

Managerial Stock Compensation and Risky Investment

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***Abstract.** This study analyzes the relationship between the mix of CEO equity-based compensation, namely stock options and restricted stock, and firms' risky investment. In general, the theory suggests that long-term compensation aligns CEOs' and shareholders' interests by inducing the managers to undertake risky investment, which has a positive impact on long-term well-being of the firm. However, as my results show, it is important to distinguish between types of awards since they can have different effects on the riskiness of the firm. In this respect, I answer the question how are different types of stock based compensation related to the executives' determination to increase or not the intensity of the firm's risky investment? I find that awarding the CEOs preponderantly with stock options positively affects the firm's level of R&D investment. Conversely, a higher proportion of restricted stock in the CEO's compensation is related to lower investment in (risky) R&D. The inverse relation of causality also holds. Firms that make intensive R&D investments are more likely to award their CEOs with more stock options relative to restricted stock. Overall, the results are consistent with the theoretical prediction, in that the managerial compensation scheme plays an important role in determining the level of R&D investment.*

Keywords: stock options; restricted stock; executive compensation; risky investment.

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JEL Codes: J33, G32, M12, M52, O32.

REL Codes: 12C, 12F, 14C.

Introduction

Under the general framework of agency theory, due to the separation of ownership and control, managers and directors may adopt corporate decisions of under-investing in long-term intangible projects such as R&D that is inconsistent with the long-term maximization of firm value. The argument is simple and related to corporate governance structure. While diversified shareholders might gain from the high returns associated with the high risk implied by R&D projects, the managers are risk averse and prefer to boost the short-term earnings at the expense of the firms' long-term well being. Although R&D expenditures are viewed by investors as a great source of future benefits and competitive advantage, they are also characterized by uncertainty and unpredictable in income, which amplifies the asymmetry information problem.

These potential critical aspects in the monitoring and investment practices can be, to some extent, mitigated by including stock option based plans in managerial compensation. Executive stock options are the most common form of equity-based compensation. Stock options are financial contracts that allow managers to buy shares of the company's stock at a fixed price, called exercise or strike price, through a specific period of time. Usually, the executives exercise the option to buy stock and then sell the stock for the cash. Therefore, if the price of the stock rises above the strike price, the CEO can exercise the option and gain the difference between

stock price and exercise price as a profit.⁽¹⁾ Stock options, due to their convex payoffs (as stock volatility and firm risk increase, the CEO's potential gain increases at an increasing rate), induce the manager to undertake risky activities, which otherwise would be avoided. Therefore, he contributes to the long-term value of the firm, the common objective with the shareholders. Restricted stock is common stock, which requires a certain period of time to pass or a specific firm's performance to be fulfilled before the manager can sell the stock. Awarding the managers with restricted stock has opposite effect on the CEO's decision to invest in R&D. Its linear payoff makes the risk-averse manager avoid risky projects, thereby lowering the firm's R&D spending.

The attractiveness of options relative to stock can be seen more clearly if we consider a numerical example. Consider the CEOs of two companies, holding options and restricted stock in two different periods of time (Table 1). Considering different alternatives, in period 2, the stock price or the volatility of the price goes up by 5%. We can see that in the first case, when the stock price increases, the total gain from holding both options and restricted stock is almost the same for both CEOs (with the values of options computed with Black-Scholes formula). However, when the stock becomes more volatile (which is directly related to the nature of risky investment), the total gain of the CEOs is hugely different and it is clear that the CEO from the Firm B, which is awarded with more options will have a better incentive to make risky investments.

Therefore, granting stock options to the managers would exert a positive influence on their behavior on investing in R&D expenditures. If managers are compensated with restricted stock, this will negatively affect the R&D investment.

In this study, I investigate the effect of the mix of stock options and restricted stock on the intensity of R&D investment by firms. Empirically, I hypothesize a positive relationship between an option-based type of contract and R&D intensity. Using a sample of 764 non-financial firms, I test this hypothesis in a simultaneous system of equations, implying a bivariate probit model where the mix ratio of options to restricted stock and R&D intensity are simultaneously determined. Consistent with the hypotheses, the results show a positive significant association between R&D intensity and mix of options and restricted stock.

Literature review

The complexity of equity-based contracts and the ultimate effect of aligning managers and shareholders interests by tying compensation to stock price performance have been analyzed in numerous studies. Kole (1997) finds that the characteristics of different types of plans (stock options and restricted stock plans) depend on the nature of assets (tangible versus intangible) being managed. He found that firms dealing mainly with intangible assets (such as high innovative firms) are more flexible in using equity-based awards. Mehran (1995) suggests that there is a positive relation between the firm

performance and the percent of managers' stock ownership, emphasizing that the type of the compensation rather than the level will determine managers to increase the value of the firm.

In relation with R&D expenditures, Cheng (2004) finds that there exists a positive relation between changes in R&D spending and changes in CEO option compensation under a horizon hypothesis (CEO approaches the retirement age) and a myopia hypothesis (the firm suffer a small decline in earnings). He found the same relationship of CEOs' total compensation (sum of salary, bonus, stock options and other long-term incentives) relative to the changes in R&D spending but without differentiating between stock options and other types of long-term compensation. In the same view, Clinch (1991) investigates how the compensation practices vary with levels of R&D activity, but his study is also limited by the choices of compensation measure (total compensation or salary and bonus). Lerner and Wulf (2006) find a strong positive association between long-term incentives of the heads of corporate research and development (stock option plans and restricted stock) and patents. Although the relationship between R&D investment and executive equity-based compensation was investigated in numerous studies, the previous research does not distinguish between different types of stock-based compensation or analyze these decisions separately. Closest to my study, Ryan and Wiggins III (2002) use a sample of firms from 1996 and examine the relation between R&D investment and stock

options and restricted stock compensation addressing the simultaneity problem but they do not support their empirical model with a solid theoretical argument. Bryan et al. (2000) examine the mix of stock options and restricted stock relative to total compensation and R&D investment but in their analysis they treat options and restricted stock separately and also ignore the simultaneity between R&D investment decisions and CEO stock compensation.

Data and empirical model

The data come from three sources.

1. I obtained data on CEO compensation from Standard and Poor's Execucomp database. This database contains data on stock options, restricted stock, cash compensation and other managerial characteristics (ownership, age, CEO-chair duality, tenure), beginning in 1992, for the top five executives of over 1,500 publicly traded companies in the U.S.

2. My second source is the Industrial Compustat database. It is used to collect data describing firms' financial indicators such as market value, R&D expenditures, total assets, sales, debt in capital structure and net cash flow.

3. Finally, I used proxy statements of firms publicly available from Security Exchange Commission (form 14 def) to supplement some of the information from the Execucomp database.

The description of all variables is given in Table 2.

I began the sample selection with 1689 firms listed in Execucomp with the

information available for 2003 retaining data only for the chief executive officers. Among the nonfinancial corporations listed in Compustat, industrial segment data, 798 firms have also available information in the Execucomp database. For 50 companies, due to their missing values for the age of the CEO, the information was hand-collected from their proxy statements available in the form 14 def of Security Exchange Commission. The final sample for this study contains 764 nonfinancial companies that have complete information from all three sources.

The analysis requires a simultaneous estimation approach because R&D intensity⁽²⁾ of the firm and mix of options and restricted stock reciprocally influence each other. According to the principal-agent model, managers are more risk averse than shareholders and tend to avoid R&D projects that increase the riskiness of the firm. Therefore, firm's long-term investment and, implicitly, the firm's value will suffer as a consequence of the CEO's actions. The optimal solution is to increase the long-term incentive payment offered to the CEO. However, while a stock option, due to its asymmetric payoff, exercise a positive influence on the manager's decision of investing in R&D, restricted stock has an opposite effect.

R&D intensity affects the stock-based compensation scheme in that high R&D intensive firms are more likely to award their CEOs with more options than restricted stock. The R&D investment outcome has a high degree of uncertainty. Therefore, by undertaking risky projects, the CEOs of

R&D intensive firms need to be compensated by long-term incentive payment that can potentially provide him huge gains (i.e. stock options). High tech firms are also usually financed by venture capital investment. The venture capitalists insist on compensating the managers with long-term payment that provide them substantial incentives (more likely with options than with restricted stock) that assure the risky project will be fulfilled.

To model the simultaneous relationship between the mix of equity-based compensation and R&D intensity of the firm, I estimate a bivariate probit model, given by the following system:

$$RD_I = \alpha_1 + \beta_1 \times TYPE + \gamma_1 \times OWNCEO + \delta_1 \times AGE + \theta_1 \times DEBT + \mu_1 \times CASH + \pi_1 \times MTB + \eta_1 \times BONPR + \nu_1 \times SIZE + \psi_1 \times TENURE + \omega_1 \times CHAIR + \varepsilon_1$$

$$TYPE = \alpha_2 + \beta_2 \times RD_I + \gamma_2 \times OWNCEO + \delta_2 \times AGE + \theta_2 \times DEBT + \mu_2 \times CASH + \pi_2 \times MTBLAG + \nu_2 \times SIZE + \psi_2 \times TENURE + \omega_2 \times CHAIR + \varepsilon_2$$

The main hypotheses (in their alternative form) to be tested are:

H1: variable TYPE has a positive impact on R&D intensity (RD I), that is, $\beta_1 > 0$. Alternatively, $\beta_1 \leq 0$ implies that the mix of stock options and restricted stock has a negative or no effect on R&D intensity.

H2: R&D intensity (RD I) has a positive impact on the mix of options and restricted stock (TYPE), that is, $\beta_2 > 0$. Alternatively, $\beta_2 \leq 0$ implies that R&D intensity has a negative or no influence on the mix of equity-based compensation.

Several influential factors are controlled for in the empirical model. Most of these variables influence both R&D intensity and CEO's compensation scheme.

CEO ownership (OWNCEO) influences both the R&D intensity and the type of equity based compensation. When the CEO holds a large portion of the firm's common equity, his interests are almost aligned with the shareholders' interests. Shareholders, whose risk is diluted through diversified portfolios, have a positive attitude towards R&D investment that can increase in the long run the value of the firm. Therefore, I expect a positive relation between R&D intensity and manager's ownership. CEO ownership is also related to the equity compensation part. A negative relation is expected since the necessity of awarding options is decreased by the already existed convergence of shareholders and CEO interests.

CEO's age is related to both type of equity compensation and R&D intensity. According to Cheng (2004), CEOs approaching the retirement age tend to invest less in R&D because they are focused more on short-term projects. As Yermack (1995) recognizes, "the corporations could counteract the horizon problem" by using more stock option awards. Therefore, I expect a negative relation between CEO's age and R&D intensity and a positive relation between CEO's age and TYPE variable.

CEO's tenure influences stock-based compensation in a way that more restricted stock is awarded if the manager holds that position for a longer time (Ryan, Wiggins,

2002). This is sustained by the fact that CEOs with longer tenure which have a greater fraction of their human capital invested in the firm is most likely to behave towards shareholders' interests. Therefore, they tend to undertake more risky projects and the demand for option awards (which provide the incentive alignment) is less.

A similar argument holds for CEO-CHAIR duality in relation with R&D intensity and equity-based compensation. As Vancil (1987) suggest, if the CEO is also the chair of the board, he already demonstrated his loyalty and consideration to the firm and therefore he has enough incentive not to avoid risky investment. Also, awarding options have a minimal effect on his decisions. Therefore, I expect a negative relation with TYPE and a positive relation with R&D intensity.

Cash bonus as percentage of total compensation (BONPR) influences R&D intensity but it does not have a direct effect on the mix of stock-based compensation. The reason for not including it as explanatory variable in TYPE equation is that cash bonus is typically granted based on short-term CEO's performance while both options and restricted stock, by their nature are related to the long-term compensation. As Jensen (1986) found, the CEOs paid with cash bonus based on short-term performance tend to avoid risky investments and to focus on projects that pay back in the very near future. Therefore, a negative relation between R&D intensity and cash bonus is expected.

In line with Cheng (2004), cash bonus variable is treated as exogenous

determinant of R&D intensity, considering that it is predetermined when the decision of investing in R&D is taken. The reason that the author suggests is that "compensation committees usually determine cash bonuses at the end of the fiscal year, while they often grant stock options before the end of the fiscal year", maintaining the flexibility of adjusting the equity-based compensation.

With respect to characteristics of the firm, financial solvency or debt is expected to have a negative relation with both R&D investment and compensation mix, with less options preferred in order to reduce the agency costs (Yermack, 1995; Ryan, Wiggins, 2002; Nam et al., 2003).

Firm's liquidity, defined as the net cash flow scaled by the market value, affects R&D investment since higher levels of cash presumably induce higher levels of R&D investment (Ryan, Wiggins, 2002; Bhagat, Welch, 1995). According to Bryan et al. (2000) and Yermack (1995), if the firm is liquidity constrained, the CEO is more likely to be paid with stock options, a proper way to economize cash. Therefore, cash availability should negatively affect the equity mix compensation.

I include the natural logarithm of firm's total assets to control for size. A larger firm has more complex operations and therefore requires a greater managerial expertise. With more assets at the managers' disposal, the possibility of agency conflicts increases. This increased probability for agency problems suggests a need for more incentive alignment through equity-based compensation.

Market-to-book value of assets, used as proxy for investment opportunities determine R&D investment (Nam et al., 2003). This measure shows the mix of the value of assets already in place and the market value of both assets in place and the value from future investment and growth opportunities. Firms that have more investment opportunities are interested to invest more in R&D to expand these opportunities (Ryan, Wiggins, 2002). High growth firms (which are mainly R&D intensive) also rely more on awarding options to ensure the incentive alignment of the CEO and shareholders. The decision for more or less options or restricted stock is taken based on investment opportunities and positive NPV projects in the previous year (Ryan, Wiggins, 2002).

To identify the equations in this two-equation simultaneous probit model, I must include one exogenous variable in each equation that is excluded from the other equation. BONPR variable is used in the first equation as the identifying variable in the R&D intensity equation. While the CEO's cash bonus may be considered endogenous in the long run, in this context I treat it as exogenous because it is predetermined at the time of decision. I use MTB LAG, a proxy for investment opportunities, as the identifying variable for the endogenous variable TYPE. Firms that have more investment opportunities are interested in investing more in R&D to expand these prospects and rely more on stock option compensation to ensure the incentive effect. The decision to offer more or less options or restricted stock is made

based on investment opportunities and positive NPV projects in the previous year. Therefore, MTB LAG influences the compensation scheme but does not directly affect the R&D intensity of the firm.

Because both equations have dichotomous dependent variables, they are estimated in a bi-variate probit model. This estimating model allows for the simultaneity between R&D intensity and the mix of equity-based compensation⁽³⁾.

Empirical results

Table 3 reports the marginal effects of the joint estimation of R&D intensity and the mix of stock options and restricted stock compensation using the bivariate probit model described in the previous section. The Wald test confirms that, indeed, a joint estimation procedure is needed, the null hypothesis of $\rho = 0$ (where $\rho = \text{cov}(\varepsilon_1, \varepsilon_2)$) being rejected at 1% significance level.

As we can see from the table, with respect to the first equation of the model, the results are consistent with the prediction for the first main hypothesis. Variable TYPE has a positive coefficient significant at 1% level, indicating that one unit increase in option-restricted stock ratio will induce an increase of 58.5% in the probability of investing more in R&D. This result indicates that the managers compensated with more stock options relative to restricted stock have a greater incentive to invest in R&D since their risk aversion effect (induced by restricted stock) is dominated by their sensitivity to the promising payoffs offered by stock options.

The other relevant determinants in the R&D equation are generally consistent with the empirical predictions described in the previous section.

CEO ownership displays a significant positive relation with R&D intensity, meaning that managers who have greater wealth invested in firm's stock are more likely to undertake risky projects, since their interests are closely aligned with shareholders' interests.

Agency cost of debt is negatively related to R&D intensity, with one unit increase in DEBT leading to 5.4% decrease in the probability of investing in R&D. This finding is consistent with the argument that firms with high debt ratio spend less on R&D and also that firms with higher growth opportunities have lower levels of debt (Bhagat, Welch, 1995).

Free cash flow (CASH) measure the liquidity of the firm and we would expect that larger the availability of the funds, greater the R&D expenditure. However, my results show a negative relation between these two variables, yet in line with Ryan and Wiggins (2002), who also found a negative significant relationship. Their explanation is related to the life cycle of the firm, i.e. the necessity of young firms to produce positive operating cash flow. I add some other possible justifications relying on the fact that firms might want to conserve their available liquidities in order to increase the cash dividends, to buyback shares of the company or to make some other investments or acquisitions.

Market-to book assets ratio, measuring the investment opportunities the firm faces

is positively associated with R&D intensity. The relationship is also in line with the established prediction that firms with higher market-to-book ratio (whose market value of assets is given mainly by the value of future investment) invest more in R&D.

Significant at 5% level, the relation between CEO's age and R&D investment shows that when the CEOs become older they are less likely to invest in R&D because of their employment horizon limitation.

As expected, cash bonus is negatively associated with R&D intensity. This finding suggests that if paid in cash, the manager is more likely to engage in opportunistic activities that can boost firm's earning on a short-time basis rather than undertaking risky projects.

The variables for CEO-chair duality and CEO's tenure display the predicted signs, while SIZE indicates an opposite effect on R&D intensity compared to what it was expected. However, these variables are not significant at usual relevance levels.

The second equation in the model shows how the mix of stock options and restricted stock is influenced by the R&D intensity along with the other relevant determinants of the equity-based compensation. As expected, firms that invest more in R&D are more likely to award their CEOs with stock options than restricted stock. The estimated marginal effect is positive and significant at 1% relevance level, which means that one unit increase in R&D intensity leads to an increase of 0.59 in the probability that stock options prevail in the compensation scheme.

With respect to the other control variables, CEO ownership is negatively related to the mix, meaning that when the CEO holds significant portions of the firm, he is less (more) likely to be paid with stock options (restricted stock), as it was expected. This is explained by the fact that CEO's interests correspond to those of shareholders and therefore the need for stock options that induce this incentive is diminished. The CEO can be compensated with restricted stock, which give the shareholders a plus in assuring he will stay with the firm and act according to their goals.

Firm's debt is negatively related to the TYPE variable. The result indicates that higher the leverage of the firm, lower the stock options awards, as the negative significant estimate for DEBT in the second equation shows. This result, in line with the previous literature (Yermack, 1995, Bryan et al., 2000) is justified by the stockholder-debtholder conflict when the firm is highly leveraged. When the managers align their interests with shareholders' interests (by being compensated with stock options), they also increase the risk of the firm (by undertaking more risky projects). This increase in risk will affect the debt holders who will require a higher risk premia for supplying more capital. Therefore, as financial leverage increases, the options awarded will decrease, reflecting firm's intention to minimize the cost of debt.

Financial liquidity is positively related to the mix of stock-based compensation indicating that more liquidities firms have more likely they are to award their CEOs

with stock options rather than restricted stock. This might be apparently contrary to the theoretical predictions that cash constrained firms make a higher use of stock options in order to conserve cash (Core, Guay, 2001; Bryan et al., 2000). However, it is in line with the results of studies as Ittner et al. (2003), Kroumova and Sasil (2006) and Jones et al. (2006). According to Kroumova and Sasil (2006), "keeping a higher proportion of their assets in cash may allow stock option firms to finance future growth by acquiring other firms in order to gain access to new technologies and customer bases." The authors also recognize that higher liquidity is "indicator of financial health" and therefore, it seems plausible that these companies pay options to their CEOs not necessarily because they are liquidity constrained and want to save cash but because they are profitable companies that choose to invest their money in increasing-value projects.

Market-to-book ratio is negatively related to TYPE variable. This indicates that firms in the sample facing previous positive NPV projects award their CEOs on a restricted stock base. The justification relies on the fact that even when paid with restricted stock, the CEOs in the sample are motivated enough not to avoid the investment opportunities that can increase the firm's market value.

CEO's age was found positively associated to the stock option-restricted stock ratio with the marginal effect significant at 5% level. This positive relationship⁴ indicates that when the

managers approaches the retirement age, his incentives of investing in R&D projects are drastically diminished and therefore the compensation committees award them more stock options.

When the CEO is also chair of the board, the alignment incentive is attained and therefore stock options are less used in payment than restricted stock. This is shown by a negative coefficient although weakly significant.

With respect to the size of the firm and CEO's tenure, the results indicate no significance relation.

After incorporating different industry dummy variables, the model has been reestimated. None of the industry dummy variables were statistically significant and the sign and significance of the relevant coefficient estimates remain unchanged.

Summary and future research

A vast empirical literature in corporate finance considers the relation between equity based compensation and R&D investment. Most of it relates only stock options to the executives' investment decisions, since until recently; options were the most common form of market-orientated incentive payment. Most of the studies that consider both types of equity-based compensation (stock options and restricted stock) analyze their relation with R&D investment ignoring the simultaneity between these decision variables.

In this study, I looked at the relation of the mix of stock based compensation in

form of stock option and restricted stock with the managers' R&D investment decision. Stock options opposite to restricted stock are the preferred form of equity payment if firm's objective is to increase R&D expenditures and reduce the agency problems. Therefore, the type of equity based compensation influence the level of R&D intensity. On the other side, growth firms that intensively invest in R&D tend to offer their CEOs stock option-based contracts rather than restricted stock-based contracts in order to assure their objectives are met.

I use a bivariate probit model and compute the marginal estimates with respect to independent variables and I find that the both marginal effect estimates reflecting the joined relationship between R&D intensity and mix of equity-based compensation are positive and significant at 1% level. With respect to the other determinants of R&D investment and compensation policy, the results suggest that CEO stock ownership exerts a positive influence on the R&D intensity of the firm and stock options are less likely to be awarded when the manager holds a large fraction of the firm's equity. Once the CEO becomes older, he tends to spend less on R&D. To insure the CEO has enough incentive to invest in R&D when he approaches retirement age, the compensation committees award him with more stock options. If the manager is also the chair of the board, the evidence suggests that he spends more on R&D projects and, therefore, his interests are aligned with those of shareholders and option awards are not

necessarily required. Firms with higher agency cost of debt invest less in R&D and pay their CEOs with less stock options and more restricted stock. The results also infer that the firms in the sample that have more cash liquidities tend to invest more their cash liquidities on projects that are not R&D intensive and pay their CEOs preponderantly with stock options.

The direct implication of this study is that equity-based compensation plays a critical role for both managers' and shareholders' decisions in assuring the long-term success of their companies and their well-being as individuals. A key to attain these goals is to understand how each type of stock-based payment affects the level of R&D investment, one of the most important sources for firm's prosperity. Based on their industry characteristics (high or low levels of innovation activity and rapid change), the companies can efficiently compensate the management and reduce the agency problem gap.

The study can be also related to the current economic aspects regarding executive compensation. Firms participating in the recent Troubled Asset Relief Program (TARP) were required to restrict their executives' cash compensation at \$500,000. While the policy sets conditions on the time of exercising the stock incentives, it does not place any limit on the amount of stock options that CEOs receive as long-term incentive plans. Although this could be viewed as a gateway

for opportunistic managerial behavior, capping stock options might have a negative effect on the companies R&D investment. Without proper incentive compensation, a CEO, due to his risk-aversion, can avoid undertaking net positive value risky projects and decrease R&D expenditures. A drastic overall reduction in the research and development programs of these firms may have an undesirable effect by leading to a general reduction in the economic growth.

Using a very recent data set, the study is conducted in a cross-sectional approach leaving out the possible changes that might appear for a longer period of time. This is an opportunity for the future research to investigate the relation between R&D investment and equity-based compensation by accounting for one of the recent governmental policy (FAS 123-R), that is directly related to the accounting treatment of stock options and indirectly affects the CEO's compensation scheme.

A larger dataset extended over years also allows exploring the relationship between the mix of stock options and restricted stock and subsequent firm performance in risky and non-risky industries. Although I expect both the stock options and restricted stock to be positively linked to later firm performance, it may be interesting to analyze which instrument has a stronger relation with firm performance when different levels of risk situations are involved.

Table 1

Numerical example for emphasizing the attractiveness of options relative to stock

Period 1:	Firm A	Firm B
Options values:	3.9 mil.	4.3 mil.
Restricted stock values:	6.3 mil.	2.1 mil.
Period 2: stock price goes up by 5%		
Gain from options:	≈ 285,000	≈ 495,000
Gain from stock:	+315,000	+105,000
Total gain:	+600,000	+600,000
Period 2: volatility of the stock goes up by 5%		
Gain from options:	+55,000	+505,000
Gain from stock:	+ ≈ 0	+ ≈ 0
Total gain:	+55,000	+505,000

Table 2

Definitions of the variables

Variable	Description
Variables related to compensation	
SALARY	CEO's annual salary (\$)
BONUS	CEO's annual cash bonus (\$)
OPT	Option value, computed based on Black-Scholes formula (\$)
RST	Restricted stock fair value (\$)
OPTPR	Black-Scholes option value as percent of total compensation
RSTPR	Restricted stock fair value as percent of total compensation
BONPR	Cash bonus as percent of total compensation
TYPE	Dummy variable for equity compensation mix; equals 1 if the total value of stock options is greater than the total value of restricted stock
Variables related to R&D investment	
RD	Annual R&D expenditures, scaled by the market value of the firm
RD_I	Dummy variable for R&D intensity; equals 1 if R&D expenditures divided by the annual sales is greater than 5% (R&D intensive firm)
Variables related to executive ownership and CEO specific characteristics	
OWNCEO	Percentage of firm's equity held by the CEO
AGE	CEO's age
CHAIR	Dummy for CEO-CHAIR duality; equals 1 if the CEO is also chair of the board
TENURE	CEO's tenure - time since the CEO held the position in the firm
Variables related to firm's financial indicators	
SIZE	log (total assets)
CASH	Liquidity constraint, computed as net cash flow in the corresponding year divided by the market value of the firm
DEBT	Agency cost of debt, computed as ratio of book value of long term debt divided by the market value of equity
MTB	Market to book ratio; measure investment opportunities
MTB_LAG	Market to book ratio for year 2002

Table 3

Marginal effects estimates from a bivariate probit model

Independent variables	Dependent variables					
	RD I			TYPE		
	Predicted sign	Marginal effect	Standard error	Predicted sign	Marginal effect	Standard error
TYPE	+	0.5860	0.01886***			
RD I				+	0.5865	0.0190***
OWNCEO	+	0.0059	0.00297**	-	-0.0074	0.00304**
SIZE	+/-	-0.0080	0.0105	+	0.0092	0.0104
CASH	+	-0.8683	0.17131***	-	0.6397	0.0030***
DEBT	-	-0.0548	0.01963***	-	-0.0304	0.0136**
MTB	+	0.0192	0.00556***			
MTB LAG				+	-0.0170	0.0049***
AGE	-	-0.0060	0.00305**	+	0.0063	0.0030**
BONPR	-	-0.0745	0.02152**			
TENURE	+	0.0011	0.0027	-	-0.0007	0.0027
CHAIR	+	0.1079	0.0819	-	-0.1141	0.0744*
Number of observations:	764					
Wald test of exogeneity:						
Wald χ^2 (d.f.)	35 (2)					
p-value	0.000					

***Significant at the 0.01 level

**Significant at the 0.05 level

*Significant at the 0.1 level

Notes

- (1) When the stock price is below exercise price, the option has zero payoff because the manager has no incentive to exercise the option.
- (2) R&D intensity, computed as the ratio of R&D expenditures to annual sales is a measure recognized by two of the most relevant research and development authorities in the world. The first is the National Science Foundation, an independent agency of the federal government that promotes research and education in science and engineering. The second is the R&D Global Scoreboard publication, published by the Department for Innovation, Universities and Skills and the Department for Business, Enterprise and Regulatory Reform and represents a leading source of information and analysis for the world's top R&D active companies both in the UK and globally. The R&D Scoreboard classifies companies into categories of R&D intensity based on annual evidence on R&D expenditures, market cap, sales and other key indicators. According to this publication, a company is "R&D vigorous" if it has R&D intensity of at least 4.5%. As the companies in this study belong to both high-tech and non high-tech sectors, we can also use 5% as the benchmark for R&D intensity. Therefore a firm was classified as R&D intensive if R&D spending as a percentage of annual sales was greater than 5 percent.
- (3) Compensation committees usually determine cash bonus awards at the end of the fiscal year while they often grant stock and options before the end of the fiscal year.
- (4) It is also called "the horizon problem" in studies like Cheng (2004) or Yermack (1995).

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