High powered Incentives and Fraudulent Behavior: Stock based versus Stock Option based Compensation

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Abstract. In this paper shareholders face the trade-off between providing managers with incentives to exert beneficial effort and to engage in costly fraudulent activity. We solve for the optimal compensation package, given that shareholders can either grant (restricted) stock or stock options and given fixed average compensation costs. We show that if the negative effect of fraud on the company's value is sufficiently large then stock based compensation is optimal. Otherwise, stock option based compensation is optimal. Furthermore, we show that the fraud to effort ratio is increasing in the strike price and that the optimal strike price is decreasing in the size of the negative effects of fraud on the company's value.

Keywords: executive compensation, stock options, restricted stock, fraud, incentives

JEL: D82, G30, M41, M52

1 Introduction

The 80s and 90s witnessed an explosion in stock option based compensation packages in the U.S. (Murphy, 1999 and Hall, Murphy, 2003). Stock options are granted with the intent to align interests of managers with those of shareholders and thus to reduce agency costs. Moreover, since stock options are by definition bounded from below, they encourage executives risk taking and thus mitigate executives risk aversion (Smith and Stulz, 1985). The popularity of stock options has also been encouraged by a conflicting accounting and tax treatment. Companies where allowed to deduct the entire expense of the option for tax purposes while not writing it off against profits.[1]

Over the past few years the proportion of pay delivered through stock options declined[2] . A Recent survey by Pearl Meyer and Partners for the New York Times documents a reduction in the value of options granted from 66% to 31% of total remuneration, while restricted stock and long term incentive plans (LTIP) over the same period increased from 14% to 30% . Thus, the current trend in corporate compensation practice is to switch from stock options to alternative compensation schemes such as, for example restricted stocks. The most famous example is Microsoft, which previously was one of the largest users of employee stock options.

One justification for this change in corporate compensation practice is the relative cost of employee stock options. If a managers is risk averse, then stock options are poor instruments to align shareholder goals with those of managers. While stock options are priced in a risk neutral and arbitrage free way, managers value stock options less because of their risk aversion (Hall and Murphy, 2000, 2003). Options have also been criticized since they boost short term gains but often neglect long term performance, leading also to the problem of finding the optimal vesting period.

[1] A new statement by the Fianancial Accounting Standards Board (FASB) requires firms to expense employee stock option at the grant-date fair value for both public comanies (starting from 15 June, 2005) and non-public companies (starting 15 December 2005).

[2] See also Hall, Murphy (2003).

The recent wave of accounting scandals such as, for example Enron, Tyco, Worldcom and Xerox, hints to a strong tie between executive compensation package and fraudulent behavior. Compensation schemes are designed to induce effort but they may also induce costly fraudulent activity (see Goldman and Slezak, 2005). Self-interested manager may engage in earnings misrepresentation and manipulation, or fraudulent information dissemination to inflate the short term stock price and thus also his compensation and wealth. This often occurs at the expense of company's long term performance.

In the present paper we are interested in the relationship between executive's incentives to manage earnings[3] and their compensation package. Shareholders face the trade-off between providing managers with incentives to exert beneficial effort and to engage in costly fraudulent activity. We solve for the optimal compensation package, given that the shareholders can either grant (restricted) stock or stock options and given fixed average compensation costs. We consider two agents, one being an effort averse manager and the other being a representative shareholder. Both individuals are risk neutral. In assuming risk-neutrality we eliminate the trade-off shareholders face between providing the manager with incentives and insurance and thus we focus on the trade-off between effort and fraudulent behavior[4] . Manager and shareholder face different time horizons. While the shareholder is interested in the long run value, manager's compensation is a function of the short run value. In our model the manager can boost the short term cash flow either by increasing effort or manipulating earnings. Whereas increasing his effort, the manager can boost the long run company's value, earning manipulations in the present paper are assumed to reduce its long-run value[5] . We show that the fraud to effort ratio is an increasing

[3] Earnings management can be classified into accounting and real value manipulation (Lev, 2003). The former occurs without affecting the cash flow or other real dimensions of the company, while the latter consists of activities such as timing of sales or investments that affect reported earnings.

[4] See also Baglioni and Colombo (2004) and Kadan and Yang (2005).

[5] Several paper document the negative relationship between earnings manipulation and its negative effects on future stock price. Chan et al (2005) using accounting accruals as a proxy for the quality of reported earnings find a strong evidence of earnings manipulations in firms with the largest accruals and that accruals are negatively related to future stock market returns. Teoh, Welch and Wong (1998a) show how issuers of initial public offerings (IPOs) with unusually high accrual in the year of issue experience poor stock performance in the subsequent three years. Teoh, Welch and Wong (1998b) provide evidence that pre-issue earnings management by seasoned equity

function of the strike price. Thus, the larger the strike price, the more the executive engages in earnings management relative to beneficial effort. We find a threshold level for the long run negative effects of fraud such that for larger values stock based compensation is optimal while for lower values stock option based compensation is optimal. This threshold level is increasing in the fraud-detection probability, the punishment in case of detection and in the effectiveness of effort, while it is decreasing in the effectiveness of fraud. Furthermore, we show that the optimal strike price is decreasing in the size of the long run negative effects of fraud on the company's value.

Recent empirical literature on the relationship between managers' compensation package and earnings management evidences a significantly, positive association between option based compensation packages and earnings management. Burns and Kedia (2005) investigate earning restatements of 215 firms compared with a control sample of firms matched by industry and size. The authors find strong evidence that higher incentives from stock options are associated with a higher propensity to misreport and also with a higher magnitude of misreporting. Furthermore, they find that equity, restricted stock and LTIP dot not have any significant impact on the propensity and magnitude to misreport. Gao and Shrieves (2002) investigate the relationship between earnings management intensity, as measured by the absolute value of discretionary current accruals scaled down by asset size, and managers' compensation package[6] . They find a positive relationship between earnings management and stock option based compensation, while they find a weaker support for a positive association between earnings management and restricted stock. Bergstresser and Philippon (2005) consider accruals-based measures of earnings management and find that periods of high accruals coincide with unusually large options exercise of CEOs and with sale of large quantities of shares by other insiders[7] . Jensen (2003) argues that discontinuities,

issuers, as reflected in discretionary accruals, explains future underperformance in stock returns. See also Jensen (2003).

[6] Accruals represent the difference between a company's accounting earnings and its underlying cash flow.

[7] Erickson, Hanlon and Maydew (2004) compare the performance of 50 firms accused of accounting fraud by the Securities and Exchange Commission (SEC) during the period 1996 - 2003 with firms not accused of fraud during the same period. They find that the likelihood of fraud is positively associated with the level of stock-based compensation, the proportion of stock-based compensation (stock-based mix) and the sensitivity of executives' stock-based wealth to a change in stock price. Johnson, Ryan and Tian (2003) stuy a sample of firms subject to

kinks and other non-linearities in the pay-for-performance function provide incentives for managers and employee to lie and to game the system[8] . Furthermore he discusses how the boosting of present day compensation may lead to a long run reduction in the firm's value.[9]

A growing literature studies the relationship between executive compensation and fraudulent behavior. Goldman and Slezak (2005), restricting their analysis to stock based compensation, study the link between executive compensation and fraudulent misreporting. They find that the optimal pay-for-performance sensitivity which balances the provision of effort and fraud. Baglioni and Colombo (2004) in a costly state verification approach show that a incentive compatible contract, where both incentive alignment and truthful revelation of the firm value are satisfied, requires a (strictly) convex compensation function. Kadan and Yang (2005) investigate the trade-off between incentive provision and executives earnings misreporting as a signalling game. Focusing on the separating equilibrium they find that lowering the exercise price of stock induces more misreporting.

The present paper is also related to Hall and Murphy (2000), where the authors determine the strike price providing the largest incentives and Oded et. al (2004), where the problem of the optimal strike price for an effort averse executive is addressed.

In Section 2 the model is introduced and the main results are stated. Section 3 concludes. All proofs are in the Appendix.

2 The model

We consider an economy consisting of 3 time periods: 1, 2 and 3. We consider times 1 and 2 to be the short run, while time 3 represents the long run. We consider two agents, one being a effort averse manager and the other being a representative shareholder. Both the manager as well as the

SEC's Accounting and Auditing Enforcement Releases (AAER). The authors find that executives at fraud firm face significantly greater financial incentives steming from stock and options holdings. Moreover they find that during fraud period, executives exercise also a larger fraction of vested options than do executives at control firms.

[8] See also Degeorge, Patel and Zeckhauser (1999) for a discussion on earnings management and thresholds.

[9] See also Jensen (2004).

representative shareholder are risk neutral. In assuming risk-neutrality we eliminate the trade-off shareholders face between providing the manager with incentives and insurance. In this way we focus on the trade-off between effort and fraud. The risk neutral interest rate is normalized to zero. Throughout the paper random variables are indicated with tilde ($\widetilde{\ }$) while realized variables are indicated without a tilde.

At time 1 the manager undertakes a risky project, whose fundamental value depends on the effort $e \geq 0$ exerted in the same time period. Further, at time 1, the manager may inflate the company's short run value engaging in earnings management $f \geq 0$. Let p be the exogenous probability that fraud is detected before time period 3. Assuming that an instantaneous price correction takes place if fraudulent behavior is discovered[10] , we define the company's value at time 2

$$\widetilde{S}_2 = \begin{cases} S + \alpha e + \beta f + \widetilde{\varepsilon}_2 & \text{with probability } 1 - p \\ S + \alpha e + \widetilde{\varepsilon}_2 & \text{with probability } p \end{cases} \tag{1}$$

where $\widetilde{\varepsilon}_2 \in U[-h, h]$ is the random variable compounding project and market specific risk, its value being realized at time 2. In (1) we implicitly assume that the event of detection is independent of $\widetilde{\varepsilon}_2$.

While effort increases the short run as well as the long run value of the company, earnings management boost only its short run value while decreasing its long run value. Thus, we assume that the company's expected long run value is

$$E\left(\widetilde{S}_3\right) = S + \alpha e - \delta f \tag{2}$$

where δf indicates the long run loss in profitability due to fraudulent behavior of the manager.

The shareholder defines the compensation package (λ, K), consisting in $\lambda \geq 0$ stock options, vesting at time 2, with strike price $K \geq 0$. For $K = 0$ the shareholder grants (restricted) stock, while for $K > 0$ he grants stock options. The Shareholder and the manager face different time

[10] Erickson, Hanlon and Maydew (2004) find that the value of the equity holdings of top managers accused of fraud was substantially overstated prior to the revelation of the fraudulent behavior.

horizons. We assume that stock options vest at time 2 and thus the executive is interested in the short run value of the company. Probability p is therefore the probability of fraudulent behavior being detected before executive's stock options get vested. Executive's compensation is defined as $\widetilde{W}_2 = \lambda \widetilde{V}_2$, where $\widetilde{V}_2 = \left\{ \widetilde{S}_2 - K \right\}^+$. Shareholders are interested in the company's long run value, i.e. $E\left(\widetilde{S}_3\right)$.

Effort level e and the fraud level f are not observable. Fraudulent behavior does not directly produce disutility such as effort, but if the manager is caught then he has to pay a penalty, which is increasing in the size of the misrepresentation f. Given the exogenous probability that fraud is detected before the options get vested p and let $P(f) = \phi \frac{f^2}{2}$ be the penalty if fraudulent behavior is observed, the executive's expected utility is

$$E\left(U\left(\widetilde{W}_2\right)\right) \equiv E\left(\widetilde{W}_2\right) - p\phi \frac{f^2}{2} - \frac{e^2}{2}$$

The shareholder defines the strike price K and the number of options granted, maximizing the long run expected present value of the company such that the incentive compatibility constraint is satisfied. The shareholder's problem can formally be stated as follows

$$\max_K E\left(\widetilde{S}_3\right) \tag{3}$$

$$\text{s.t.} \quad e, f = \arg\max E\left(U\left(\widetilde{W}_2\right)\right) \tag{4}$$

where (4) is the incentive compatibility constraint. This maximization problem is furthermore constrained. We consider the case where the expected compensation costs are fixed to $\overline{W}$ and thus determine the optimal compensation package (λ, K) which maximizes the long run expected present value of the company (2). In this case the constraint reads

$$\lambda E\left(\widetilde{V}_2\right) = \overline{W} \tag{5}$$

where (5) is the project's budget constraint. In what follows we assume that parameters are such that the participation constraint is always satisfied, that is the executive's expected utility is always larger than its outside option[11] .

Once the budget constraint (5) is imposed, we can rewrite λ as a function of K. Consequently, the problem of the shareholder reduces to finding the optimal strike price which maximizes the long run value of the company (2).

In the following lemma we characterize the optimal fraud and effort choice for the manager, conditional on the contract (λ, K), as resulting form the incentive compatibility constraint (4).

Lemma 1 *Optimal effort e and fraud f are both continuous, increasing in λ and decreasing in K.*

Thus, an increase in the number of options granted increases the effort as well as the fraud level, while an increase in the strike price decreases the effort as well as the fraud.

Intuitively, if the strike price increases the value of the option decreases and thus more options have to be granted if the budget constraint (5) has to bind. This result is shown formally in the Appendix. Thus, from Lemma 1 we know that an increase in K reduces both effort and fraud, but an increase in λ increases both effort and fraud. The following lemma describes the behavior of the fraud to effort ratio as the strike price K increases.

Lemma 2 *The fraud to effort ratio is a continuous and increasing function of the strike price K.*

Thus, an increase in the strike price K leads to an increase in the fraud to effort ratio. In other words, the manager engages relatively more in fraudulent behavior than in productive activities as the strike price increases. This has important and direct consequences on the optimal choice of the strike price K and the corresponding compensation package (λ, K) since the company's long run value depends positively on the effort exerted by the manager, but it depends negatively on the manager's earnings management.

[11] In particular we require $\overline{W}$ to be such that the participation constraint is always satisfied, i.e. $E\left(U\left(\widetilde{W_2}\right)\right) \geq U_0$, where U_0 represents the executive's utility for a given outside option.

The shareholder faces a trade-off, where gains from increased effort have to be traded off against long term losses due to fraudulent behavior. The following proposition describes the optimal compensation structure.

Proposition 1 *For $\delta > \overline{\delta}$ stock based compensation is optimal ($K = 0$), while for $\delta < \overline{\delta}$ stock option based compensation is optimal ($K > 0$), where $\overline{\delta} \equiv \frac{\alpha^2}{\beta} \frac{p\phi}{1-p}$.*

In Proposition 1 a threshold level for δ is defined whereas for values of δ larger than this threshold, stock based compensation is optimal while for lower values stock option based compensation is optimal. This threshold level is increasing in the detection probability (p), the punishment in case of detection (ϕ) and in the effectiveness of effort (α), while it is decreasing in the effectiveness of fraud (β).

The following comparative statics result for the optimal strike price can be proved.

Corollary 1 *Consider the case where $\delta < \overline{\delta}$. The optimal strike price (K) is decreasing in δ.*

A larger long run negative effect of fraud on the company's value decreases the optimal strike price K.

Note that, in the present model, conflicts between the shareholder and the manager are eliminated in this framework if both face the same time horizon. If stock options vest at time 3, fraudulent behavior decreases not only the shareholder's but also the manager's wealth. In a similar vein, a longer vesting period, i.e. a higher detection probability p, increases the range of parameter values where stock option based compensation is optimal. This result is in accordance with recent suggestions to increase the vesting period of stock options as a way to reduce conflicts between shareholders and CEOs.

3 Conclusion

We studied the optimal managerial compensation package if shareholders can either grant stock or stock options. The shareholder, in providing incentives, trades off gains from beneficial effort against costs arising from fraudulent behavior. We find a threshold level for the cost of fraud, above which stock based compensation is optimal. This threshold level is increasing in the detection probability, the punishment in case of detection and in the effectiveness of effort, while it is decreasing in the effectiveness of fraud. Furthermore, we find that the fraud to effort ratio is an increasing function of the strike price and that the optimal strike price is decreasing in the size of the long run negative effects of fraud on the company's value. Our analysis also suggests that increasing the vesting period of stock options mitigates conflicts between shareholders and managers, while the problem of the optimal vesting period remains an open one.

4 Appendix

Let us define $X = \min\{S - K + \alpha e, h\}$ and $X' = \min\{S - K + \alpha e + \beta f, h\}$, then

$$E\left(\widetilde{V}_2\right) = \tfrac{1}{2h}\left\{(1-p)\left[(S-K+\alpha e+\beta f)(h+X') + \tfrac{h^2-X'^2}{2}\right] + \right. \\ \left. +p\left[(S-K+\alpha e)(h+X) + \tfrac{h^2-X^2}{2}\right]\right\} \tag{6}$$

Three cases arise: (1) If $X = X' = h$, i.e. $S - K + \alpha e + \beta f > S - K + \alpha e > h$; (2) If $X' = h$ and $X = S - K + \alpha e$, i.e. $S - K + \alpha e + \beta f > h > S - K + \alpha e$; and (3) $X' = S - K + \alpha e + \beta f$ and $X = S - K + \alpha e$, i.e. $h > S - K + \alpha e + \beta f > S - K + \alpha e$. Note that we switch from one case to the other changing the strike price K.

Proof of Lemma 1. Case (1) The manager's problem is

$$\max_{e,f} \lambda\left(S - K + \alpha e + (1-p)\beta f\right) - \frac{e^2}{2} - p\phi\frac{f^2}{2}$$

From the first order conditions (FOC) we obtain

$$e^{(1)} = \alpha\lambda \tag{7}$$

$$f^{(1)} = \beta\lambda\frac{1-p}{p\phi} \tag{8}$$

Case (2) The manager's problem is

$$\max_{e,f} \lambda\left[(1-p)(S-K+\alpha e+\beta f) + p\frac{(S-K+\alpha e+h)^2}{4h}\right] - \frac{e^2}{2} - p\phi\frac{f^2}{2}$$

From the FOC we obtain

$$e^{(2)} = \alpha\lambda \frac{p\,(S-K) + (2-p)\,h}{2h - p\alpha^2\lambda} \tag{9}$$

$$f^{(2)} = \beta\lambda \frac{1-p}{p\phi} \tag{10}$$

If $\frac{p(S-K)+(2-p)h}{2h-p\alpha^2\lambda} = 1$, $e^{(1)} = e^2$ and $S-K+\alpha e^{(1)} = S-K+\alpha e^{(2)} = h$ and thus the optimal effort level is continuous in K. Its is easy to see that $e^{(2)}$ is increasing in λ and deceasing in K, and that $f^{(2)}$ is increasing in λ.

Case (3) The manager's problem is

$$\max_{e,f} \frac{\lambda}{4h}\left[(1-p)\,(S-K+\alpha e+\beta f+h)^2 + p\,(S-K+\alpha e+h)^2\right] - \frac{e^2}{2} - p\phi\frac{f^2}{2}$$

From the FOC, after rearranging terms, we obtain

$$e^{(3)} = \alpha\lambda p \frac{(S-K+h)\left(2h\phi - \beta^2\lambda\,(1-p)\right)}{2hp\phi\,(2h-\alpha^2\lambda) - \beta^2\lambda\,(1-p)\,(2h-p\alpha^2\lambda)} \tag{11}$$

$$f^{(3)} = \beta\lambda\,(1-p)\,\frac{2h\,(S-K+h)}{2hp\phi\,(2h-\alpha^2\lambda) - \beta^2\lambda\,(1-p)\,(2h-p\alpha^2\lambda)} \tag{12}$$

In order to proof continuity of e and f we show that if $S-K+\alpha e^{(3)}+\beta f^{(3)} = h$, then $f^{(2)} = f^{(3)}$, $e^{(2)} = e^{(3)}$. Substituting (11) and (12) into condition $S-K+\alpha e^{(3)}+\beta f^{(3)} = h$ we obtain

$$(S-K+h)\,\frac{2hp\phi}{2hp\phi\,(2h-\alpha^2\lambda) - \beta^2\lambda\,(1-p)\,(2h-p\alpha^2\lambda)} = 1 \tag{13}$$

Setting $f^{(2)} = f^{(3)}$ and rearranging terms we obtain (13). Instead of proving that $e^{(2)} = e^{(3)}$, we show that $\frac{f^{(2)}}{e^{(2)}} = \frac{f^{(3)}}{e^{(2)}}$. This latter condition can be rewritten as

$$\frac{2h\phi}{2h\phi - \beta^2\lambda\,(1-p)} = \frac{2h - p\alpha^2\lambda}{p\,(S-K) + (2-p)\,h}$$

and thus rearranging terms (13) can be obtained. $e^{(2)} = e^{(3)}$ follows from the fact that $f^{(2)} = f^{(1)}$ and $\frac{f^{(2)}}{e^{(2)}} = \frac{f^{(3)}}{e^{(2)}}$. Furthermore, simple algebra shows that $\frac{\partial e^{(3)}}{\partial\lambda} > 0$ and $\frac{\partial f^{(3)}}{\partial\lambda} > 0$. ■

Proof of Lemma 2. We are going to derive the fraud to effort ratio $\Phi \equiv \frac{f}{e}$ for each of the three cases and show that Φ is increasing in K. In particular, we are going to derive $\Phi^{(1)} \equiv \frac{f^{(1)}}{e^{(1)}}$, for case (1), $\Phi^{(2)} \equiv \frac{f^{(2)}}{e^{(2)}}$ for case (2) and $\Phi^{(3)} \equiv \frac{f^{(3)}}{e^{(3)}}$ for case (3); we are going to show that $\Phi^{(1)}$, $\Phi^{(2)}$ and $\Phi^{(3)}$ are continuous within each case and between cases and further that $\Phi = \left\{\Phi^{(1)}, \Phi^{(2)}, \Phi^{(3)}\right\}$ is increasing in K.

Case (1) From (7) and (8) we obtain the fraud to effort ratio $\Phi^{(1)} \equiv \frac{f^{(1)}}{e^{(1)}} = \frac{\beta}{\alpha}\frac{1-p}{p\phi}$, being independent of λ and K.

Case (2) From (9) and (10) we obtain the fraud to effort ratio

$$\Phi^{(2)} \equiv \frac{f^{(2)}(\lambda, K)}{e^{(2)}(\lambda)} = \frac{\beta}{\alpha}\frac{1-p}{p\phi}\frac{2h - p\alpha^2\lambda}{p(S-K) + (2-p)h} \tag{14}$$

For the continuity of the function Φ in K we observe that $\Phi^{(2)}$ is continuous. Furthermore, if $\frac{p(S-K)+(2-p)h}{2h-p\alpha^2\lambda} = 1$, $e^{(1)} = e^2$ and $S - K + \alpha e^{(1)} = S - K + \alpha e^{(2)} = h$. It follows that, since $f^{(1)} = f^{(2)}$, $\Phi^{(1)} = \Phi^{(2)}$ and consequently the function Φ is continuous.

In order to prove that $\Phi^{(2)}$ is increasing in K we apply the implicit function theorem to the budget constraint (5) and obtain

$$\frac{d\lambda}{dK} = \lambda \frac{\frac{p(S-K)+h(2-p)}{2h-\alpha^2\lambda p}}{E\left(\widetilde{V}_2\right) + \lambda\alpha^2\left(\frac{p(S-K)+(2-p)h}{2h-p\alpha^2\lambda}\right)^2 + \lambda(1-p)^2\beta^2\frac{1}{p\phi}} \tag{15}$$

Taking the derivative of (14) with respect to K and taking into account that λ changes according to (15) we obtain that the fraud to effort ratio increases as long as

$$\frac{d\lambda}{dK} < \frac{2h - p\alpha^2\lambda}{\alpha^2(p(S-K) + (2-p)h)} \tag{16}$$

To prove that (16) is always satisfied we substitute (15) into the left-hand-side of inequality (16) and obtain $\lambda E\left(\widetilde{V}_2\right) + \lambda^2(1-p)^2\beta^2\frac{1}{p\phi} > 0$, which is always satisfied.

Case (3) Using (11) and (12) the fraud-effort ratio can be rewritten as follows

$$\Phi^{(3)} \equiv \frac{f^{(3)}}{e^{(3)}} = \frac{\beta}{\alpha}\frac{1-p}{p}\frac{2h}{2hp\phi - \beta^2\lambda p(1-p)} \tag{17}$$

In order to prove that Φ is continuous in K we observe that function $\Phi^{(3)}$ is continuous. Equality $\Phi^{(2)} = \Phi^{(3)}$ has already been proved in the proof of Lemma 1.

Finally we have to prove that $\Phi^{(3)}$ is increasing in K. It is easy to see that $\frac{\partial\lambda E\left(\widetilde{V}_2\right)}{\partial K} < 0$. Furthermore, simple algebra shows that $\frac{\partial e^{(3)}}{\partial\lambda} > 0$ and $\frac{\partial f^{(3)}}{\partial\lambda} > 0$ and consequently $\frac{\partial\lambda E\left(\widetilde{V}_2\right)}{\partial\lambda} > 0$.

Thus, applying the implicit function theorem to the budget constraint (5) we obtain $\frac{d\lambda}{dK} > 0$, and thus we observe from (17) that $\Phi^{(3)}$ is increasing in K. ■

Proof of Proposition 1. Case (1) Notice that for $K = 0$, i.e. stock based compensation, we are always in this case. Using (7) and (8) we obtain

$$E\left(\widetilde{S}_3\right) = S + \lambda\left[\alpha^2 - \beta\delta\frac{1-p}{p\phi}\right] \tag{18}$$

$$E\left(\widetilde{V}_2\right) = S - K + \lambda\left[\alpha^2 + \beta^2\frac{(1-p)^2}{p\phi}\right] \tag{19}$$

Using (19), the budget constraint (5) and condition $\lambda > 0$ we obtain

$$\lambda = \frac{-(S-K) + \sqrt{(S-K)^2 + 4\eta\overline{W}}}{2\eta} \tag{20}$$

where $\eta = \alpha^2 + \beta^2\frac{(1-p)^2}{p\phi}$. Note that λ is strictly increasing in K. Two situations arise: (i) $\alpha^2 > \beta\delta\frac{1-p}{p\phi}$ (ii) $\alpha^2 < \beta\delta\frac{1-p}{p\phi}$. In case (i) the expected firm's value at time 3 is increasing in λ. Thus, since λ is increasing in K, there exists no solution for $S - K + \alpha e^{(1)} > h$. On the other hand, in case (ii) the expected firm's value at time 3 is decreasing in λ. Thus, since λ is strictly increasing in K, the optimal strike price is $K = 0$.

In order to proof that $K = 0$ is an optimal solution if $\alpha^2 < \beta\delta\frac{1-p}{p\phi}$, we have to show that $\frac{dE\left(\widetilde{S}_3\right)}{dK}$ is negative also in case (2) and (3).

Case (2). Note that $E\left(\widetilde{S}_3\right)$ is decreasing in K if $\frac{f_K^{(2)}}{e_K^{(2)}} \geq \frac{\alpha}{\delta}$, where $f_K^{(2)}$ and $e_K^{(2)}$ are the derivatives taken with respect to K, taking into account that the budget constraint binds. If $\alpha^2 \leq \beta\delta\frac{1-p}{p\phi}$, then $\alpha e^{(1)} \leq \delta f^{(1)}$. Since the fraud to effort ratio is increasing in K we have that $\frac{\alpha}{\delta} \leq \frac{f^{(2)}}{e^{(2)}}$ and furthermore we have that $\frac{f_K^{(2)}}{e_K^{(2)}} \geq \frac{f^{(2)}}{e^{(2)}}$. Putting these results together we obtain that $\frac{f_K^{(2)}}{e_K^{(2)}} \geq \frac{f^{(2)}}{e^{(2)}} \geq \frac{\alpha}{\delta}$ and thus the result is established.

Case (3). Note that $E\left(\widetilde{S}_3\right)$ is decreasing in K if $\frac{f_K^{(3)}}{e_K^{(3)}} \geq \frac{\alpha}{\delta}$, where $f_K^{(3)}$ and $e_K^{(3)}$ are the derivatives taken with respect to K, taking into account that the budget constraint binds. If $\alpha^2 \leq \beta\delta\frac{1-p}{p\phi}$, then $\alpha e^{(1)} \leq \delta f^{(1)}$. Since the fraud to effort ratio is increasing in K we have that

$\frac{\alpha}{\delta} \leq \frac{f^{(3)}}{e^{(3)}}$ and furthermore we have that $\frac{f_K^{(3)}}{e_K^{(3)}} \geq \frac{f^{(3)}}{e^{(3)}}$. Putting these results together we obtain that $\frac{f_K^{(3)}}{e_K^{(3)}} \geq \frac{f^{(3)}}{e^{(3)}} \geq \frac{\alpha}{\delta}$ and thus the result is established. ■

Proof of Corollary 1. $\frac{f}{e}$ is increasing in K implies that $\frac{f_K}{e_K} \geq \frac{f}{e}$. Thus, in the optimal strike price $\frac{dE(\widetilde{S}_3)}{dK} = 0$, where $\frac{f_K}{e_K} = \frac{\alpha}{\delta} > \frac{f}{e}$, and consequently $E\left(\widetilde{S}_3\right) = S + \alpha e - \delta f > S$. An increase in δ reduces $E\left(\widetilde{S}_3\right)$, and thus, since $\frac{f}{e}$ is increasing in K, optimal K has to decrease. ■

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