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ABSTRACT

This research explores the interaction of behavioral theory and agency theory, investigating their joint effects on firm-level R&D investment. Based on the logic of organizational routines driving R&D investment, we rely on the effects of organizational slack, performance relative to aspirations and distance from bankruptcy as the foundation for our research model. We argue that managerial incentives moderate the relationships between these behavioral theory variables and R&D investment, albeit in contrasting directions. Specifically, we hypothesize that stock option pay positively moderates these relationships while managerial stock ownership has a negative moderating effect. Using panel data for 573 publicly-traded manufacturing firms, we find support for several of our hypotheses, highlighting the interdependence of these two perspectives on R&D investment.

1. Introduction

Investments in research and development (R&D) represent one way for firms to search for innovations that may strengthen existing product-market positions, and/or provide opportunities to enter new product-market domains (He & Wong, 2004; Katila & Ahuja, 2002), thereby improving performance. Behavioral theory (Cyert & March, 1963) suggests that a firm may invest in R&D in response to its performance relative to its aspirations, the degree of organizational slack it possesses, and its distance from bankruptcy. Scholars have found strong support for such arguments (e.g., Chen, 2008; Chen & Miller, 2007; Greve, 2003a; Singh, 1986).

The agency theory perspective suggests that R&D spending may also be influenced by managerial incentives (Cheng, 2004; Makri, Lane, & Gomez-Mejia, 2006; Ryan & Wiggins, 2002). The different risk-bearing properties associated with stock ownership and option pay can motivate either risk aversion or risk-seeking choices by managers. The implications of this difference are especially important given that R&D projects themselves often entail significant risk. R&D projects tend to be long-term in nature with uncertain and distant payoffs (Lee & O'Neill, 2003), and may not lead to viable products (Levinthal & March, 1993). Thus, the propensity to invest in R&D can be influenced by the nature of managerial incentives.

The behavioral agency model (BAM) integrates elements of both of the aforementioned perspectives. BAM focuses on the loss aversion of managers in the decision-making process, highlighting the importance of organizational context and individual problem framing to explain when managers may exhibit risk-averse vs. risk-seeking behavior (Wiseman & Gomez-Mejia, 1998). Thus, according to BAM, the willingness of managers to make R&D investments can be influenced by managerial incentives (e.g., Cheng, 2004; Larraza-Kintana, Wiseman, Gomez-Mejia, & Welbourne, 2007; Makri et al., 2006; Ryan & Wiggins, 2002; Wu & Tu, 2007) as well as key organizational and individual reference points. Wu and Tu (2007) rely on BAM to offer initial insights into the effects of organizational slack and firm performance on the CEO stock option pay-R&D investment relationship.

The objective of this study is to further examine the interaction of the behavioral and agency theory viewpoints towards a more comprehensive understanding of firm-level R&D investment. We suggest that the interaction effects between these two perspectives at times are complementary in driving R&D investment, while at other times they may counteract one another. Specifically, our baseline model identifies the impact of attainment discrepancy, organizational slack and distance from bankruptcy on firm-level R&D spending, following behavioral theory arguments. Hypotheses are then developed that examine the moderating effects of stock option pay and managerial stock ownership on these baseline relationships, focusing on managerial risk bearing and the differential effects of these two incentives. We use a panel data set of 573 manufacturing firms over 7 years (2001–2007) to examine these interaction effects.

Our study provides a more comprehensive understanding of the drivers of firm innovation activity. We extend the work of Wu and Tu (2007) in two ways. First, we include managerial stock ownership,

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performance relative to target, and distance from bankruptcy in a more complete model of R&D investment. Second, we consider the incentives of the top management team since complex decisions, such as investing in R&D, often involve other members of the team in addition to the CEO.

The remainder of the paper proceeds as follows. First, we provide an overview of the existing literature that examines the links between behavioral theory and R&D investment. Next, we discuss the influence of managerial incentives on R&D investment, highlighting the similarities and differences between stock ownership and option pay. We then develop our hypotheses, identifying the moderating role of managerial incentives on the behavioral theory-R&D investment relationships. Our research design and the results of our analysis follow. Finally, we conclude with a discussion of the implications of our findings.

2. Theory and hypotheses

The behavioral theory of the firm (Cyert & March, 1963) portrays the firm's decision process as managers relying on the firm's standard operating procedures to make decisions in the face of uncertainty. Investment decisions, such as R&D expenditures, are based on prior patterns and processes (Gavetti, Greve, Levinthal, & Ocasio, 2012). However, key contextual factors, including organizational slack, performance relative to aspirations, and the threat of bankruptcy, can influence firms to deviate from these routines. This perspective forms the foundation of our arguments. We assume that behavioral theory explanations of R&D investments form the main effects in our model given the heavy reliance on organizational routines to make such investment decisions. We then propose that agency theoretic arguments moderate the effects of the behavioral theory constructs on R&D investments, suggesting that managerial incentives may alter firm decision routines due to managerial risk bearing.

2.1. Behavioral theory determinants of R&D investment

2.1.1. Organizational slack

Slack refers to such excess resources as underutilized overhead and financial reserves (Cyert & March, 1963; Levinthal & March, 1981). In the context of innovation, slack resources include R&D facilities, R&D employees, and time for R&D activities, as well as the financial resources that can be used to fund R&D projects. Higher levels of slack provide a buffer for the organization, offering some protection against uncontrollable change and downside risk. With this cushion, managers may be more comfortable deploying such resources towards experimentation and innovation (March, 1981; Nohria & Gulati, 1996). Conversely, organizational flexibility is reduced and strategic options are limited when firms have little slack (Miles, 1982). Behavioral theory thus posits a positive relationship between organizational slack and innovation (Damanpour, 1991; Nohria & Gulati, 1996; Singh, 1986), as well as R&D investment (Chen & Miller, 2007; Greve, 2003a).

2.1.2. Attainment discrepancy

Attainment discrepancy refers to the difference between firm performance and aspirations as judged by managers (Lant, 1992). Attainment discrepancy is unfavorable when performance falls short of aspirations, triggering problemistic search to solve the performance shortfall (Cyert & March, 1963). The performance shortfall is likely to spur firms to deviate from the status quo. Thus, R&D investment will be increased if problemistic search directed toward technology and product development can help to solve the performance problem. In terms of attainment discrepancy, for firms performing below aspirations (higher levels of attainment discrepancy), managers would be likely to pursue risky R&D investments to try to close performance gaps. Conversely, the likelihood of engaging in organizational change declines when attainment discrepancy is deemed favorable or low (Greve, 1998). Firms tend to maintain current routines and limit investments in innovation when performance exceeds aspirations (Levinthal & March, 1981). Scholars have found support for this relationship between performance relative to aspirations and risky investments (e.g., Palmer & Wiseman, 1999; Wiseman & Bromiley, 1996), including R&D investments (Chen & Miller, 2007; Greve, 2003a, 2003b).

2.1.3. Distance from bankruptcy

The distance from bankruptcy represents a second reference point with implications for R&D investment (Chen & Miller, 2007). Based on the "threat-rigidity" view (e.g., Staw, Sandelands, & Dutton, 1981), firms tend to limit investments and tighten financial controls when survival is threatened. In addition, when bankruptcy is imminent firms avoid new activities, conserve resources by streamlining current operations, and avoid risky investments and activities that are not essential to survival (March & Shapira, 1987, 1992). Consequently, due to the risky nature of R&D, firms limit or curtail investments in new technology and innovation when close to bankruptcy. Conversely, risk taking is likely to increase when firms are less threatened by bankruptcy (Chen & Miller, 2007; Miller & Chen, 2004).

In sum, behavioral theory posits a positive effect of organizational slack, attainment discrepancy, and distance from bankruptcy on R&D investment. These relationships form the baseline or direct effects in our research model. We now proceed to a brief overview of the agency theory perspective, and the influence of managerial incentives on R&D investment.

2.2. Influence of managerial incentives on R&D investments

Agency theory (Jensen & Meckling, 1976) suggests that by aligning managerial incentives with the interests of stockholders, managers will act according to stockholder interests, making decisions and investments that can lead to an increase in the value of the firm's equity. Equity ownership and stock option pay can motivate managers to seek out new investment opportunities that often involve greater risk (Gaver & Gaver, 1995). A central assumption in this logic is that bigger risks are associated with bigger returns (Core, Guay, & Larcker, 2003).

Different types of managerial incentives may have different effects on risk-taking actions (e.g., Sanders, 2001; Wright, Ferris, Sarin, & Awasthi, 1996; Wright, Kroll, Krug, & Pettus, 2007). In addition, managerial incentives have been shown to have strong effects on R&D investment (Cheng, 2004; Larraza-Kintana et al., 2007; Makri et al., 2006; Ryan & Wiggins, 2002). However, when substantial amounts of managerial wealth are at risk by linking it to potentially volatile stock prices, risk aversion may dominate incentive alignment. In such situations, managers may take actions to reduce the performance variability of the firm, thereby reducing the risk to managerial wealth and employment (e.g., Sanders, 2001; Wright, Kroll, Lado, & Van Ness, 2002; Wright et al., 1996).

In the following subsections, we discuss the similarities and differences between two important types of incentives, managerial stock ownership and option pay. In general, scholars suggest that these forms of variable compensation should elicit risky investments by focusing managerial attention on the upside potential of such investments (Wright et al., 2007). However, the focus of managerial attention may be different depending on which type of incentive is employed. Thus, these differences provide the impetus for offering a full set of opposing moderating effects for stock ownership and option pay in this study.

2.2.1. Effects of managerial stock ownership

In theory, managerial stock ownership should encourage managers to adopt a longer-term mindset (Gaver & Gaver, 1995). Research suggests, however, that the propensity to make such investments likely depends on the level of ownership (Wright et al., 2002). Low to moderate levels of stock ownership are not likely to pose too much of a threat to a manager's personal wealth. Thus, the focus of managerial attention is likely to be on the upside potential of such holdings, which may entice a manager to make risky investments which may involve longer-term

uncertain payoffs in order to increase the value of the stock (and his holdings).

Conversely, at very high levels of stock ownership, scholars have found evidence of risk aversion due to managerial risk-bearing (Wright et al., 1996; Wright et al., 2002). Stock ownership involves downside risk to managerial wealth. In this scenario, managerial focus shifts away from the upside potential associated with stock ownership. Managers with substantial ownership may choose investments that reduce the performance variability of the firm to protect their own interests resulting in more conservative, less risky decisions (e.g., Ryan & Wiggins, 2002; Sanders, 2001; Wright et al., 2002).

Taken together these findings suggest that while low to moderate levels of managerial ownership may motivate riskier investments (particularly as ownership approaches moderate levels), substantial levels of managerial ownership may lead to risk-aversion. Thus, a positive relationship between managerial stock ownership and R&D spending is expected until a substantial level of ownership is reached. Beyond this point, risk aversion is likely to become evident due to greater managerial risk bearing associated with share ownership.

2.2.2. Effects of option pay

Option pay is also a long-term equity-based incentive; however, there is an important difference between option pay and stock ownership. In theory, the upside potential of option pay is unlimited, while the downside risk is limited to the value of the option. The option holder will only exercise the option if the stock price exceeds the exercise price. This limited downside risk to managerial wealth provides managers with incentives to take risks to increase stock prices (Sanders, 2001; Wright et al., 2002; Wright et al., 2007). This motivation is likely to be stronger than for stock ownership because of the limited downside risk. Sanders and Hambrick (2007) found that stock options may encourage executives to make larger, higher-variance investments. Option pay has been shown to be positively related to R&D investments (Cheng, 2004; Ryan & Wiggins, 2002; Sanders & Hambrick, 2007; Wu & Tu, 2007).

In the next section we extend these arguments related to the differing effects of various managerial incentives to explore how they moderate the behavioral theory effects on R&D investment. These differential effects of managerial incentives form the basis for the contrasting hypotheses that we develop.

2.3. The moderating effects of managerial incentives on the behavioral theory-R&D investment relationship

2.3.1. Managerial incentives and organizational slack

We now focus on the interactive effects of organizational slack and managerial incentives. Wu and Tu (2007) discuss two elements of slack that highlight the positive association between slack and R&D. First, slack provides a greater level of resources to invest in R&D. Second, "…slack resources buffer managers from immediate pressures for positive gains, which can possibly encourage more technological experimentation and more distant technological search (Cyert & March, 1963)" (Wu & Tu, 2007: 484). Option pay motivates managers to pursue R&D investment to create long-term value, yet downside risk is limited. Thus, with high option pay and high levels of slack, managers have increased resources to invest, a buffer against potential losses, as well as strong encouragement to take risks, even large ones (Sanders & Hambrick, 2007). In contrast, lower levels of option pay suggest that managers are somewhat less motivated to pursue risky R&D projects, suggesting a weaker effect on the slack-R&D investment relationship. This hypothesis corresponds to that of Wu and Tu (2007).

Hypothesis 1a. *Stock option pay will positively moderate the relationship between organizational slack and R&D investment.*

As noted above, increasing levels of managerial stock ownership from low to moderate levels would likely encourage R&D investment. However, in the case of substantial managerial stock ownership, managers face considerable downside risk to their wealth, which may hinder R&D investment. In terms of moderating effects, at lower to moderate levels of managerial stock ownership, we would expect managers to be motivated to pursue R&D investments, which would strengthen the positive effects of slack on R&D investment. However, high levels of managerial stock ownership are likely to reduce or mitigate the effects of slack on R&D investment. While managers may have excess resources to invest in R&D, the greater managerial risk bearing from incentives may lead managers to forego deploying those resources in risky R&D projects. Instead managers may maintain a larger cushion of resources to protect their wealth from downside risk (Wiseman & Gomez-Mejia, 1998). This suggests the following:

Hypothesis 1b. *Managerial stock ownership will negatively moderate the relationship between organizational slack and R&D investment.*

2.3.2. Attainment discrepancy and managerial incentives

Attainment discrepancy is likely to have a positive direct effect on R&D. When faced with higher attainment discrepancy (i.e., performance below expectations), managers are more likely to increase R&D spending to try to close the performance gap. Higher levels of option pay are likely to further increase R&D investment. Managers are already motivated to increase R&D spending to correct the performance shortfall; higher levels of option pay provide additional encouragement to make significant investments with greater risk (Sanders & Hambrick, 2007) to close the performance gap. At lower levels of option pay, the positive link between attainment discrepancy and R&D investment will still exist. But, it will be less strong since managers lack the additional motivation provided by greater option pay. This leads to the following hypothesis:

Hypothesis 2a. *Stock option pay will positively moderate the relationship between attainment discrepancy and R&D investment.*

At low levels of managerial stock ownership, managers may not be motivated to pursue R&D investments due to the lack of long-term equity incentives. However, at moderate levels of stock ownership managers may be more likely to make R&D investments, suggesting that at low to moderate levels of stock ownership, we expect a positive moderating effect of stock ownership on the effects of attainment discrepancy on R&D; however, we do not expect this to be an overly strong moderating effect. As levels of managerial stock ownership increase to very high levels, managers are less willing to invest in risky R&D projects. Thus, high levels of managerial stock ownership are likely to counteract the effects of attainment discrepancy to some extent. The motivation to invest in R&D to close performance shortfalls is less strong since such investments expose managerial wealth to greater downside risk. This leads to the following hypothesis:

Hypothesis 2b. *Managerial stock ownership will negatively moderate the relationship between attainment discrepancy and R&D investment.*

2.3.3. Distance from bankruptcy and managerial incentives

As the firm moves further from bankruptcy, risk-taking is likely to increase and firms are more likely to make R&D investments (Chen & Miller, 2007). Similar to the arguments above, higher levels of stock option pay are likely to provide managers with additional motivation to pursue R&D investments, suggesting that such conditions will enhance the extent of R&D investments the greater the distance from bankruptcy. In contrast, lower levels of option pay will provide less motivation, suggesting a weaker positive relationship between distance from bankruptcy and R&D investment. This suggests the following:

Hypothesis 3a. *Stock option pay will positively moderate the relationship between distance from bankruptcy and R&D investment.*

Based on the arguments above, we again expect a negative moderating effect of managerial stock ownership. At high levels of managerial stock ownership, the exposure of managerial wealth to downside risk would curtail R&D investment to some extent, even if the firm is not threatened by bankruptcy. If the firm is threatened by bankruptcy, high levels of ownership would give managers further cause to reduce R&D funding. However, at low to moderate levels of managerial ownership, managers have some motivation to pursue R&D activities if the firm is not threatened by bankruptcy suggesting a moderate enhancement of the effects of distance from bankruptcy. These arguments suggest the following hypothesis:

Hypothesis 3b. *Managerial stock ownership will negatively moderate the relationship between distance from bankruptcy and R&D investment.*

3. Research design

3.1. Sample

The sample consists of publicly traded U.S. manufacturing firms (SIC 2000–3999) listed in the Compustat database from 2001 to 2007. This approach yielded an unbalanced panel of 4400 firms over 9 years. We then removed observations with missing data, all industries (4-digit SIC level) with less than 5 firms, and any firms with R&D intensity values greater than 1 (since these firms would have R&D expenses that exceed revenues). We also removed extreme outliers with values beyond 4 standard deviations from the mean. The final sample includes 573 firms, with a total of 2543 observations (an average of 4.4 observations per firm). Data for the dependent variable, behavioral theory variables, and control variables were obtained from Compustat. The managerial incentives variables were obtained from Execucomp.

3.2. Measures

3.2.1. Dependent variable

Due to the methodological issues associated with using ratio measures (Wiseman, 2009), we use the numerator of the traditional R&D intensity ratio (R&D expenditures divided by sales) (Chen & Miller, 2007; Greve, 2003a) as the dependent variable, and we use the denominator of the ratio as a control variable in our model. Thus, our dependent variable is the log of *R&D expenditures*.

3.2.2. Behavioral theory variables

Recoverable slack is typically measured as the ratio of selling, general, and administrative expenses to sales (Greve, 2003a). We measure *recoverable slack-S, G, &A* as the log of sales, general and administrative expenses. As noted above, sales will be included as a control variable (see below). Chen and Miller (2007) measure available slack as a composite of two measures: the firm's current ratio (current assets divided by current liabilities), and the firm's ratio of working capital to sales. We measure *available slack-current ratio* using the first component of Chen and Miller (2007). We do not decompose this ratio since it has theoretical meaning (Wiseman, 2009). *Available slack-working capital* is measured as the numerator of Chen and Miller's (2007) second component (with the denominator, sales, included as a control variable). These slack measures are lagged one year from the dependent variable.

Attainment discrepancy is measured following Palmer and Wiseman (1999) and Bromiley (1991). The first step was to compare ROA in year t-2 to the industry average ROA (4-digit SIC level) for year t-2. If firm performance exceeded the industry average, then aspiration level for year t-1 was calculated by multiplying the performance in year t-2 by 1.05. If firm performance was below the industry average, then aspiration level for year t-1 was the average industry performance in year t-2. Attainment discrepancy in year t-1 was then calculated as aspiration level minus performance (both in year t-1). A positive attainment discrepancy represents performance below aspirations, while a negative (or lower) attainment discrepancy represents performance above aspirations.

We used Altman's Z (Chen & Miller, 2007) lagged one year from the dependent variable to measure the *distance from bankruptcy*. A lower Z-score indicates a greater likelihood of bankruptcy. Altman's Z (Altman, 1983) is calculated as $(1.2\times \text{working capital/total assets}) + (1.4\times \text{retained earnings/total assets}) + (3.3\times \text{income before interest expense and taxes/total assets}) + (0.6\times \text{market value of equity/total liabilities}) + (1.0\times \text{sales/total assets})$.

3.2.3. Managerial incentives variables

Each of the variables captures the incentives of the top management team of the firm for each year, with the variables lagged one year from the dependent variable. In addition, due to issues related to non-normality, we used the natural logs of the incentive variables. We measure *stock option pay* using the dollar value of options granted to the top management team (Cheng, 2004; Sanders, 2001; Wright et al., 2002) using the Black–Scholes value. We measured *managerial stock ownership* using the dollar value of equity owned by the top management team (Sanders, 2001; Wright et al., 2002), calculated as the number of shares owned multiplied by the firm's closing stock price for the year. We used the dollar value of equity holdings since this measure captures the impact on managerial wealth.

3.2.4. Control variables

We included dummy variables to capture firm and year effects. All other control variables are lagged one year from the dependent variable. *Short-term pay* consists of two components: salary (Cheng, 2004; Wright et al., 2007) and bonus (Cheng, 2004; Makri et al., 2006), which were summed together. We measured *firm size* as the log of the firm's sales to include the denominator of the ratio variables, as discussed above. We also controlled for industry effects using two measures (both at the 4-digit SIC level): *industry average R&D expenditures* using the same method to measure R&D expenditure as above, and *industry sales growth* using the percentage change in industry sales from year t-2 to year t-1.

3.3. Model

We estimate a fixed effects model to test our hypotheses, including both firm and year effects. To account for potential heteroskedasticity, we use the Huber–White sandwich estimator which clusters the observations by firm. This approach produces a consistent estimator when the errors are not identically distributed. We also centered the managerial incentives and behavioral theory variables prior to creating the interaction terms.

4. Results

Table 1 provides the descriptive statistics and correlations between the dependent, independent, moderating and control variables. We examined the variance inflation factors (VIFs) for the regression models and all VIFs were below the recommended threshold of 10.

Table 2 provides the analysis of our hypotheses. Model 1 provides the regression of the control variables on R&D expenditures. Model 2 incorporates the direct effects of the behavioral theory variables. Model 3 adds the effects of the managerial incentives on R&D expenditures. Model 4 includes the interaction terms to test our hypotheses.

In terms of the direct effects of behavioral theory variables in Model 3, available slack-current ratio is the only one that does not have a strong impact on R&D expenditures. Distance from bankruptcy, available slack-working capital, and recoverable slack all have significant positive effects on R&D spending. Attainment discrepancy has a strong negative influence on R&D spending. In terms of managerial incentives, stock ownership has a marginally significant positive effect on R&D expenditures ($p = .09$), suggesting that managerial stock ownership

Table 1
Descriptive statistics and correlation matrix.[a]

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. R&D expenditures (log)	3.95	1.55	–										
2. Option pay $(log)_{t-1}$	7.99	1.29	0.62***	–									
3. Stock ownership $(log)_{t-1}$	9.27	1.73	0.32***	0.26***	–								
4. Available slack—working $capital_{t-1}$	5.61	1.26	0.73***	0.54***	0.33***	–							
5. Available slack—current $ratio_{t-1}$	3.03	2.75	−0.14***	−0.02	−0.03	−0.01	–						
6. Recoverable slack—$SG\&A_{t-1}$	5.53	1.41	0.79***	0.53***	0.34***	0.74***	−0.40***	–					
7. Attainment discrepancy	0.04	0.17	−0.06**	−0.07**	−0.19***	−0.11***	−0.03	−0.10***	–				
8. Distance from $bankruptcy_{t-1}$	6.29	10.36	0.01	0.11***	0.20***	−0.02	0.46***	−0.16***	−0.20***	–			
9. Short-term pay $(log)_{t-1}$	8.08	0.62	0.55***	0.43***	0.29***	0.55***	−0.36***	0.73***	−0.10***	−0.14***	–		
10. Industry $R\&D_{t-1}$	125.98	247.43	0.15***	0.04*	0.06**	0.06**	−0.03	0.08***	−0.01	−0.01	0.06**	–	
11. Industry $growth_{t-1}$	0.07	0.17	0.05*	−0.01	0.06**	0.02	0.02	−0.02	0.03†	0.09***	0.06**	0.00	–
12. Firm $size_{t-1}$	6.95	1.54	0.65***	0.43***	0.33***	0.71***	−0.48***	0.90***	−0.16***	−0.20***	0.75***	0.10***	−0.03

[a] N = 2543.
*** p<.001.
** p<.01.
* p<.05.
† p<.10.

provides a moderately positive influence on R&D activity. Prior research has suggested that managerial ownership may exhibit a curvilinear effect on risk-taking (e.g., Wright et al., 1996, 2002). In a separate model not reported here, we explored whether such curvilinear effects existed in Model 3 by adding a managerial ownership squared term; there was no evidence of non-linear effects. Stock option pay has a strong positive effect on R&D spending (p = 0.04), which corresponds to prior research (e.g., Cheng, 2004; Wu & Tu, 2007).

Model 4 presents the test of our hypotheses. The interaction of available slack—current ratio and option pay is positive and moderately significant (p = 0.08). The interaction term of available slack-working capital and stock option pay is not significant. The coefficient on the recoverable slack-option pay interaction term is positive and marginally significant (p = 0.07). Thus, it appears that the results provide limited support for Hypothesis 1a. We graphed these interactions in Fig. 1a and b to confirm our interpretation. As evident in Fig. 1a, higher option pay provides a stronger positive relationship between available slack-current ratio and R&D spending. Fig. 1b again shows that the presence of higher option pay provides a stronger positive relationship between recoverable slack and R&D expenditures, supporting our hypothesis.

For Hypothesis 1b, the coefficient on the interaction term of managerial ownership with available slack-current ratio is not significant. The coefficient for the managerial ownership and available slack-working capital interaction term is positive and moderately significant (p<0.10), counter to Hypothesis 1b. However, the recoverable slack-managerial ownership interaction term is negative and significant (p = 0.04). We graph these relationships in Fig. 1c and d to confirm our interpretation. Fig. 1c shows that higher levels of stock ownership are associated with a stronger positive link between available slack-working capital and R&D spending, counter to Hypothesis 1b. Fig. 1d demonstrates that lower levels of stock ownership result in a more positive association between recoverable slack and R&D expenditures, which supports our hypothesis. Thus, Hypothesis 1b is partially supported.

The coefficient of the interaction term of attainment discrepancy and stock option pay is not significant, failing to support Hypothesis 2a. Similarly, the interaction term between attainment discrepancy and managerial stock ownership is not significant, failing to support Hypothesis 2b.

Hypothesis 3a argues for a positive interaction effect between stock option pay and distance from bankruptcy. This coefficient is not significant, failing to support Hypothesis 3a. In Hypothesis 3b, we propose a negative interaction effect between distance from bankruptcy and managerial stock ownership. The hypothesis is supported, since the interaction term is negative and significant (p = 0.02). In Fig. 2, the graph of this interaction confirms our interpretation; higher levels of stock ownership result in a more negative relationship between distance from bankruptcy and R&D spending.

In sum, consistent with our hypotheses, stock option pay positively moderates the effects of available slack-current ratio and recoverable slack on R&D investments. Managerial stock ownership positively

Table 2
Effects of managerial incentives and behavioral theory on R&D expenditures.[a]

	Model 1	Model 2	Model 3	Model 4
Intercept	−0.54	−0.93**	−1.04**	−0.84
Industry $R\&D_{t-1}$	0.00	0.00	0.00	0.00
Industry $growth_{t-1}$	0.09*	0.11**	0.11**	0.10**
Firm $size_{t-1}$	0.57***	0.19**	0.16**	0.14**
Short-term pay $(log)_{t-1}$	0.06**	0.06**	0.06**	0.05**
Attainment discrepancy		−0.13*	−0.13*	−0.11
Distance from $bankruptcy_{t-1}$		0.01*	0.01†	0.01**
Available slack—working $capital_{t-1}$		0.04**	0.04**	0.04**
Available slack—current $ratio_{t-1}$		0.00	0.00	−0.00
Recoverable slack—S,$G\&A_{t-1}$		0.50***	0.51***	0.53***
Option pay $(log)_{t-1}$			0.02*	0.08†
Stock ownership $(log)_{t-1}$			0.02†	−0.06
Available slack—working $capital_{t-1}$ * Option pay $(log)_{t-1}$				0.01
Available slack—current $ratio_{t-1}$ * Option pay $(log)_{t-1}$				0.01†
Recoverable slack—S, $G\&A_{t-1}$ * Option pay $(log)_{t-1}$				0.03†
Attainment discrepancy * Option pay $(log)_{t-1}$				−0.00
Distance from $bankruptcy_{t-1}$ * Option pay $(log)_{t-1}$				−0.01
Available slack—working $capital_{t-1}$ * Stock ownership $(log)_{t-1}$				0.02†
Available slack—current $ratio_{t-1}$ * Stock ownership $(log)_{t-1}$				0.01
Recoverable slack—S,$G\&A_{t-1}$ * Stock ownership $(log)_{t-1}$				−0.05*
Attainment discrepancy * Stock ownership $(log)_{t-1}$				0.00
Distance from $bankruptcy_{t-1}$ * Stock ownership $(log)_{t-1}$				−0.04*
F-statistic	42.53***	36.21***	32.99***	23.43***
R-sq.	0.44	0.62	0.63	0.64

[a] N = 2543; Firm and year fixed effects are included in the models but not displayed here.
*** p<.001.
** p<.01.
* p<.05.
† p<.10.

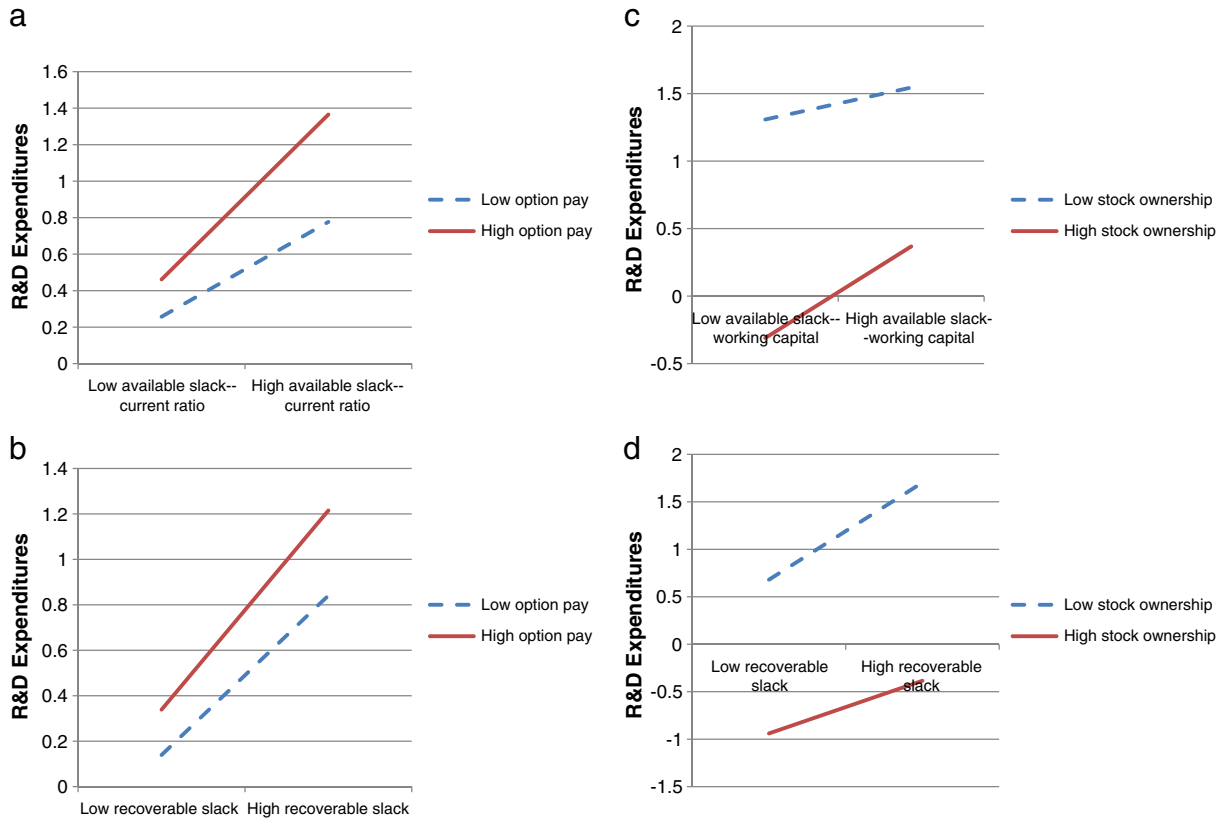

Fig. 1. a. Interaction effects between option pay and available slack—current ratio. b. Interaction effects between option pay and recoverable slack. c. Interaction effects between stock ownership and available slack—working capital. d. Interaction effects between stock ownership and recoverable slack.

moderates the effects of available slack-working capital on R&D expenditures, which is opposite of our hypothesis. Finally, consistent with our hypotheses, managerial stock ownership negatively moderates the effects of recoverable slack and distance from bankruptcy on R&D expenditures. In the next section we discuss the implications of these findings.

5. Discussion and implications

The objective of this research was to further explore the interaction effects of behavioral theory and agency theory to explain R&D investment. Our findings offer several contributions for researchers. The primary contribution of this study is that it offers a more complete picture of R&D investment by demonstrating both the direct and joint

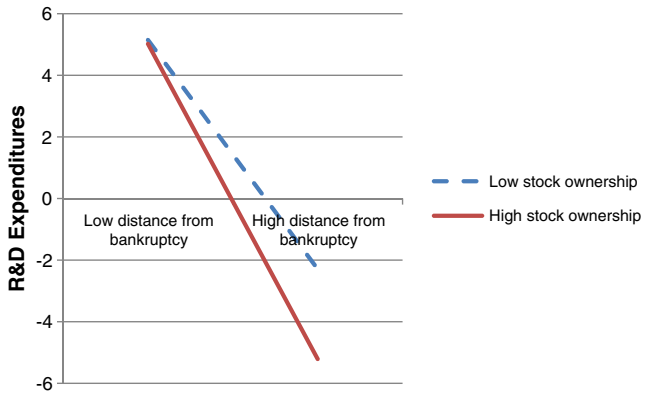

Fig. 2. Interaction effects between stock ownership and distance from bankruptcy.

effects of these two theoretical perspectives. Our empirical findings offer general support to the behavioral agency model (Wiseman & Gomez-Mejia, 1998), demonstrating the complex set of relationships between the two perspectives in understanding risk taking. The interaction effects demonstrated here highlight how these two theories at times complement each other and magnify the motivation to pursue R&D investments, while at other times counteract one another to reduce R&D expenditures.

Our findings suggest that stock option pay complements the effects of organizational slack to increase R&D investment. Higher levels of liquidity provide resources to invest in R&D (i.e., the means to pursue R&D). Higher stock option pay serves to provide the motivation to deploy this capital. In addition, the buffer or cushion provided by higher levels of recoverable slack provides further encouragement to pursue risky R&D investments, complementing the effects of stock option pay (Sanders & Hambrick, 2007).

Counter to our arguments, in the presence of greater working capital higher managerial stock ownership also served to enhance the effects on R&D investment. We had expected that the greater threat to managerial wealth due to substantial managerial equity stakes (e.g., Wright et al., 1996, 2002) would counteract the positive influence of slack on R&D investment. Our findings suggest the opposite—it appears that the presence of liquid resources may reduce managerial concerns for downside risk to some extent. Managers may thus be more likely to pursue investment in R&D which the incentive was designed to encourage. This is one possible explanation for this finding. Given the restrictions of our dataset, our ability to probe this finding is somewhat limited, but offers an area for future research.

Our findings also demonstrate that the downside risk to managerial wealth at high levels of managerial stock ownership can counteract the behavioral theory motivations to pursue R&D investment in certain situations. Before exploring the moderating effects, it is worth examining

the direct effects first. Stock ownership has a moderately positive direct effect on R&D investment. While we tested for curvilinearity, we did not find any strong evidence of an inverted-U shaped effect of managerial ownership on R&D spending, which scholars had found for risk-taking in general (e.g., Wright et al., 1996).

Turning to the moderating effects, stock ownership appears to counteract the effects of recoverable slack and distance from bankruptcy on R&D investment. It appears that the threat to managerial wealth from high levels of ownership dominates the buffering effect of recoverable slack. Our findings suggest that when managers hold high levels of equity, they prefer to preserve that slack cushion to protect against downside risk. This echoes the findings of Sanders (2001), Ryan and Wiggins (2002) and Wright et al. (1996) among others. Stock ownership also counteracts the positive influence of distance from bankruptcy on R&D spending. As the firm moves further away from the threat of bankruptcy, managers may be encouraged to make R&D investments. However, with high levels of stock ownership, managers apparently would rather preserve these resources to protect their wealth exposure.

Attainment discrepancy did not appear to have any joint effects with managerial incentives on R&D investment. Behavioral theory posits a positive effect of attainment discrepancy; as firms perform below expectations, they may engage in problemistic search. However, we find a significant negative effect of attainment discrepancy on R&D investment (Models 2 and 3). One possible explanation is that firms engage in slack search, corresponding to higher levels of R&D spending when performance exceeds aspirations (Chen & Miller, 2007). Such slack can motivate the loosening of controls and greater experimentation, resulting in greater R&D investment when performance is above, rather than below, expectations. In other words, slack search is more likely than problemistic search. This conjecture merits further investigation in future research.

Our research offers a second contribution by extending the arguments of Wu and Tu (2007), who test several of BAM's arguments. First, we incorporate the effects of the incentives of the entire top management team, rather than just the CEO, since the top management team often makes R&D investment decisions. Second, we use a more comprehensive set of behavioral theory variables. While Wu and Tu (2007) found that performance plays a moderating role, behavioral theory is more focused on performance relative to a reference point. In our study, we incorporate two key reference points, performance relative to aspirations and distance from bankruptcy. Third, our analysis encompasses stock option pay *and* managerial stock ownership. Both of these incentives have been shown to influence managerial decisions, particularly R&D investment. Our theoretical arguments and findings highlight the importance of examining both types of incentives. We argued and generally found support for differing effects from managerial stock ownership and stock option pay on R&D investments. These results offer further evidence of the critical impact that the extent of downside risk to managerial wealth plays in managerial behavior (e.g., Sanders, 2001; Wright et al., 2002). Thus, our study offers a more comprehensive model of the interaction effects of behavioral theory and managerial incentives.

There are several limitations in our research. First, due to the availability of managerial incentives data, our sample is limited to larger and higher performing public companies in the U.S. Smaller firms may demonstrate a slightly different pattern of findings, particularly since slack search and problemistic search may occur with different intensities for smaller firms relative to larger firms. Second, we have focused on the level of R&D expenditures in the firm, which is only one proxy for innovation. It would be interesting for future research to examine these relationships using other measures of innovation, and also within smaller firms.

In conclusion, our findings highlight the existence of strong relationships between behavioral theory constructs, managerial incentives and R&D investment. The existence of joint effects between these two theories suggests a more complex organizational model of R&D investment that weaves together organizational routines and decision processes with elements of corporate governance. The findings highlight the importance of interdependencies across theoretical perspectives when examining the outcomes of organizational processes. Future research can further explore the complementary effects of behavioral theory and agency theory on other strategic investments.

References

Altman, E. I. (1983). *Corporate distress. A complete guide to predicting, avoiding, and dealing with bankruptcy*. New York: Wiley.

Bromiley, P. (1991). Testing a causal model of corporate risk taking and performance. *Academy of Management Journal*, *34*(1), 37–59.

Chen, W. R. (2008). Determinants of firms' backward- and forward-looking R&D search behavior. *Organization Science*, *19*(4), 609–622.

Chen, W. R., & Miller, K. D. (2007). Situational and institutional determinants of firms' R&D search intensity. *Strategic Management Journal*, *28*(4), 369–381.

Cheng, S. (2004). R&D expenditures and CEO compensation. *The Accounting Review*, *79*(2), 305–328.

Core, J. E., Guay, W. R., & Larcker, D. F. (2003). Executive equity compensation and incentives: A survey. *Economics and Policy Review*, *9*(1), 27–50.

Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. Englewood Cliffs (NJ): Prentice-Hall.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal*, *34*(3), 555–590.

Gaver, J. J., & Gaver, K. M. (1995). Compensation policy and the investment opportunity set. *Financial Management*, *24*(1), 19–32.

Gavetti, G., Greve, H. R., Levinthal, D. A., & Ocasio, W. (2012). The behavioral theory of the firm: Assessments and prospects. *The Academy of Management Annals*, *6*(1), 1–40.

Greve, H. R. (1998). Performance, aspirations, and risky organizational change. *Administrative Science Quarterly*, *44*(1), 58–86.

Greve, H. R. (2003a). A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Academy of Management Journal*, *46*(6), 685–702.

Greve, H. R. (2003b). Investment and the behavioral theory of the firm: Evidence from shipbuilding. *Industrial and Corporate Change*, *12*(5), 1051–1076.

He, Z. L., & Wong, P. K. (2004). Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science*, *15*(4), 481–494.

Jensen, M., & Meckling, W. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360.

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, *45*(6), 1183–1194.

Lant, T. K. (1992). Aspiration level adaptation: An empirical exploration. *Management Science*, *38*(5), 623–644.

Larraza-Kintana, M., Wiseman, R. M., Gomez-Mejia, L. R., & Welbourne, T. M. (2007). Disentangling compensation and employment risks using the behavioral agency model. *Strategic Management Journal*, *28*(10), 1001–1019.

Lee, P. M., & O'Neill, H. M. (2003). Ownership structures and R&D investments of U.S. and Japanese firms: Agency and stewardship perspectives. *Academy of Management Journal*, *46*(2), 212–225.

Levinthal, D. A., & March, J. G. (1981). A model of adaptive organizational search. *Journal of Economic Behavior and Organization*, *2*(4), 307–333.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal*, *14*(S2), 95–112.

Makri, M., Lane, P. J., & Gomez-Mejia, L. R. (2006). CEO incentives, innovation, and performance in technology-intensive firms: A reconciliation of outcome and behavior-based incentive schemes. *Strategic Management Journal*, *27*(11), 1057–1080.

March, J. G. (1981). Footnotes to organizational change. *Administrative Science Quarterly*, *26*(4), 563–577.

March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management Science*, *33*(11), 1404–1418.

March, J. G., & Shapira, Z. (1992). Variable risk preferences and the focus of attention. *Psychological Review*, *99*(1), 172–183.

Miles, R. E. (1982). *Coffin nails and corporate strategies*. Englewood Cliffs (NJ): Prentice-Hall.

Miller, K. D., & Chen, W. R. (2004). Variable organizational risk preferences: Tests of the March–Shapira model. *Academy of Management Journal*, *47*(1), 105–116.

Nohria, N., & Gulati, R. (1996). Is slack good or bad for innovation? *Academy of Management Journal*, *39*(5), 1245–1264.

Palmer, T. B., & Wiseman, R. M. (1999). Decoupling risk taking from income stream uncertainty: A holistic model of risk. *Strategic Management Journal*, *20*(11), 1037–1062.

Ryan, H. E., & Wiggins, R. A. (2002). The interactions between R&D investment decisions and compensation policy. *Financial Management*, *31*(1), 5–29.

Sanders, W. G. (2001). Behavioral responses of CEO's to stock ownership and stock option pay. *Academy of Management Journal*, *44*(3), 477–492.

Sanders, W. G., & Hambrick, D. C. (2007). Swinging for the fences: The effects of CEO stock options on company risk taking and performance. *Academy of Management Journal*, *50*(5), 1055–1078.

Singh, J. V. (1986). Performance, slack, and risk taking in organizational decision making. *Academy of Management Journal*, *29*(3), 562–585.

Staw, B., Sandelands, L. E., & Dutton, J. E. (1981). Threat rigidity effects in organizational behavior: A multilevel analysis. *Administrative Science Quarterly*, *26*(4), 501–524.
Wiseman, R. M. (2009). On the use and misuse of ratios in strategic management research. In D. D. Bergh, & D. J. Ketchen (Eds.), *Res Methodol Strat Manage*, *Vol. 5*. (pp. 75–110)New York: Emerald Group.
Wiseman, R. M., & Bromiley, P. (1996). Toward a model of risk in declining organizations: An empirical examination of risk, performance and decline. *Organization Science*, *7*(5), 524–543.
Wiseman, R. M., & Gomez-Mejia, L. R. (1998). A behavioral agency model of firm risk-taking. *Academy of Management Review*, *23*(1), 133–154.
Wright, P., Ferris, S. P., Sarin, A., & Awasthi, V. (1996). Impact of corporate insider, blockholder, and institutional equity ownership on firm risk taking. *Academy of Management Journal*, *39*(2), 441–463.
Wright, P., Kroll, M., Krug, J. A., & Pettus, M. (2007). Influences of top management team incentives on firm risk taking. *Strategic Management Journal*, *28*(1), 81–89.
Wright, P., Kroll, M., Lado, A., & Van Ness, B. (2002). The structure of ownership and corporate acquisition strategies. *Strategic Management Journal*, *23*(1), 41–53.
Wu, J., & Tu, R. (2007). CEO stock option pay and R&D spending: A behavioral agency explanation. *Journal of Business Research*, *60*(5), 482–492.