanders & Hambrick, 2007; Schliefer & Vishny, 1990; Stein, 1989). Analyses that incorporate realistic assumptions about managerial beliefs about stock market behavior call into question long-standing interpretations of stock options as a remedy for managerial myopia (Edmans, 2009). We hope that such issues become a mainstay of future work rather than treated as one-off anomalies.

Scholars may want to investigate further how managers interpret the behavior of the stock market, a topic on which we have few studies. Whereas scholars look at large samples across multiple firms over time, we suspect managers focus mainly on the variation in their own firm's stock price. The options held by managers probably increase this tendency. For a manager with options, the price of the firm's stock relative to other stock prices has little importance, whereas changes in the firm's stock price over time directly translate into personal wealth, immediate if the manager has stock or exercisable options and delayed otherwise.

Our work complements the efforts of behavioral agency theory to enhance understanding of the impact of incentive compensation (e.g., Pepper & Gore, 2015; Sanders & Carpenter, 2003; Wiseman & Gomez-Mejia, 1998). Behavioral agency theory generally assumes managers have conventional beliefs about the capital market valuations but react to risk in a way consistent with findings from behavioral decision theory (see reviews by Kahneman, Slovic, & Tversky, 1982; Yates, 1992). Our work adds empirically supported beliefs about the stock market to the behavioral agency approach to explain the timing of managerial decisions about real investment in R&D and CAPX. A more complete view of managerial responses to incentives should incorporate both how managers believe the world will respond to their actions and psychological factors that influence the connections among incentives, beliefs, and chosen actions. Such work may also want to consider beliefs of members of boards of directors (Lim & McCann, 2014).

More broadly, this paper complements several other research streams. Scholars have found potential distortions to firm investment policy caused by earnings pressure from security analysts (e.g., Benner, 2010; Zhang & Gimeno, 2010) and institutional investors (e.g., Connelly, Tihanyi, Certo, & Hitt, 2010; David, Hitt, & Gimeno, 2001; David, O'Brien, Yoshikawa, & Delios, 2010). Other studies have noted a need to add precision to constructs featured in agency theory (Sanders & Hambrick, 2007). From a compensation perspective, prior work has shown that managers can enrich themselves through the timing of both option grants (e.g., Lie, 2005) and exercising options (e.g., Carpenter & Remmers, 2001; Cicero, 2009). In some cases, these behaviors derive from private information held by managers (e.g., Bartov & Mohanram, 2004) or selective release of information to the public (e.g., Yermack, 1997). Taken together, these studies demonstrate that in boundedly efficient capital markets, behaviors encouraged by stock options may not correspond to the best interests of the stockholders.

Practical Implications

From a practical standpoint, these results join a series of studies that cast doubt on the ability of options to align managerial and stockholder interests appropriately. Studies raising such doubts have shown that high levels of options associate with increased accounting misrepresentation (Harris & Bromiley, 2007) and the rejection of profitable investments to meet earnings targets (Graham et al., 2005, 2006). More broadly, research has shown that managerial investment decisions depart from classic theorizing by reflecting many factors other than the merits of the investment itself—such as the finding that CEO age correlates negatively with R&D intensity (Lundstrum, 2002). Our results contribute to discussions about the incentive effects of options by demonstrating that the influence of options on managerial behavior depend on recent changes in value, along with whether they are in the money or underwater, and whether they are exercisable or not exercisable.

Although our work does not directly examine whether options promote the most desirable allocation of funds to R&D and CAPX, we provide evidence suggesting such allocations depend on option conditions unrelated to the merits of investment projects under consideration. For boards to achieve a desired end requires a very complex understanding of the impact of options on managerial behavior in designing compensation agreements. The addition of restricted stock and direct cash incentives further increases the complexity of the problem. In essence, this would require solving an extremely complex problem involving numerous sources of uncertainty over many years. Such an analysis would depend heavily on assumptions regarding the distribution of stock returns contingent on R&D and CAPX allocations over multiple years. This does not sound like the descriptions of board decisions on management compensation in the research or practitioner literature on boards and option granting behavior. Such evidence makes it hard to see how any firm could implement options policies that result in shareholder wealth's maximizing allocations of R&D and CAPX.

We do not conclude firms should avoid stock options entirely. After all, our results suggest stock options effectively influence managerial behavior. The challenge for firms is that these influences reflect the nuanced complexities of beliefs and behavioral valuations, along with historical and current business outcomes rather than a simplified model. Such efforts also run into a core assumption of agency theory that is probably correct: Managers (agents) usually have greater insight regarding the benefits of investments than investors (principals) do. Combined with rudimentary but verifiable expectations about stock market responses to investments in R&D or CAPX, the presence of stock option compensation appears to give managers a way to manipulate the timing of such resource allocations to their own benefit. Such manipulations are admittedly on the margin, but rushing or delaying investments for reasons based on managerial self-interest rather than expected firm performance constitutes precisely the type of problem agency theory advocates claimed options would alleviate. Our managerial prescriptions call for caution rather than specific and aggressive actions. If boards cannot craft option and incentive packages that will have ideal outcomes, and such packages have unintended and undesirable outcomes, then perhaps boards should provide weaker incentives.

Future research could address several limitations of this paper. First, while we base our assumptions about managerial beliefs on empirical findings, we do not have direct evidence of managerial beliefs in these firms. Additional direct evidence on managerial beliefs would help researchers validate or disconfirm these assumptions. Second, whereas our analysis focuses on explaining allocations, future research could consider the performance and stock market impacts of such allocations. Third, we address beliefs regarding the impact of R&D and CAPX on the stock market. Managerial action depends on beliefs, and in a parallel to industry recipes (Spender, 1989), future research could address a wider set of managerial beliefs regarding the efficacy of diversification, stock buybacks, layoffs, and so forth.

Conclusion

We argue for the importance of modeling management beliefs about the stock market in drawing conclusions about the impact of incentive alignment on firm resource allocation. Our results find that the incentives provided by stock options operate in a more nuanced way than advocates have suggested and are consistent with predictable behavioral responses to factors that vary over time, such as option exercisability. In showing these effects, our research casts new doubt on the usefulness of options as a remedy for short-termism, despite their increased prominence in executive pay.

Notes

1. We do not offer hypotheses regarding long-term debt because we view it as a financing choice (in contrast to issuing equity shares) rather than a different type of long-term investment.

2. We appreciate helpful dialogue with the anonymous reviewers that helped clarify the range of methodological issues warranting discussion in this section.

3. By construction, all of the values for this variable have negative signs. This causes the hypothesized effect—deeper losses when options decrease farther in value—to be represented by a coefficient carrying a positive sign.

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