Cost of Capital as a Moderator of the Effect of Equity-Based Compensation on Risk-Taking by Managers

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Agency theory and contract theory predict that compensation contract can be designed to reduce the agency cost of equity and agency cost of debt in terms of risk taking by managers. Prior empirical studies focus on cost of equity effect and find that equity-based compensation reduces agency cost of equity by providing manager incentives to increase firm's risk. This study takes into account of cost of debt to argue that agency cost of debt as measured by financial leverage affects the association between equity-based compensation and risk taking by managers. The paper analyzes a sample of 2,017 American firms over the period from 1992 to 2004 by use of the simultaneous equation models, which address the simultaneity of compensation decisions by board of directors and risk taking decisions by managers. The results show that chief executive officers (CEOs) act differently for firms with different financial leverage and different types of debt. Specifically, the sensitivity of CEO wealth to stock returns volatility (Vega) has a lower impact on risk taking for debt-financed firms than all-equity firms, while the sensitivity of CEO wealth to stock price (Delta) has a higher impact on risk taking for debt-financed firms than all-equity firms, where risk taking by managers is measured as observable risky investment decisions, Research and Development (R&D) investments. The results hold even after controlling for the effects of firm's size, investment opportunities, surplus cash, and sales growth. The results support the argument that equity-based compensation mitigates agency cost of debt in addition to agency cost of equity in terms of risk taking by managers.

Introduction

Modern corporations are characterized by a separation of ownership and control. There are two main conflicts of interest within the modern corporation, the conflict of interest between shareholders and managers, and the conflict of interest between shareholders and bondholders.

The first conflict arises when shareholders find it efficient to delegate decision-making to managers, but managers want to maximize their own benefits instead of those of the shareholders. The alignment of shareholders' and managers' interests has become the main task of corporate governance. This conflict may arise in terms of managers' choice of effort or risk. Shareholders prefer that managers provide effort to improve output. If managers incur a personal cost for providing effort, and that managerial effort is not observable (or inferable) by shareholders, then managers have an opportunity to choose actions that increase benefit that accrue to them only. In addition, managers and shareholders may differ in their attitudes toward risk taking. Relative to shareholders, managers are assumed more risk averse due to human capital risk as well as less diversified of their wealth portfolios. They may choose to avoid risk-increasing positive NPV projects that benefit shareholders. Shareholders care only about expected NPV payoff of the project (not risk), while managers care about both.

The second conflict within corporations is the one between shareholders and bondholders. The payoff to equity value in a levered firm can be viewed as a call option where the underlying asset is the firm's asset value and the exercise price is the face value of debt. Since the value of call options – equity value – increases with the variance of the underlying asset, the value of common stock increases with the volatility of the firm's cash flows. Jensen and Meckling (1976) argue that excessive debt creates incentives for shareholders to take on risk-increasing negative NPV projects at the expense of debtors. This is referred to as the asset substitution problem. Since shareholders have limited liability if the firm does not perform well, they may prefer to shift to high risk negative NPV investment, believing that they are playing with other people's money.

Previous theoretical studies have demonstrated that incentive compensation contracts can be used to minimize both (1) agency costs of equity and (2) agency costs of debt. The arguments are as follows. (1) Incentive compensation contracts reduce agency costs of equity. As mentioned above, the conflict of interests between managers and shareholders is that managers are more effort- and risk- averse. Prior theoretical studies suggest that the problem can be solved using different compensation forms based on alternative performance measures and compensation forms. To induce effort, managers are provided with incentive compensation that is tied to performance. This, however, increases the riskiness of manager's compensation and creates an incentive for risk-averse managers to reduce firm risks. Executive Stock Option (ESO) compensation provides incentives for risk-averse managers to increase firm risks by introducing convexity into compensation contract and protecting the downside loss of managers. However, the risk-increasing incentive effect of ESO is challenged in several recent studies, which suggest that the general wisdom that ESO increases manager's risk taking may not be true for all circumstances.

(2) Incentive compensation contracts reduce agency costs of debt. Previous theoretical models suggest several ways to overcome managers' asset substitution problem. John and John (1993) argue that higher incentive management compensation exacerbates asset substitution problem associated with risky debt, which effectively increases managerial risk taking for firms with asset substitution problem. Alternatively, convertible debt can be used to reduce managers' risk shifting behavior. More recently, Garvey and Mawani (2005) argue that stock options can reduce asset substitution problem.

Previous empirical studies on the relation between compensation and risk taking typically recognize that leverage affects firm risk, and include it as a control variable (Rajgopal and Shevlin (2002), Knopf et al. (2002), Ryan and Wiggins (2002), and Coles et al. (2006)). However, there is limited study on whether equity compensation has different impacts on firm risk for firms with different levels of financial leverage. Does the conflict of interest between shareholders and bondholders affect the options' impact on managerial risk taking decisions? Does options-based compensation increase managerial risk taking or reduce managerial risk taking for firms with financial leverage?

This paper tests empirically whether equity-based compensation has different impact on managerial risk taking for firms with and without financial leverage. The samples are obtained from Compustat Execucomp firms over the period 1992-2004, with financial and returns data obtained from Compustat Industrial Annual and CRSP, respectively. Following Core and Guay (2002a), Rajgopal and Shevlin (2002), and Coles et al. (2006), the equity compensation incentives are measured using Vega and Delta. Vega is defined as the sensitivity of the CEO's option portfolio value to a 1% change in the underlying stock return volatility, where the option value is the Black-Scholes value of a European call option as adjusted for dividends by Merton (1973). Delta is defined as the change in total CEO's wealth based on stock and option ownership from a 1% change in stock price. The managerial risk-taking choices are measured as observable risky investment decisions, Research and Development (R&D) spending. Firms are classified as debt-financed firms and all-equity firms based on long-term debt ratio (long-term debt / total assets).

The results of this study show that compensation affects managerial risk taking differently for debt-financed firms and all-equity firms. In particular, it documents that, on average, CEO's managerial risk taking incentives as captured by Vega has a positive impact on managerial risk taking. However, this effect is lower for debt-financed firms relative to all-equity firms. On the other hand, Delta has a higher impact on managerial risk choices for debt-financed firms relative to all-equity firms. The results hold after controlling for alternative specifications. Thus, the evidence suggests that compensation contracts may incorporate anticipated reactions of bondholders as well as of managers in terms of managerial risk taking choices.

This paper makes the following contributions to the literature. First, previous empirical literatures on managerial incentives and managerial risk taking mainly examine the ability of equity-based compensation to align manager and shareholder interests, namely, encourage managers to invest in risky projects (Rajgopal and Shevlin (2002), Coles et al. (2006)). This study extends the literature by examining whether equity-based compensation is used to incorporate the reactions of bondholders with interests of managers and shareholders in terms of managerial risk taking choices. It provides empirical evidence of the different relation between equity-based compensation and managerial risk taking choices for firms with different financial leverage.

Second, previously studies on compensation mitigating the conflict of interests between shareholders and bondholders focus on compensation designs. For example, Ortiz-Molina (2007) finds that Delta decreases in firms with straight debt, but is higher in firms with convertible debt. In addition, as leverage increases, CEO Delta in options decreases faster than Delta in stock. This study is different from Ortiz-Molina (2007) in that it investigates the impact of the design of the compensation on managerial risk taking for firms with different financial leverage.

Third, this paper recognizes the potential endogeneity and simultaneity problems in empirical tests utilizing equity compensation and managerial risk taking consequences.

On the one hand, the compensation committee sets CEO incentive compensation based on the firms' expected future risks. On the other hand, CEO makes risk-taking decisions based on the incentives created by their compensation contract. To solve the potential endogeneity problem, simultaneous equations method and lag compensation incentives are used to model risky investments as affected by equity incentive compensations.

Literature Review and Research Hypotheses

Literature review

There has been extensive empirical literature on managerial incentive affecting firms' risk taking. For example, Rajgopal and Shevlin (2002) examine whether ESO provides managers with incentives to invest in risky projects using oil and gas firms on Execucomp for the period 1992-1997. They measure ESO risk incentives as Vega and the exploration risk as the coefficient of variation (CV) in expected future cash flows arising from exploration undertaken in period t+1. They use two-stage least squares to allow for the endogeneity of risk taking by managers and executive compensation decision by the compensation committee, while controlling for leverage and investment opportunity sets for exploration risk, and controlling for investment opportunity sets, Delta, size, CEO cash compensation, and cash balance for ESO Vega. They find that ESO risk taking incentives at t are significantly positively related to the level of exploration risk taken by the firm at t+1.

Coles et al. (2006) examine the causal relation among CEO Vega and riskier investment policy, riskier debt policy, and higher volatility of stock returns using CEOs identified from Execucomp using "CEOANN" supplemented by CEOs identified using "BECAMECE" for the period 1992-2002. Using simultaneous equations and three-stage-least-squares (3SLS) method, they find that higher Vega leads to higher investment in R&D expenditures, lower investment in capital expenditures, increased firm focus, higher leverage, and higher stock return volatility. In addition, Vega increases with R&D expenditures, firm focus, leverage, and stock return volatility, and decreases with capital expenditures. On the other hand, Delta decreases with R&D expenditures, firm focus, leverage, and stock return volatility, and increases with capital expenditures.

The above studies on equity-based compensation and risk taking typically focus on that equity compensation reduces agency cost of equity, and recognize that leverage affects firm risk, including it as a control variable. However, there is limited study that examines whether equity-based compensation has different impacts on firm risk for firms with different levels of leverage.

Another line of research on compensation that incorporates agency cost of debt typically focus on the design of the compensation contract (Gilson and Vetsuypens (1993), Bryan et al. (2006), Ortiz-Molina (2007)). For example, Ortiz-Molina (2007) finds that leverage affects CEO Delta using data from 1993-1999. Specifically, using median regression and two-stage least absolute deviation estimator, the author finds that Delta decreases in firms with straight debt, but is higher in firms with convertible debt. In addition, as leverage increases, CEO Delta in options decreases faster than Delta in stock. Furthermore, CEO annual compensation is affected by leverage. The fraction of annual pay in options decreases in firms with straight debt, but increases in firms with convertible debt. The author suggests that these results are consistent with the hypothesis that firms trade-off shareholders' and managers' incentive alignment in order to mitigate the conflict of interest between shareholders and bondholders. In summary, studies that incorporate agency cost of debt on compensation and risk taking relation have shown that the design of managerial compensation contracts is affected by the conflict of interest between the shareholders and bondholders, but limited research has examined how the use of equity-based compensation affects the managerial risk taking choices when there are interactions of shareholder-bondholder conflict and manger-shareholder conflict.

Hypotheses

This study investigates how compensation forms affect managerial risk taking decision when there are interactions of shareholder-bondholder conflict and manager-shareholder conflict by examining whether the impacts of options compensation on investment decisions are different for debt-financed firms relative to all-equity firms. All-equity firms only have managers and shareholders agency problem, i.e., conflict of interest between managers and shareholders. In this case, the risk-related agency problem primarily is that managers are more risk averse than shareholders. Stock options, by providing convexity to the compensation contract, provide incentives for increased managerial risk taking. For debt-financed firms, there are two possible predictions:

First, as suggested by Garvey and Mawani (2005), options-based compensation provides "homemade leverage" to managers through the adjustment of the exercise price of options. Specifically, the option exercise price can be reduced as the firm's debt ratio increases. In this way, managers are far more leveraged due to options effect than shareholders, and financial leverage will not increase managers' inclination to take on risk-increasing project. Therefore, stock options may overcome the asset substitution problem of financial leverage, which effectively reduces managerial risk taking for firms with asset substitution problem.

Second, as argued by John and John (1993), managerial compensation in a levered firm can serve as a pre-commitment device to minimize asset substitution behavior. Top management compensation should reduce the risk taking incentive of compensation contracts for firms with higher debt levels. Higher equity compensation in contracts exacerbates the asset substitution problem associated with risky debt, which increases managerial risk seeking incentives. They suggest that reducing the alignment between managers and shareholders' interest reduces managers' risk shifting behavior. Given these conflicting arguments, I do not predict the direction of managerial risk taking choices in response to CEO Vega for firms with different financial leverage. Delta increases managerial risk taking since managers that fully aligned with shareholders through stock and restricted stock holdings will have the same incentive as shareholders, i.e., exacerbating the asset substitution problem. The hypotheses about the equity-based compensation risk taking incentive effects for firms with different debt and equity structure, stated in null form, are as follows:

Hypothesis 1: Ceteris paribus, Vega has the same impact on managerial risk taking for debt-financed firms as for all equity-financed firms.

Hypothesis 2: Ceteris paribus, Delta has the same impact on managerial risk taking for debt-financed firms as for all equity-financed firms.

Methodology

Sample Selection

The samples are obtained from the Standard & Poor's Execucomp, Compustat industrial annual, and CRSP databases. The Standard & Poor's Execucomp database is used to construct the equity-based-compensation induced risk incentives. The "BECAMECE" as well as "LEFTOFC" provided by Execucomp are used to identify CEOs of firms at the end of fiscal year from 1992 to 2004, appended by "CEOANN" and DEF 14A from EDGAR on SEC website. After excluding missing values in calculating Vega and Delta, aggregating CEO multiple options grants, excluding firms in financial industries (SIC codes between 6000-6999), industries with less than five observations, and using prior year Vega and Delta for the same CEO, the sample size is reduced to 12,191 firm-year observations with 2,017 firms.

In order to test whether the equity-based compensation impact on managerial risk taking choices are different for firms with or without financial leverage, I group firms into two subgroups based on firms' debt ratios. The debt ratio is computed as firm's long-term debt divided by total assets. Firms with long-term debt ratio as zero are defined as all-equity firms.[1]

Model

The empirical analysis is based on an augmented version of the standard simultaneous equations for estimating the relation between executive compensation and managerial risk taking. The simultaneous equations are used because of potential endogeneity problem. As discussed previously, there are actions conducted by both corporate compensation committees and CEOs: the compensation committee sets CEOs incentive compensation based on the firms' expected future risks; and CEOs make risk-taking decisions based on Vega. This gives each equation a clear ceteris paribus interpretation, which makes an appropriate simultaneous equations model. Following Coles et al. (2006), I use 3SLS regression framework. In addition, to examine ESO impacts on managerial risk taking, following Broussard et al. (2004) and Rajgopal and Shevlin (2002), I focus on the Vega impact on the subsequent risky investment.

The following simultaneous equations are estimated by controlling industry and year dummies to examine whether Vega impacts on managerial risk taking are different for debt-financed relative to all-equity firms, and high debt firms relative to low debt ratio firms.

$$\text{Investment}_t = \alpha_0 + \alpha_1 \text{Vega}_{t-1} + \alpha_2 \text{Delta}_{t-1} + \alpha_3 \text{Debt dummy} + \alpha_4 \text{Debt dummy} * \text{Vega}_{t-1} + \alpha_5 \text{Debt dummy} * \text{Delta}_{t-1} + + \alpha_9 \text{controls}_t + \text{errors}_t \quad (1)$$

$$\text{Vega}_{t-1} = \beta_0 + \beta_1 \text{Investment}_t + \beta_2 \text{Delta}_{t-1} + \beta_3 \text{controls}_t + \text{errors}_t \quad (2)$$

$$Delta_{t-1} = \gamma + \gamma_1 \, Investment_t + \gamma_2 \, Vega_{t-1} + \gamma_3 \, controls_t + errors_t \quad (3)$$

where Debt dummy = 1 if a firm's long-term debt ratio is greater than zero and 0 otherwise.

The question I hope to answer is: if Vega exogenously increased by compensation committee, will that increase, on average, affect managerial risk investments similarly for all-equity firms relative to debt-financed firms? Further, will that increase, on average, affect managerial risky investments similarly for high debt firms relative to low debt firms in addition to the debt effect? If H_1 and H_2 are valid, I expect $\alpha_4 = 0$ and $\alpha_5 = 0$. However, α_4 and α_5 can be positive if Vega and Delta aggravate the asset substitution problem; or, they can be negative if Vega and Delta reduce the asset substitution problem. In addition, I expect $\beta_1 > 0$: other factors being equal, firms with higher expected risk will provide higher Vega to CEOs.

Variable definitions and measurements

Risky Investments

The dependent variable is measured using observable managerial investment decisions, R&D investments divided by firms' prior year total assets. Among the different types of firms' investments, e.g., R&D investments, advertising investments, and capital expenditures, R&D investments better proxies firms' risky investments due to the following reasons. R&D investments are longer-term horizon and riskier than advertisement investments. In addition, they have higher degree of uncertainty than the firm's capital expenditures. Unlike long-term capital expenditures, which are capitalized and expensed gradually over time, U.S. GAAP SFAS No. 2 requires that firms uniformly expense R&D expenditures and acquired in-progress R&D when incurred. This treatment is based on the presumption that the future benefits created by R&D are too uncertain to justify asset recognition. As a result, SFAS No. 2 only requires separate disclosure of R&D expenditures if the amount is significant. Kothari et al. (2002) and Shi (2003) examine the riskiness in R&D. The authors find that R&D spending has a stronger association with future earnings variability than capital expenditure, suggesting that R&D investments have greater risk than capital expenditures. Following Bizjak et al. (1993), Ryan and Wiggins (2002), and Coles et al. (2006), I set R&D equal to zero when it is missing. This is reasonable because SFAS No. 2 only requires separate disclosure of R&D expenditures if the amount is significant, and insignificant amount of R&D spending is the main reason why the data are missing for many firms.

Risk Taking Incentives

As pointed out in Core et al. (2003), a key point in analyzing executive incentives is that the equity incentives are properly measured by portfolio incentives, i.e., the holdings of common stock, restricted stock, and stock options and not the grants for a given year. In addition, as argued previously, stock options and stockholdings not only add convexity to the relation between managers' wealth and stock price, but also increase the slope of this relation. Therefore, when examines compensation incentive effects on firm's risk one should control Delta to examine Vega, and vice versa. Following Guay (1999) and Core and Guay (2002), Vega is measured as the sensitivity of the CEO's option portfolio value to a 0.01 change in the underlying stock return volatility, where the option value is the Black-Scholes value of a European call option as adjusted for dividends by Merton (1973). For previously granted options, I use the Core and Guay (2002) one-year approximation approach. The CEO Delta is estimated as the change in total CEO's wealth from a 1% change in stock price. Specifically, it is the sum of the change in the value of ESO slope incentives, the restricted stock holdings incentives, and the normal stock holdings incentives.

Control Variables

The control variables for the equations on investment decisions, Vega, and Delta mainly follow prior studies, such as Coles et al. (2006), Core and Guay (1999), and Ryan and Wiggins (2002). The control variables for risky investments include firm size, market to book, surplus cash, sales growth, stock returns, CEO tenure, CEO cash compensation, and two-digit SIC industry and year dummies. (1) Firm size. Smith and Watts (1992) argue that the larger the firm size, the greater the diversification, and consequently the lower return variance. This leads to a negative relation between firm size and firm risk. Firm size is measured as log of sales. (2) Market to book. Smith and Watts (1992) find that market to book ratio is highly correlated with firm's future growth. Firms with higher growth opportunity conduct more R&D to maintain their future growth. Therefore, market to book is predicted to have a positive relation on firm's risk. Market to book ratio is measured as market value of equity plus the book value of total assets less book value of common equity, divided by book value of total assets. (3) Surplus Cash. A large literature examines the influence of financial constraints on investment, such as Fazzari, Hubbard, and Petersen (1988), Hoshi, Kashyap, and Scharfstein (1991) and Petersen and Rajan (1994). They find that cash flows and liquidity measures are strongly related to investment. Coles et al. (2006) find that surplus cash is significantly positively related to R&D investment. Following prior studies, the level of risky investment is expected to be positively related to surplus cash. Surplus Cash is measured as net cash flow from operating activities less maintenance investment expenditure plus research and development expenditure plus advertising expense, divided by beginning of year book value. The maintenance investment expenditure is measured as amortization and depreciation. (4) Sales growth. Sales growth is expected to have a positive impact on firm's risky investment. This variable is predicted to have a positive sign. (5) CEO tenure. As the CEO's tenure increases, his control over internal monitoring increases, and he is more insulated from the threat of dismissal. As his human capital vested in the firm increases, CEO has more incentive to reduce firm specific risk. May (1995) and Berger et al. (1997) find that CEOs with longer tenure are likely to reduce firm risk. (6) CEO's cash compensation. Following Core and Guay (1999), CEO cash compensation is included to control for the level of CEOs' outside wealth, and is used to proxy for CEO's risk aversion. The higher the cash compensation, the lower the CEO's risk aversion. CEOs with high cash compensation are expected to have negative relation with firm's risk.

The control variables in determining the Vega and Delta include firm size, market to book, firm risk, leverage, CEO cash compensation, and CEO tenure. (1) Firm size is included to control for the probability of having a formal incentive compensation plan and the level and incentive sensitivity of compensation. Some previous studies argue that large firms may have greater equity compensation because (a) larger firms have higher agency costs and are harder to monitor, (b) large firms are more willing to incur the fixed administration costs of implementing sophisticated compensation plan, and (c) large firms are likely to employ more talented managers and tend to provide them with larger pay packages. Smith and Watts (1992) find that firm size and the use of incentive compensation plans are positively related. (2) Several empirical studies examine the relation between the investment opportunity sets and executive compensation policies, such as Smith and Watts (1992) and Guay (1999). Smith and Watts (1992) argue that growth firms are harder to monitor relative to firms with more asset in place, and more likely to use incentives compensation schemes. They provide evidence that firms with growth opportunities are less likely to use accounting-based bonus plans and more likely to use stock-option plans. Guay (1999) finds that cross-sectionally the Vega is positively related to firm's investment opportunities as measured by book to market ratio, R&D expenditure, and investment expenditure (the sum of capital expenditure plus acquisitions). This variable is predicted to have a positive relation with Vega and Delta. (3) Firm risk. Previous empirical studies have found conflicting results on the relation between firm risk and Delta or Vega. Demsetz and Lehn (1985) predict and find a strong positive association between firm risk and Delta. However, Aggarwal and Samwick (1999) argue that greater firm risk reduces Delta, and they find a significant negative relation between firm risk and CEO Delta. Core and Guay (2002b) argue that A&S re-documents a size effect, and they find a positive effect after choosing an appropriate proxy for firm's risk. Therefore, it is difficult to make a clear priori prediction. (4) Leverage: John and John (1993) show that shareholders optimally lower managers' Delta as leverage increases in order to reduce the expected agency costs of debt. On the other hand, Leland and Pyle (1977) find theoretical positive relationship between leverage and equity level and compensation. To the extent that leverage represents monitoring by bondholders, and as a substitute monitoring mechanism for equity-based compensation, it is expected to have a negative relation with managerial equity compensation. (5) CEO cash compensation. The higher the cash compensation, the more diversified the CEO is likely to be, and the less risk averse the CEO will be. Therefore, the compensation committee can give a more-diversified CEO lower Vega as compared to a less diversified CEO. This induces a negative relation between cash compensation and Vega. However, a positive relation is predicted if firms pay a risk premium in terms of cash compensation for CEOs with higher Vega for the retention of the CEO. Rajgopal and Shevlin (2002), Hanlon et al. (2004), and Coles et al. (2006) find that cash compensation is positively related to Vega. (6) CEO tenure. Ryan and Wiggins (2002) argue that CEO tenure proxies for CEO experience, and is more likely to influence Delta than Vega. CEOs who have held their positions longer are likely to own more shares of stock. The variable is expected to have a positive sign on Delta.

Following Guay (1999) and Coles et al. (2006), I winsorize all the variables at the 1st and 99th percentiles.

Results

Descriptive Statistics

Table 1 presents descriptive data about the risky investments, CEO compensation, firm's leverage, and other firm characteristics. Mean (median) pay-risk-incentive (Vega) is $85,499 ($30,690), mean (median) pay-performance-incentive (Delta) is $633,771 ($170,415), and mean (median) cash compensation is $1,143,403 ($853,987). These descriptive data are generally consistent with previous studies such as Coles et al. (2006). The last column of Table 1 reports the results of t-tests. These tests compare groups of firm-years with the all-equity firms versus the debt-financed firms. The CEO cash compensation and Vega are significantly lower for all-equity firms. On the other hand, Delta is significantly higher for all-equity firms. In addition, the all-equity firms have significantly higher R&D spending than debt-financed firms.

Regression Results

Table 2 shows that for all-equity firms, ESO Vega on average increases risk taking (α_1 = 0.7698, t=4.55), and Delta on average decreases risk taking (α_2 = -0.1388, t=-11.54). The coefficient α_3 on debt dummy is the difference in intercepts between all-equity firms and debt-financed firms. It has a negative sign, suggesting that even after controlling for the factors that are considered to affect the R&D expenditures, debt-financed firms invest significantly less than the all-equity firms. The coefficient on the Debt dummy * Vega$_{t-1}$ interaction term (α_4=-0.5020, t=-3.11) is significantly negative, which is consistent with Garvey and Mawani (2005)'s argument that options compensation reduces the asset substitution problems. The coefficient on the Debt dummy * Delta$_{t-1}$ interaction term (α_5=0.0963, t=8.29) is significantly positive, which suggests that by fully aligning managers' and shareholders' interests, stock based compensation aggravates asset substitution problem. The estimates are also economically significant. Based on the coefficient estimates, the effect of one standard deviation increase in Vega, holding other factors fixed, is to increase R&D intensity for all equity financed firms by about 0.121 (= 0.157*0.7698). However, the effect for debt-financed firms is relatively lower, about 0.037 (= 0.157*0.2678). On the other hand, the effect of one standard deviation increase in Delta is to decrease R&D intensity for all-equity firms by about 0.224 (= 1.615*(-0.1388)), while for debt-financed firms, the effect of one standard deviation increase in Delta is to decrease R&D intensity by about 0.068 (= 1.615*(-0.0425)). In terms of the control variable, the results are similar to previous studies, e.g., surplus cash, market to book ratio, and CEO tenure positively affect R&D investment, while cash compensation, size, and stock return negative affect R&D investments. For the determinants of CEO Vega and Delta, the results show that for firms with high R&D, CEOs are given higher Vega (β_1 = 0.7412, t=18.94) and lower Delta (γ_1 =-10.4066, t=-23.08).

The usage of convertible debt

Green (1984) and John and John (1993) argue that convertible debt can be used to mitigate asset substitution problems because the benefits of increasing volatility accrue to the convertible bondholders who are not managers. If firms use convertible debt to reduce the agency cost of debt, options-based compensation may not have different impacts on firms with or without financial leverage. In order to investigate this issue, I separate the firm's debt into convertible debt and straight debt, and conduct the following two tests. First, the sample is separated into two subsamples: firms with convertible debt (convertible debt/total assets is greater than zero), and firms without convertible debt

Table 1. Descriptive statistics

Variables	Mean	StdD	25th pct	50th pct	75th pct	Mean difference (p-value, two-tailed) for all equity- (n=1,527) vs. debt-financed firms (n=10,664)
$Vega_{t-1}$	85	157	10	31	84	-25 (0.00)
$Delta_{t-1}$	634	1615	63	170	479	295 (0.00)
Cash compensation	1143	944	527	854	1429	-437 (0.00)
Tenure (years)	8	7	3	5	11	1.587 (0.00)
RD	0.035	0.066	0.000	0.000	0.042	0.049 (0.00)
Debt ratio	0.201	0.164	0.049	0.190	0.307	-0.230 (0.00)
Sales	3,528	6,918		1,056	3,103	-3,066 (0.00)
Sales growth	0.151	0.313	0.009	0.091	0.216	0.026 (0.00)
Surplus cash	0.097	0.113	0.030	0.075	0.145	0.088 (0.00)
Stock return	19.170	57.367	-13.615	11.244	38.286	10.321 (0.00)
Firm risk (stock return volatility)	0.420	0.200	0.280	0.370	0.520	0.163 (0.00)
Market to book	2.090	1.506	1.206	1.583	2.337	1.340 (0.00)

Note: The samples are obtained from the Execucomp, Compustat industrial annual, and CRSP databases. The sample 12,191 firm-year observations are for the first sets of regressions. It includes 2,017 sample firms. All the variables are winsorized at the 1st and 99th percentiles to reduce the influence of outliers. CEO Vega is measured as the sensitivity of the CEO's option portfolio value to a 1% change in the underlying stock return volatility, where the option value is the Black-Scholes value of a European call option as adjusted for dividends by Merton (1973). CEO Delta is the change in total CEO wealth from a 1% change in stock price, where total CEO wealth is the sum of change in the value of ESO slope incentives, the restricted stock holding incentives, and the normal stock holdings incentives. RD is R&D expenditures scaled by the firm's average total assets. CAPX is capital expenditure plus acquisitions less sale of PPE scaled by the firm's average total assets. Firm Size is defined as logarithm of sales. Sales growth is the log of sales to prior-year sales ratio. Surplus cash is net cash flow from operating activities less maintenance investment expenditure plus research and development expenditure plus advertising expense, divided by beginning of year book value of total assets. Stock return is one year total return to shareholders, including the monthly reinvestment of dividends. For firms available on ExecuComp, firm risk is measured as bs_volat. When firm's bs_volat is not available on ExecuComp, it is calculated as annualized standard deviation of daily stock returns using the CRSP database. Firm's market to book ratio is measured as the market value of equity plus the book value of total asset less book value of common equity, divided by book value of total asset. CEO tenure is the number of years the CEO has become CEO. CEO cash compensation is the logarithm of salary plus bonus from ExecuComp. All-equity firms are defined as firms with zero debt ratio (Compustat data9/data6); otherwise defined as debt-financed firms.

Table 2 Simultaneous equation regressions of risky investment intensity on interactive variables between lag CEO compensation incentive and debt-financed vs. all-equity firms

Independent variable	R&D	CEO Vega	CEO Delta
CEO Vega $_{t-1}$	0.7698*** (4.55)		4.9655*** (53.68)
CEO Delta $_{t-1}$	-0.1388*** (-11.54)	0.0451*** (52.24)	
Debt dummy	-0.0550*** (-5.05)		
Debt dummy X CEO Vega $_{t-1}$	-0.5020*** (-3.11)		
Debt dummy X CEO Delta $_{t-1}$	0.0963*** (8.29)		
Tenure	0.0019*** (10.97)		0.0394*** (23.33)
Cash compensation	-0.0092*** (-5.94)	0.0510** (32.76)	
Size	-0.0030** (-1.97)	0.0223*** (20.22)	-0.0183* (1.67)
Market to book	0.0280*** (18.56)	-0.0113*** (-11.04)	0.3102*** (29.27)
Surplus cash	0.1508*** (14.09)		1.3782*** (9.26)
Sales growth	-0.0005 (-0.16)		
Stock return	-0.0002*** (-7.52)		
Debt ratio		0.0477** (6.15)	-0.4949*** (-6.37)
R&D		0.7412*** (18.94)	-10.4066*** (-23.08)
Capital expenditure		-0.0438*** (-3.34)	0.3252*** (2.50)
Firm risk		0.0251** (3.48)	0.8942*** (11.80)
2-digit SIC and year dummies	yes	yes	yes
Observations	12,191	12,191	12,191

Note: The following simultaneous regressions are estimated using 3SLS:

$$\text{Investment}_t = \alpha_0 + \alpha_1 \text{Vega}_{t-1} + \alpha_2 \text{Delta}_{t-1} + \alpha_3 \text{Debt dummy} + \alpha_4 \text{Debt dummy} * \text{Vega}_{t-1} + \alpha_5 \text{Debt dummy} * \text{Delta}_{t-1} + \alpha_9 \text{controls}_t + \text{errors}_t \quad (1)$$

$$\text{Vega}_{t-1} = \beta_0 + \beta_1 \text{Investment}_t + \beta_2 \text{Delta}_{t-1} + \beta_3 \text{controls}_t + \text{errors}_t \quad (2)$$

$$\text{Delta}_{t-1} = \gamma + \gamma_1 \text{Investment}_t + \gamma_2 \text{Vega}_{t-1} + \gamma_3 \text{controls}_t + \text{errors}_t \quad (3)$$

Data definitions please refer to Table 1. Debt dummy = 1 if a firm's debt ratio greater than zero, and 0 otherwise. The t statistics are in parenthesis. ***/**/* denote the significance at the 0.01/0.05/0.10 level.

(convertible debt/total assets equals to zero). For firms with convertible debt, since the agency cost of debt has been mitigated, Vega is expected to have same impacts on managerial risk taking choices for debt financed firms relative to all-equity firms. On the other hand, for firms without convertible debt, Vega is expected to have differential managerial risk taking. Second, I include an additional control variable, the proportion of convertible debt as a percentage of total long-term debt, in the simultaneous estimation equations to control for the nature of the debt. Table 3 provides the results for regressions for all-equity firms relative to straight-debt only firms, and all-equity firms relative to firms with convertible debts. Table 3.A shows that the coefficients on the interaction of low and high straight debt dummy and Vega are both significantly negative, while Table 3.B shows that the interaction of the low and high convertible debt dummy and Vega are statistically insignificant. The results are consistent with the prediction that convertible debt can be used as a mechanism to control for the asset substitution problem. In addition, Unreported results show that after controlling for the convertible debt variable the main results do not change.

Conclusion

This study investigates the influence of equity-based compensation on managerial risk taking choices for firms with and without financial leverage. Using the Standard & Poor's Execucomp, Compustat industrial annual, and CRSP data over the period 1992-2004, I find that ESO Vega impact on firm risk is lower for firms with debt- financed relative to all-equity firms. Additional tests show that the results are robust to alternative specifications. This is consistent with the hypothesis that equity-based compensation is used to incorporate the interests of bondholders with those of managers and shareholders in terms of managerial risk taking choices.

Previous studies on the relation between executive compensation and managerial risk taking mainly focus on the shareholders' and managers' conflict of interests. In addition, previous studies find that agency cost of debt affect the design of executive compensation. This study extends the literature by examining whether the impact of executive compensation and managerial risk taking are different when there are interactions of shareholder-bondholder conflict and manager-shareholder conflict. Using simultaneous equation model, the study find that Vega has a lower impact on managerial risk taking for debt-financed firms than equity-financed firms, while Delta has a higher impact on managerial risk taking for debt-financed firms than equity-financed firms. This study expands our understanding of the topic by providing evidence of the effectiveness of the managerial incentives in risk taking decisions for firms with and without financial leverage. Since samples are based on Compustat ExecuComp, the results of the study may be limited to S&P 1,500 firms. Further research can replicate the study by manually collecting executive compensation for firms beyond S&P 1,500 firms and examine any change in results. In addition, future research can investigate the relation between executive compensation and managerial risk taking for firms with high bankruptcy risk, an extreme case of agency cost of debt, and examine any change in results.

Table 3 Simultaneous equation regressions of risky investment intensity on interactive variables for all equity firms relative to debt firms by straight debt and convertible debt

	Panel A: All-equity firms relative to straight debt firms			Panel B: All-equity firms relative to convertible debt firms		
Dependent variable	R&D	CEO Vega	CEO Delta	R&D	CEO Vega	CEO Delta
CEO Vega$_{t-1}$	0.7449*** (5.69)		4.6201*** (42.96)	0.2381*** (3.36)		5.1355*** (25.67)
CEO Delta $_{t-1}$	-0.1122*** (-10.89)	0.0389*** (41.61)		-0.0240*** (-7.36)	0.0530*** (27.18)	
D1	-0.0382*** (-4.00)			0.0018 (0.28)		
D1 X CEO Vega$_{t-1}$	-0.4818*** (-3.92)			-0.0757 (-1.28)		
D1 X CEO Delta$_{t-1}$	0.0718*** (7.29)			0.0133*** (3.91)		
D2	-0.0535*** (-6.16)			0.0218*** (3.91)		
D2 X CEO Vega$_{t-1}$	-0.4845*** (-3.96)			-0.0917 (-1.38)		
D2 X CEO Delta$_{t-1}$	0.0747** (7.39)			0.0106*** (3.29)		
Tenure	0.0018*** (10.08)		0.0410*** (21.91)	-0.0005*** (-3.57)		0.0303*** (9.64)
Cash compensation	-0.0108*** (-6.80)	0.0538*** (31.87)		-0.0045*** (-2.48)	0.0479*** (15.15)	
Size	-0.0013** (-0.79)	0.0215*** (17.80)	0.0227* (1.84)	-0.0168*** (-9.57)	0.0246*** (11.05)	0.0455** (1.92)
Market to book	0.0229*** (15.62)	-0.0080*** (-7.65)	0.2964*** (26.01)	0.0150*** (12.63)	-0.0157*** (-9.81)	0.2760*** (16.46)
Surplus cash	0.1524*** (14.38)		1.6768*** (10.18)	0.1415*** (13.17)		0.7391*** (2.95)
Sales growth	0.0108*** (3.63)			-0.0006 (-0.19)		
Stock return	-0.0001*** (-6.44)			-0.0002*** (-7.26)		
Debt ratio		0.0588*** (6.51)	-0.9365*** (-9.68)		0.0333* (1.73)	-0.6366*** (-2.92)
Convertible debt / total assets					-0.0500 (-1.60)	1.0200*** (2.97)
R&D		0.6660*** (15.95)	-11.1729*** (-22.22)		0.8045*** (13.62)	-6.6863*** (-8.93)
Capital expenditure		-0.0467*** (-3.70)	0.3508*** (2.72)		-0.0264 (-1.08)	0.3142 (1.14)
Firm risk		0.0409*** (5.32)	0.8404*** (10.03)		0.0214 (1.61)	0.5908*** (3.90)
Firm risk dummy	-0.0099*** (-3.45)			-0.0225*** (-5.31)		
Firm risk dummy X Vega $_{t-1}$	-0.0084 (-0.57)			0.0252 (1.17)		
2-digit SIC and year control	yes	yes	yes	yes	yes	yes
Observations	10,237	10,237	10,237	3,469	3,469	3,469

Footnote

1 There are 1,579 firm-year observations with debt ratio equals to zero, and 1,771 firm-year observations with long-term debt less than 0.1 percent of total assets. I choose debt ratio equals to zero as all-equity firms. The main results for defining all equity-financed firms as less than 0.1% debt ratios are similar. I also use long term debt + current portion of long-term debt) / total assets, or (*Compustat* item (data9+data44) / data6 to check robustness, and obtain similar results.

Table 3 - Notes

Notes: The following simultaneous regressions are estimated using 3SLS after controlling for industry and year dummies.

$$\begin{aligned}\text{Investment}_t =\ & \alpha_0 + \alpha_1 \text{Vega}_{t-1} + \alpha_2 \text{Delta}_{t-1}\\ &+ \alpha_3 \text{D1 (Debt Lo or Convertible debt Lo)}\\ &+ \alpha_4 \text{D1 (Debt Lo or Convertible debt Lo)* Vega}_{t-1}\\ &+ \alpha_5 \text{D1 (Debt Lo or Convertible debt Lo)* Delta}_{t-1}\\ &+ \alpha_6 \text{D2 (Debt Hi or Convertible debt Hi)}\\ &+ \alpha_7 \text{D2 (Debt Hi or Convertible debt Hi)* Vega}_{t-1}\\ &+ \alpha_8 \text{D2 (Debt Hi or Convertible debt Hi)* Delta}_{t-1}\\ &+ \alpha_9 \text{controls}_t + \text{errors}_t \qquad (4)\end{aligned}$$

$$\text{Vega}_{t-1} = \beta_0 + \beta_1 \text{Investment}_t + \beta_2 \text{Delta}_{t-1} + \beta_3 \text{controls}_t + \text{errors}_t \qquad (5)$$

$$\text{Delta}_{t-1} = \gamma + \gamma_1 \text{Investment}_t + \gamma_2 \text{Delta}_{t-1} + \gamma_3 \text{controls}_t + \text{errors}_t \qquad (6)$$

Data definitions please refer to Table 1. Debt Lo = 1 if a firm's debt ratio greater than 0 and less than the median debt ratio of all sample; Debt Hi = 1 if a firm's debt ratio greater than median debt ratio of all sample. Convertible debt Lo = 1 if a firm's convertible debt / long-term debt ratio is greater than zero and less than the median of the sample, and 0 otherwise; Convertible debt Hi = 1 if convertible debt / long-term debt ratio is greater than the median of the sample, and 0 otherwise. The t statistics are in parenthesis. ***/**/* denote the significance at the 0.01/0.05/0.10 level.

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