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# The Effect of Executive Stock Option Grants on Financing Decisions*

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## 1 Introduction

In this paper we consider the capital structure of a firm with stock option grants as managerial compensation in real options framework. Murphy (1999) suggests the equity-based pay represents a significant proportion of executive compensation. The equity-based ownership can potentially align the interests between shareholders and managers and thus mitigate the agency problems due to the separation of ownership and control. We focus on pay-performance sensitivity (PPS), that is, the sensitivity of changes in CEO wealth to changes in shareholder one, and discuss about the stock option grants and the capital structure.

Ortiz-Molina (2007) provides empirical evidences on the relationship between the CEO compensation and firms' capital structures by the PPS through two channels. First, the agency cost of equity hypothesis suggests since debt mitigates shareholder-manager agency problems, more levered firms have lower PPS. Secondly, the agency cost of debt hypothesis suggests managerial incentives are driven by the need to mitigate not only shareholder-manager but also shareholder-bondholder conflicts of interest. The implication of this hypothesis is a negative association between the PPS and the financial leverage. Furthermore, he finds that the fraction of annual pay in the form of stock option grants decreases in the amount of straight debt. Also, John and John (1999) provide negative relationship between PPS and leverage.

There are some empirical evidences on the relationship between executive stock option and firms' capital structures. Lewellen et al. (1987), Berger et al. (1997) and Dong et al. (2010) find a positive effect of leverage on stock option grants. On the other hand, John and John (1993), Bryan et al. (2000) and Ryan and Wiggins (2001) find a negative effect of the leverage on the stock option grants. The evidence from these studies relating financial leverage and executive pay is mixed and difficult to interpret. Moreover, Hall and Liebman (1998) provide empirical evidences on the relationship between the PPS and the executive stock option that the PPS in managerial compensation contracts increases significantly in the 1990s primarily due to a dramatic increase in the use of stock options.

Recently, the interaction among firm's capital structure, managerial compensation and investment under uncertainty by means of real options framework has been studied in Lambrecht and Myers (2008), Andrikopoulos (2009), Henderson (2010), Shibata and Nishihara (2010),

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Kanagaretnam and Sarkar (2011), etc.. However, in these previous works, the managerial compensation and the PPS of firms with the stock option grants has not been taken into account. We extend a model in Kanagaretnam and Sarkar (2011) by incorporating the stock option grants.

In this study, we propose a theoretical model regarding the managerial compensation of firms with stock options grants. We investigate how the stock option grants and the leverage affect the PPS, and discuss the some consistencies of our theoretical model about the PPS with empirical evidences in Ortiz-Molina (2007) and John and John (1999). Furthermore, we explore the effect of the stock option grants on the agency costs between equity holders and managers, and the relation between the stock option grants and the leverage for the optimal capital structure.

The remainder of this paper is organized as follows. Section 2 describes the model. In Section 3, we derive the numerical results and provide some discussion of the numerical analysis. Section 4 summarizes this paper and gives some concluding remarks.

## 2 Model

We consider a firm with a single perpetual project, which issues equity and debt, and use a standard contingent claim structural model with an endogenous default strategy. We suppose that the firm determines the optimal strategies, observing a demand shock $X_t$ given by a geometric Brownian motion

$$dX_t = \mu X_t dt + \sigma X_t dW_t, \quad X_0 = x, \tag{2.1}$$

where $\mu$ and $\sigma$ are the risk-adjusted expected growth rate and the volatility of $X_t$, respectively, and $W_t$ is a standard Brownian motion defined on a probability space $(\Omega, \mathcal{F}, \mathbb{P})$. We assume that all agents are risk-neutral and discount their future payoffs at a rate $r(> \mu)$.

We consider the firm with stock option grants in a managerial compensation. We assume that the manager has the compensation package consists of a salary, a severance pay at default, and stocks and stock options ownership. We suppose that the manager can receive a constant salary of $f$ prior to default. At default, the manager receives a severance pay of $nf$ $(n > 1)$. The manager's stock ownership is a fraction $\delta_s$ of the total equity of the company. Let $\delta_o$ be the shareholding ratio issued for the original equity at exercise of the stock option and $K$ be the exercise price for the stock option. We define that $K$ is equal to the shareholding ratio $\delta_o$ issued at exercise of the stock option of the equity value at grant time of stock option.

We suppose the stock price movement at exercise of the stock option follows Galai and Schneller (1978) and Noreen and Wolfson (1981). Once the manager exercises the stock option, the manager pays the exercise price $K$ and then can receive the stocks. The equity value will rise by $K$ and will be diluted to $\frac{1}{1+\delta_o}$. When the manager exercises the stock option, he can receive a fraction $\frac{\delta_o}{1+\delta_o}$ of the original equity. Since the price of the existing shareholding is also diluted, the manager holds a fraction $\frac{\delta_s+\delta_o}{1+\delta_o}$ of equity after exercise.

We assume that the debt holders can receive the coupon payment $c$ per unit of time and the equity holders can receive the instantaneous profit

$$\pi(X_t) = (1 - \tau)(QX_t - c - f), \tag{2.2}$$

where $\tau$ is a constant corporate tax rate and $Q$ is the quantity produced from the asset in place. Letting $\epsilon(X_t)$ be the expected value of the perpetual benefit given by

$$\epsilon(X_t) = \frac{1-\tau}{r-\mu} Q X_t \tag{2.3}$$

and $\theta$ be the proportional bankruptcy cost, the debt holders can receive $(1-\theta)\epsilon(X_t)$ at default time $t$.

The optimal default policy of the equity holders selects the optimal default time, maximizing the equity value. Furthermore, the optimal exercise policy of the manager selects the optimal exercise time, maximizing the manager's value. The optimal problems for the equity holders and the manager must be solved simultaneously. First, we present the formulations for the values of the equity, the debt and the manager before exercise of the stock option. After that, we consider the values after exercise.

## 2.1 Before exercise of the stock option

In this section, we examine the equity value, the debt value and the manager's value before exercise of the stock option. When the demand level $X_t$ becomes lower, the default occurs. On the other hand, when the demand level $X_t$ becomes higher, then the manager exercises the stock option. Since the equity values before and after exercise are different, the optimal default strategies before and after exercise are also different. Denoting $E(X_t)$ as the total value of the equity at time $t$, $D(X_t)$ as the value of the debt at time $t$, $M(X_t)$ as the manager's value before exercise, $x_d$ as the optimal default threshold before exercise and $x_e$ as the optimal exercise threshold, the equity value, the debt value and the manager's value before exercise satisfy

$$\frac{1}{2}\sigma^2 x^2 \frac{d^2 E}{dx^2} + \mu x \frac{dE}{dx} - rE + (1-\tau)(Qx - c - f) = 0, \tag{2.4}$$
$$\frac{1}{2}\sigma^2 x^2 \frac{d^2 D}{dx^2} + \mu x \frac{dD}{dx} - rD + c = 0, \tag{2.5}$$
$$\frac{1}{2}\sigma^2 x^2 \frac{d^2 M}{dx^2} + \mu x \frac{dM}{dx} - rM + f + \delta_s(1-\tau)(Qx - c - f) = 0 \tag{2.6}$$

for $x_d < x < x_e$. The value matching conditions of the equity value, the debt value and the manager's value at the optimal default threshold $x_d$ and the optimal exercise threshold $x_e$ are given by

$$\begin{cases} E(x_d) &= 0 \\ D(x_d) &= (1-\theta)\epsilon(x_d) \\ M(x_d) &= nf \\ E(x_e) &= E_a(x_e) \\ D(x_e) &= D_a(x_e) \\ M(x_e) &= M_a(x_e) - \delta_o E(x_0), \end{cases} \tag{2.7}$$

where $E_a(X_t)$, $D_a(X_t)$ and $M_a(X_t)$ are the equity value, the debt value and the manager's value after exercise at time $t$ and $E(x_0)$ is the equity value at grant time of the stock option

$(x_d < x_0 < x_e)$ . Then, we can obtain the following value functions:

$$
\begin{aligned}
E(x) &= (1-\tau)\left(\frac{Qx}{r-\mu}-\frac{c+f}{r}\right) \\
&+\left\{E_a(x_e)-(1-\tau)\left(\frac{Qx_e}{r-\mu}-\frac{c+f}{r}\right)\right\}p_1(x;x_e,x_d) \\
&-(1-\tau)\left(\frac{Qx_d}{r-\mu}-\frac{c+f}{r}\right)p_2(x;x_e,x_d), \qquad (2.8)\\
D(x) &= \frac{c}{r}+\left(D_a(x_e)-\frac{c}{r}\right)p_1(x;x_e,x_d)+\left((1-\theta)(1-\tau)\frac{Qx_d}{r-\mu}-\frac{c}{r}\right)p_2(x;x_e,x_d), \qquad (2.9)\\
M(x) &= \frac{f}{r}+\delta_s(1-\tau)\left(\frac{Qx}{r-\mu}-\frac{c+f}{r}\right) \\
&+\left\{M_a(x_e)-\delta_o E(x_0)-\left(\frac{f}{r}+\delta_s(1-\tau)\left(\frac{Qx_e}{r-\mu}-\frac{c+f}{r}\right)\right)\right\}p_1(x;x_e,x_d) \\
&+\left\{nf-\left(\frac{f}{r}+\delta_s(1-\tau)\left(\frac{Qx_d}{r-\mu}-\frac{c+f}{r}\right)\right)\right\}p_2(x;x_e,x_d). \qquad (2.10)
\end{aligned}
$$

where $p_1(x;x_e,x_d)$ and $p_2(x;x_e,x_d)$ are

$$
\begin{aligned}
p_1(x;x_e,x_d) &= \frac{x^{\beta_1}x_d^{\beta_2}-x^{\beta_2}x_d^{\beta_1}}{x_e^{\beta_1}x_d^{\beta_2}-x_e^{\beta_2}x_d^{\beta_1}}, \qquad (2.11)\\
p_2(x;x_e,x_d) &= \frac{x_e^{\beta_1}x^{\beta_2}-x_e^{\beta_2}x^{\beta_1}}{x_e^{\beta_1}x_d^{\beta_2}-x_e^{\beta_2}x_d^{\beta_1}}. \qquad (2.12)
\end{aligned}
$$

and $\beta_1=\frac{1}{2}-\frac{\mu}{\sigma^2}+\sqrt{\left(\frac{1}{2}-\frac{\mu}{\sigma^2}\right)^2+\frac{2r}{\sigma^2}}>1$ and $\beta_2=\frac{1}{2}-\frac{\mu}{\sigma^2}-\sqrt{\left(\frac{1}{2}-\frac{\mu}{\sigma^2}\right)^2+\frac{2r}{\sigma^2}}<0$.

The optimal default threshold is determined by the smooth-pasting condition of the equity value at the default threshold. Moreover, the exercise threshold is determined from the smooth-pasting condition of the manager's value at the exercise threshold. Since the optimal default and exercise thresholds cannot be solved analytically, these must be solved numerically.

## 2.2 After exercise of the stock option

In this section, we examine the equity value, the debt value and the manager's value after exercise of the stock option. When the manager exercises the stock option, the manager pays the exercise price and then he can receive the stocks. The equity value will rise by the exercise price $\delta_o E(x_0)$ and will diluted to $\frac{1}{1+\delta_o}$. We define $E_b(x)$ as the difference between the equity value after exercise and the increased equity value at exercise:

$$E_b(x)\equiv E_a(x)-\frac{\delta_o}{1+\delta_o}E(x_0). \qquad (2.13)$$

Similarly, since the manager holds a fraction $(\delta_s+\delta_o)$ of the equity after exercise, we define $M_b(x)$ as follows:

$$M_b(x)\equiv M_a(x)-(\delta_s+\delta_o)\frac{\delta_o}{1+\delta_o}E(x_0), \qquad (2.14)$$

Denoting $x_d^a$ as the optimal default threshold after exercise, the values $E_b(x)$, $D_a(x)$ and $M_b(x)$ satisfy the ordinary differential equations

$$\frac{1}{2}\sigma^2x^2\frac{d^2E_b}{dx^2}+\mu x\frac{dE_b}{dx}-rE_b+\frac{1}{1+\delta_o}(1-\tau)(Qx-c-f)=0, \tag{2.15}$$

$$\frac{1}{2}\sigma^2x^2\frac{d^2D_a}{dx^2}+\mu x\frac{dD_a}{dx}-rD_a+c=0, \tag{2.16}$$

$$\frac{1}{2}\sigma^2x^2\frac{d^2M_b}{dx^2}+\mu x\frac{dM_b}{dx}-rM_b+f+\frac{\delta_s+\delta_o}{1+\delta_o}(1-\tau)(Qx-c-f)=0 \tag{2.17}$$

for $x > x_d^a$. The value matching conditions of the equity value, the debt value and the manager's value at the optimal default threshold after exercise $x_d^a$ are given by

$$\begin{cases} E_a(x_d^a) &= 0, \\ D_a(x_d^a) &= (1-\theta)\epsilon(x_d^a), \\ M_a(x_d^a) &= nf. \end{cases} \tag{2.18}$$

Thus,

$$\begin{cases} E_b(x_d^a) &= -\dfrac{\delta_o}{1+\delta_o}E(x_0), \\ M_b(x_d^a) &= nf-(\delta_s+\delta_o)\dfrac{\delta_o}{1+\delta_o}E(x_0). \end{cases} \tag{2.19}$$

Since the smooth-pasting conditions of the equity value at the default threshold is given by

$$\frac{dE_a}{dx}(x_d^a)=0,\ \frac{dE_b}{dx}(x_d^a)=0, \tag{2.20}$$

we obtain the following value functions:

$$\begin{aligned} E_a(x) &= \frac{1}{1+\delta_o}\left\{(1-\tau)\left(\frac{Qx}{r-\mu}-\frac{c+f}{r}\right)+\delta_oE(x_0)\right. \\ &\quad \left.-\left((1-\tau)\left(\frac{Qx_d^a}{r-\mu}-\frac{c+f}{r}\right)+\delta_oE(x_0)\right)\left(\frac{x}{x_d^a}\right)^{\beta_2}\right\}, \end{aligned} \tag{2.21}$$

$$D_a(x) = \frac{c}{r}+\left((1-\theta)(1-\tau)\frac{Qx_d^a}{r-\mu}-\frac{c}{r}\right)\left(\frac{x}{x_d^a}\right)^{\beta_2}, \tag{2.22}$$

$$\begin{aligned} M_a(x) &= \frac{f}{r}+\frac{\delta_s+\delta_o}{1+\delta_o}\left((1-\tau)\left(\frac{Qx}{r-\mu}-\frac{c+f}{r}\right)+\delta_oE(x_0)\right) \\ &\quad +\left\{nf-\frac{f}{r}-\frac{\delta_s+\delta_o}{1+\delta_o}\left((1-\tau)\left(\frac{Qx_d^a}{r-\mu}-\frac{c+f}{r}\right)+\delta_oE(x_0)\right)\right\}\left(\frac{x}{x_d^a}\right)^{\beta_2} \end{aligned} \tag{2.23}$$

and the optimal default threshold after exercise:

$$x_d^a=\frac{\beta_2}{\beta_2-1}\frac{r-\mu}{(1-\tau)Q}\left((1-\tau)\frac{c+f}{r}-\delta_oE(x_0)\right). \tag{2.24}$$

The value functions and the default threshold after exercise include the equity value before exercise. Hence, these must be also solved numerically.

### 2.3 Constraint conditions

We consider two cases about the leverage in order to investigate the relationship between the stock option grants and the capital structure.

In the first case, we suppose that the financial leverage is fixed. Since the sum of the equity value and the debt value gives the firm value:

$$V(x) = E(x) + D(x), \tag{2.25}$$

the leverage ratio $l$ is given by

$$l = \frac{D(x)}{V(x)}. \tag{2.26}$$

Here, we present the important factor in this paper, the PPS, that is, the sensitivity of changes in the CEO wealth to changes in the shareholder one. The PPS is given by

$$\frac{dM(x)}{dE(x)} = \frac{\frac{dM}{dx}(x)}{\frac{dE}{dx}(x)}. \tag{2.27}$$

We analyze the PPS by fixing leverage ratio $l$.

Furthermore, in order to analyze the agency cost between the equity holders and the manager, we consider the another default policy. It selects the optimal default time, maximizing the manager's value. Then, we use the following smooth-pasting conditions at default.

$$\frac{dM}{dx}(x_d) = 0, \quad \frac{dM_a}{dx}(x_d^a) = 0 \tag{2.28}$$

Let $V^E(x)$ and $V^M(x)$ be the firm value on the equity value and the manager's value maximization at default, respectively. Then, the agency cost between the equity holders and the manager $AC(x)$ is given by

$$AC(x) = \frac{V^E(x) - V^M(x)}{V^E(x)}. \tag{2.29}$$

In the second case, we consider the optimal capital structure. It selects the optimal coupon payment, maximizing the firm value:

$$c^*(x) = \arg\max_{c>0} V(x; c). \tag{2.30}$$

We explore the optimal leverage, the PPS, the optimal default and exercise thresholds, the equity value, the debt value and the manager's value for the optimal capital structure.

## 3 Numerical Analysis

In this section, we present the calculation results in order to examine the relationship between the leverage and the PPS and investigate how the stock option grants affect the financial decision for the optimal capital structure. We use the following base parameters: $Q = 1$, $\mu = 0$, $\sigma = 0.2$, $r = 0.05$, $\theta = 0.3$, $\tau = 0.3$, $f = 0.01$, $\delta_s = 0.05$, $\delta_o = 0.05$, $n = 25$ and $x = 1.0$.

Table 1 represents the PPS for the leverage ratio $l$ and the shareholding ratio issued at exercise of the stock option $\delta_o$ when the leverage ratio is fixed. It can been seen that the stock option grants increase the PPS. Since the increase of the equity value leads to that of the value of the stock option, the value of the manager who holds the stock option increases. Thus, As $\delta_o$ increases, the PPS also increases. This result is consistent with empirical evidences in Hall and Liebman (1998). Also, the PPS decreases in the leverage ratio. This is because the debt mitigates the shareholder-manager agency problems and is consistent with results in Ortiz-Molina (2007) that provides a negative association between the PPS and the financial leverage.

Table 1: The effect of the stock option grants and the leverage ratio on the PPS : the fixed leverage ratio

| $l$ | $\delta_o = 0.00$ | $\delta_o = 0.01$ | $\delta_o = 0.05$ |
|---|---|---|---|
| 0.2 | 0.04844 | 0.05329 | 0.07244 |
| 0.4 | 0.04653 | 0.05145 | 0.07088 |
| 0.6 | 0.03615 | 0.04232 | 0.06657 |
| 0.8 | 0.03615 | 0.04232 | 0.06657 |

Table 2 represents the agency cost between the equity holders and the manager for the shareholding ratio issued at exercise of the stock option $\delta_o$. We have shown in this table that the stock option grants decrease the agency cost between the equity holders and the manager. This implies that the stock option grants can align the interests between shareholders and managers.

Table 2: The Agency cost between the equity holders and the manager : the fixed leverage ratio

| $\delta_o$ | $V^E(x)$ | $V^M(x)$ | $V^E(x) - V^M(x)$ | $AC(x)$ |
|---|---|---|---|---|
| 0.00 | 14.144 | 13.796 | 0.348 | 0.025 |
| 0.01 | 14.110 | 13.783 | 0.327 | 0.023 |
| 0.02 | 14.077 | 13.767 | 0.310 | 0.022 |
| 0.03 | 14.044 | 13.748 | 0.297 | 0.021 |
| 0.04 | 14.012 | 13.727 | 0.285 | 0.020 |
| 0.05 | 13.981 | 13.706 | 0.275 | 0.020 |

Table 3 represents the calculation results for the optimal capital structure. We can obtain that the stock option grants do not affect the optimal coupon payment. When the shareholding ratio issued at exercise of the stock option is higher, the PPS and the optimal leverage ratio are also higher. This result for the leverage ratio is consistent with result in Lewellen et al. (1987) and Berger et al. (1997), etc. that find a positive effect of the leverage on the stock option grants. Before exercise of the stock options, default occurs earlier in the firm with the stock option grants relative to that without the grants from the possibility of dilution. On the other hand, after exercise, the possibility of default decreases since the more wealth transfer from the manager to the shareholders occurs when $\delta_o$ is higher. When the stock option grants increase, the manager exercises earlier from increase of the shareholding ratio. When the stock option grants is higher, the equity value and the debt value are lower and the manager's value is higher. This result related to the debt is consistent with the empirical evidence in Ortiz-Molina (2007) that finds a negative association of the stock option grants and the amount of the debt.

Table 3: The effect of the stock option grants on the optimal coupon payment, the PPS, the optimal leverage ratio, the optimal default and exercise thresholds, the equity value, the debt value and the manager's value: the optimal capital structure

| $\delta_o$ | $c^*$ | PPS | $D(x)/V(x)$ | $x_d$ | $x_d^a$ | $x_e$ | $E(x)$ | $D(x)$ | $M(x)$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.735 | 0.04101 | 0.68906 | 0.42129 | - | - | 4.88082 | 10.81601 | 1.33589 |
| 0.01 | 0.735 | 0.04642 | 0.69031 | 0.42182 | 0.41943 | 1.93081 | 4.85153 | 10.81408 | 1.36187 |
| 0.03 | 0.734 | 0.05718 | 0.69220 | 0.42232 | 0.41523 | 1.92573 | 4.80317 | 10.80153 | 1.41289 |
| 0.05 | 0.734 | 0.06784 | 0.69460 | 0.42334 | 0.41165 | 1.92095 | 4.74772 | 10.79798 | 1.46195 |

# 4 Conclusions

In this paper, we propose the theoretical model regarding the managerial compensation of the firm with the stock option grants. We show that the PPS decreases in the leverage ratio. This result is consistent with empirical evidences in Ortiz-Molina (2007) and John and John (1999). Furthermore, the stock option grants increase the PPS. This is consistent with results in Hall and Liebman (1998). Also, we show that the stock option grants decrease the agency cost between the equity holders and the manager. For the optimal capital structure, we obtain a positive effect of the leverage on the stock option grants. This is consistent with results in Lewellen et al. (1987) and Berger et al. (1997), etc.. Before exercise, default occurs earlier in the firm with the stock option grants relative to that without the grants. On the other hand, after exercise, the possibility of default decreases. Moreover, the manager exercises earlier when the stock option grants increase. The stock option grants decrease the debt value. This result is consistent with empirical evidences in Ortiz-Molina (2007). In future work, we'd like to analyze the credit spread and the relation between the stock option grants and the investment.

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