Should executive stock options be abandoned?

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Should Executive Stock Options Be Abandoned?[1]

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Abstract:
Recent corporate scandals around the world have led many to single out executive stock options as one of the main culprits. More corporations are abandoning stock options and reverting to restricted stock. This paper argues that such a change is not entirely justifiable. We first provide a critical review of the pros and cons of executive stock options. We then compare option-based contracts with stock-based contracts using a simple principal-agent model with moral-hazard. In a general environment without restrictions on preferences or technologies, option-based contracts are shown to weakly dominate stock-based contracts. The weak dominance relation becomes strict if the manager is risk neutral. Numerical examples are provided to show that, even if the manager is risk averse, strict dominance is more likely the case.

Keywords:
EXECUTIVE STOCK OPTIONS; RESTRICTED STOCK; OPTIMAL CONTRACT.

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1. Introduction

In the wake of high-profile accounting frauds and governance failures that recently plagued corporations around the world, much of the blame has been directed to executive compensation in general, and stock options in particular. Remedial actions and recommendations have been made by corporations, investors and regulators alike. Regulators have been pushing to mandate expensing of stock options against accounting earnings. For example, the International Accounting Standards Board announced in February 2003 that firms using international accounting standards must expense stock options beginning January 1, 2005. The US Financial Accounting Standards Board is of a similar view, although a suitable valuation model has yet to be worked out. Institutional investors are also urging expensing of stock options. TIAA-CREF has announced a campaign to lobby 1,750 major public corporations in which it owns shares to begin expensing options. Institutional Shareholder Services and the Council of Institutional Investors in the US have also called for the use of indexed options although this would reduce reported earnings according to the current US accounting rule (*Business Week*, February 28, 2000).

Steps taken by corporations have been diverse. Dozens of large US corporations have committed to expensing options. They include Amazon.com, Bank One, Citigroup, Coca-Cola and Hewlett-Packard while many high technology companies including Intel, Cisco and Siebel are against expensing stock options (*Forbes*, July 24, 2002; *The New York Times*, March 17, 2004).On the other hand, not a few corporations are taking the antipodean approach of abandoning stock options altogether. In July 2003, Microsoft announced that it would stop issuing stock options but instead award restricted stock to its 50,000 employees. Following the announcement, *The Wall Street Journal* (July 9, 2003) declared, “The golden age of stock options is over.” General Electric would also replace stock options for its CEO with share units subject to performance hurdles (*The Wall Street Journal*, September 18, 2003).[4]

At least in the US, there is indeed a visible trend indicating that the mix of long-term incentives for CEOs is changing. The Wall Street Journal-Mercer Human Resource Consulting 2004 CEO Compensation Survey (Mercer Human Resource Consulting, 2005) reports that the most striking of the changing trend in CEO compensation is the movement away from stock options and toward other long-term vehicles. Out of 350 large US companies surveyed, a total of 273 companies awarded stock options to CEOs in 2004, compared to 278 in 2003 and 295 in 2002, a gradual decline of 7.5 percent over the two year period. But 166 CEOs received restricted stock grants in 2004, compared to 138 in 2003 and 104 in 2002, a 59.6 percent jump over the same period. In value terms, stock options represented 76 percent of long-term incentives in 2002, declined to 62

[4] Other firms are changing the terms of stock option grant. For example, IBM is scrapping at-the-money options and granting premium options to its senior executives, following a path taken by German companies such as SAP and Siemens (*The New York Times*, February 25, 2004). Other high-tech companies continue to rely on stock options, however. Recently Apple, Adobe, and EDS have adjusted downwards the exercise prices of employee stock options that are out of the money (*The Asian Wall Street Journal*, August 13, 2003).

percent in 2003, and to 57 percent in 2004. During the same period, the value of restricted stock increased from 12 percent to 20 percent, and then to 23 percent.[5]

Scrapping of executive stock options is not limited to the US. Several large Australian companies such as Commonwealth Bank, Telstra and WMC announced they would also abandon stock options. By and large, they are replacing stock options with shares subject to performance hurdles. In an interview with the Australian Broadcasting Company on August 22, 2002, David Murray, CEO and managing director of Commonwealth Bank, said, “We felt that we can achieve in our long-term incentive plans all that we need to without options and with shares, still with performance hurdles and at far less dilution to the shareholder and without that sort of extra prize to the executive that if you happen to be around in the right circumstances in a boom. (...) So we felt it was better to get rid of them.”

It is conceivable that these changes have been prompted by a host of factors. Changes in accounting rules, the introduction of tighter corporate governance codes such as Sarbanes-Oxley in the US, the pressure from institutional investors and shareholder groups such as the California Pension Retirement System (CalPERS), and, perhaps to an extent, corporations’ bid to look legitimate to public eyes may all account for the changes. How or whether these factors have led to the current trend is an important question that needs to be studied further as more data become available. However it is beyond the scope of this paper.

Should executive stock options be abandoned? Do alternative stock-based incentive schemes serve the purpose of incentive compensation better than stock options? This paper attempts to provide answers to these questions. In doing so, we make a number of simplifying assumptions. First, the answers would depend on a variety of factors such as internal governance mechanisms, regulation pertinent to compensation, and the workings of stock markets. We assume, therefore, that all these factors remain the same when we compare alternative contractual forms. Nonetheless, criticisms against executive stock options are almost always related to these factors. We thus offer some discussions on these factors in Section 2. Second, we will not be explicit about various performance hurdles such as total shareholders return, which often come with option grant. While such performance hurdles have been common in Australia for some time, they are relatively new in the US, presumably due to unfavourable accounting treatment of such instruments. Third, our approach, as most other approaches in economics and finance, will be agency-theoretic. Should other theories of corporate governance be more pertinent, the answers to our questions could be different.[6] In sum, our focus is on comparing contracts based on stock options with their main replacement, those based on restricted stock, within the same, simple environment in which there are intrinsic conflicts of interests between shareholders and self-interested managers.

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[5] It is often argued that smaller start-ups may be disadvantaged by this trend because they often face cash constraints and options can provide more incentives in the presence of growth opportunities. While such an argument is not limited to executive stock options, empirical evidence on the relationship between option grants and cash constraints is mixed. See, for example, Oyer and Schaefer (2005).

[6] Alternative theories, proposed most notably in the area of organizational behavior, include managerial hegemony theory, stakeholder theory, stewardship theory, resource dependence theory, and institutional theory.

The remainder of the paper is organized as follows. In Section 2, we discuss the criticisms against executive stock options and review the relevant literature. Section 3 provides dominance results. In a most general environment without restrictions on preferences or technologies, option-based contracts are shown to weakly dominate stock-based contracts. With a risk-neutral manager protected by limited liability, the dominance relation becomes strict. In Section 4, we offer numerical examples and show that strict dominance is more likely the case even if the manager is risk averse. Section 5 concludes the paper.

2. Executive Stock Options: Critique and the Literature Review

The main criticisms against executive stock options can be summed up as: (i) the difficulty of accounting issues in general, and of expensing options in particular;[7] (ii) the opportunity cost of options for the granting firm higher than the value of options to undiversified executives; (iii) giving extra incentives to executives to manipulate accounting information; (iv) rewarding executives excessively in the boom market; (v) failure to penalize bad performance by resetting option price in the down market; and, related to the above two, (vi) encouraging executives to take excessive risks at the cost of the shareholders.

The issue of expensing options is still hotly debated among academics and practitioners alike, and it does not seem that we could reach a clear answer. Suffice it to summarize the main arguments for and against. There are three main arguments in favour of expensing options. First, the information regarding option compensation as currently contained in the footnotes of company reports is not sufficient to tell investors the actual costs to the firm. In support of this, the US Federal Reserve Board estimates that the failure to expense options has led to the overstatement of corporate profits by at least 2.5 percent a year over the five-year period to 2002 (*The Economist*, 2002). Second and related, expensing options will provide a level playing field so that both the firms using cash bonuses and the firms using stock options will have an expense on the income statement. Third, it will improve corporate governance by reducing or eliminating incentives to manipulate accounting information.

Those against expensing options argue that the playing field is already level since the market will deduce the actual value of the stock diluted by additional shares promised by stock option awards. Moreover a lack of consensus as to how to value executive stock options for expensing purpose could lead to an even more distorted picture of a firm's economic condition than financial statements currently paint (Sahlman, 2002). Second, expensing options will unfairly disadvantage start-ups and high-tech companies with growth opportunities as they typically lack cash to motivate and retain high quality employees. Third, manipulation of accounting information is a broader governance issue, rather than the problem of compensation practice per se.

Some argue that options are an expensive way to motivate executives (Hall and Murphy, 2000, 2002; Meulbroek, 2001). The opportunity cost of an option to the granting

[7] At least in the US, an additional criticism is as to why different options are treated differently for accounting and tax purposes (Hall and Murphy, 2003).

firm is the option premium the firm can receive by selling the option in the market. However the value of an option to executives is smaller than its market value since their wealth and human capital are undiversified, and many restrictions attached to executive stock options do not render the same risk-neutral valuation of an option applicable for the receiving executives. While correct, this argument is only one-sided. It does not consider the incentives options can generate. Suppose the firm awards its CEO $1 million worth of incentive package in the form of restricted stock. Suppose now the firm replaces the restricted stock by stock options worth $1 million (to the firm). The incentives generated from the former cannot be the same as those from the latter. Quite simply, stock options make the slope of CEO's compensation function steeper (unless the exercise price is equal to zero, in which case stock options are the same as stock). To argue whether stock options are an 'expensive' way to motivate executives, one needs to strike a balance by accounting for both their costs and their benefits. Simulations studies by Lambert and Larcker (2004) show that, for reasonable parameter values, the net benefits of stock options generally outweigh those of restricted stock for those executives who can 'make a difference'. After all, stock options should not be used for those who cannot.

Incentives for accounting manipulation are closely related to the other criticisms, along with broader issues of corporate governance, as mentioned above. So we will not discuss this separately.[8] Many executives were rewarded handsomely during the boom market, making the gap between their pay and an average worker's pay drift apart wider and wider.[9] To the extent that this reward was a simple windfall as much of the anecdotal evidence during the dot.com boom suggests, the criticism is justified. At least in the US, this is due to near non-existence of performance hurdles or relative performance evaluation in executive stock options.[10] As long as performance hurdles are absent, restricted stock is also subject to the same criticism, only to a different degree. What needs to be done, therefore, is to modify option compensation to filter out industry-wide effects and reward more for firm-specific performance.

As for the fifth criticism, one needs to be careful in weighing the benefits of resetting against its costs. The main benefits of resetting are reincentivization and retaining valuable employees who might otherwise 'reset themselves by leaving the firm' when their options are deeply under water. However, resetting could harm initial incentives when it is anticipated (Acharya et al., 2000). Ultimately, therefore, it is an empirical question whether option resetting is indeed a bad thing. Empirical evidence as to the benefits and costs of resetting is not conclusive: resetting is more likely in firms with greater agency problems, and tends to occur following poor firm-specific performance without significant follow-up gains (Brenner et al., 2000; Chance et al., 2000); resetting is more likely in young, high-tech firms operating in competitive labour markets (Carter and Lynch, 2001); firms that restrict resetting are more vulnerable to

[8] Using the US data on 50 firms accused of accounting fraud by the SEC during 1996-2003, Erickson et al. (2004) report a positive correlation between the likelihood of accounting fraud and the proportion of stock-based compensation.

[9] In 1999, an average pay of CEO in large US companies was about 475 times that of an average manufacturing worker, an increase by almost a factor of 10 compared to three decades earlier (Towers Perrin; Standard and Poor's).

[10] In Australia, various performance hurdles and relative evaluation have been in place for some time, with relative total shareholders return being the predominant metric used. See Kerin (2003).

voluntary executive turnover (Chen 2004); costs of resetting are modest while restricting resetting pushes firms to inferior contractual choices at deadweight losses to shareholders (Chidambaran and Prabhala, 2004). Finally, there is some evidence that CEOs might opportunistically choose the timing of resetting (Callaghan et al., 2004).

Regarding the final criticism, it is not so much an issue of whether options intrinsically encourage excessive risk-taking, but whether the contracts are designed optimally. An option-based contract does not necessarily lead to excessive risk taking if the terms of the contract such as the size of the grant, maturity and exercise price, are chosen optimally (Carpenter, 2000; Choe, 2001, 2003).[11] For example, if more risk taking is desirable for the firm as a whole (e.g., for firms in growth industries), the exercise price can be adjusted upwards, thereby setting a higher goal. It is possible that these terms are not chosen optimally in corporations with 'captive' boards, in which CEOs use stock options as a camouflaging device for rent seeking (Bebchuk et al., 2002; Bebchuk and Fried, 2004). It is in this sense that executive stock options cannot be considered in isolation from broader governance issues.

3. Option-Based Contracts Dominate Stock-Based Contracts

3.1. General Model and Weak Dominance

Our basic model is embedded in a simple, but general, moral hazard environment. The firm consists of two players whom we call the owner (shareholders as a whole or the board that diligently represents shareholders' interests) and the manager (CEO or a management team).[12] The owner initially holds 100% of the firm. The manager privately chooses the level of effort $e \in E$ that affects the firm's share price denoted by $p \in \Re_+$. Conditional on the manager's level of effort *e*, the cumulative distribution of p is denoted by $F(p\,|\,e)$ with corresponding density function $f(p\,|\,e)$. The owner's preference is represented by an increasing, concave von-Neumann Morgenstern utility function v defined on her monetary payoff. The manager's preference is represented by $u(y,e)$ where u is increasing and concave in y, his monetary payoff, and decreasing and concave in *e*. His reservation utility is denoted by $\overline{U}$. Both players maximize their expected utility.

Suppose first that the owner uses a stock-based contract to motivate the manager. Denote the stock-based contract by $(\alpha_s, b_s) \in [0,1] \times \Re$ where α_s is a fraction of the firm and b_s is a base salary. Note that we did not impose any restriction on b_s. When we later impose limited liability on the contract, we will assume $b_s \geq 0$. Given (α_s, b_s), if the manager chooses e_s, then his expected utility is

[11] Ross (2004) provides a general analysis of conditions under which incentive schemes make an agent more or less risk averse. In particular he shows that the common folklore that a convex payoff structure of options makes an agent to take more risks is false.

[12] We will use the female gender pronoun for the owner and the male gender pronoun for the manager.

$$U_s(\alpha_s, b_s, e_s) \equiv \int u(b_s + \alpha_s p, e_s) dF(p \mid e_s), \tag{1}$$

and the owner's expected utility is

$$V_s(\alpha_s, b_s, e_s) \equiv \int v[(1-\alpha_s)p - b_s)] dF(p \mid e_s). \tag{2}$$

The owner's optimal contracting problem can be written as

$$\begin{aligned} &\text{Maximize}_{(\alpha_s, b_s, e_s)} V_s(\alpha_s, b_s, e_s) \qquad \text{subject to} \\ &\text{(IC): } e_s \in \arg\max_{(e')} U_s(\alpha_s, b_s, e') \text{ and (PC): } U_s(\alpha_s, b_s, e_s) \geq \overline{U} \end{aligned} \tag{3}$$

where (IC) is the incentive compatibility constraint and (PC) is the participation constraint. Let $C_s \subset [0,1] \times \Re \times E$ denote the set of (α_s, b_s, e_s) satisfying (IC) and (PC). Thus C_s specifies the set of feasible stock-based contracts. We assume that C_s is non-empty and problem (3) has a solution.

We now turn to option-based contracts. Denote the option-based contract by $(\alpha_o, k, b_o) \in [0,1] \times \Re_+ \times \Re$ where α_o is a fraction of the firm that the manager can buy at an exercise price k and b_o is a base salary. For obvious reasons, we assume that the exercise price cannot be negative. Given (α_o, k, b_o), if the manager chooses e_o, then his expected utility is

$$U_o(\alpha_o, k, b_o, e_o) \equiv \int u[b_o + \alpha_o (p-k)^+, e_0] dF(p \mid e_o), \tag{4}$$

and the owner's expected utility is

$$V_o(\alpha_o, k, b_o, e_o) \equiv \int v[p - \alpha_o (p-k)^+ - b_o] dF(p \mid e_o). \tag{5}$$

In the above, $(p-k)^+ \equiv \max\{p-k, 0\}$. The owner's optimal contracting problem is then

$$\begin{aligned} &\text{Maximize}_{(\alpha_o, k, b_o, e_o)} V_o(\alpha_o, k, b_o, e_o) \qquad \text{subject to} \\ &\text{(IC): } e_o \in \arg\max_{(e')} U_o(\alpha_o, k, b_o, e') \text{ and (PC): } U_o(\alpha_o, k, b_o, e_o) \geq \overline{U}. \end{aligned} \tag{6}$$

Let us denote the set of $(\alpha_o, k, b_o, e_o) \in [0,1] \times \Re_+ \times \Re \times E$ satisfying (IC) and (PC) of (6) by C_o, which specifies the set of feasible option-based contracts. Again we assume that there is a solution to problem (6). Note that, if $k = 0$, then the restriction of C_o to $[0,1] \times \Re \times E$ coincides with C_s. Denote this set by $C_o \mid_{k=0}$. Then we have

$V_s(\alpha,b,e) = V_o(\alpha,0,b,e)$ for all $(\alpha,b,e) \in C_o \mid_{k=0}$. Comparing (3) and (6), it is easy to see that option-based contract weakly dominate stock-based contracts.

Suppose $(\alpha_o^*, k^*, b_o^*, e_o^*)$ solves (6) and $(\tilde{\alpha}_s, \tilde{b}_s, \tilde{e}_s)$ solves (3). Suppose first $k^* = 0$. Then, by the argument above, $(\alpha_o^*, b_o^*, e_o^*)$ should also solve problem (3), hence $V_o(\alpha_o^*, 0, b_o^*, e_o^*) = V_s(\tilde{\alpha}_s, \tilde{b}_s, \tilde{e}_s)$. If $k^* > 0$, then, by the definition of $(\alpha_o^*, k^*, b_o^*, e_o^*)$ being a solution to (6), we have $V_o(\alpha_o^*, k^*, b_o^*, e_o^*) \geq V_o(\alpha,0,b,e)$ for all $(\alpha,b,e) \in C_o \mid_{k=0}$. Since $(\tilde{\alpha}_s, \tilde{b}_s, \tilde{e}_s) \in C_o \mid_{k=0}$, we have $V_o(\alpha_o^*, k^*, b_o^*, e_o^*) \geq$ $V_o(\tilde{\alpha}_s, 0, \tilde{b}_s, \tilde{e}_s)$ = $V_s(\tilde{\alpha}_s, \tilde{b}_s, \tilde{e}_s)$. Thus the owner's expected utility from an optimal option-based contract is at least as large as that from an optimal stock-based contract. This leads to

PROPOSITION 1: An optimal option-based contract weakly dominates an optimal stock-based contract.

The logic of Proposition 1 is quite simple. With option-based contracts, the contract designer has one more contractual variable, namely exercise price, at disposal. As long as this additional contractual variable is suitably chosen, the designer cannot do any worse than stock-based contracts. Precisely because of this simple logic, the above weak dominance result applies to most general situations. For example, we did not impose any restrictions on utility functions, nor made any assumptions on the distribution function.[13] The flip side of the coin is that, if the manager rather than the owner were designing the contract, he would again be no worse off with option-based contracts than with stock-based contracts.[14]

However, the weak dominance result of Proposition 1 is not an entirely robust defense for option-based contracts. If an optimal option-based contract is more likely to have zero exercise price under reasonable utility and distributional assumptions, we are on a shaky ground arguing that option-based contracts are better than stock-based contracts, although the latter are a special case of the former with zero exercise price. Unfortunately, we cannot say much more than the weak dominance result for general utility functions. The reason for this is the incentive-risk tradeoff.

Suppose the owner replaces shares of stock by options with positive exercise price, of which costs to the owner remain the same. For any positive exercise price, the owner can grant more options, thereby making the slope of the manager's compensation function steeper[15] and increasing the pay-performance sensitivity (Jensen and Murphy, 1990). This would induce more effort from the manager. On the other hand, such a convex transformation of compensation function leads the manager to bear more income

[13] The result does not depend on any assumptions on F such as the monotone likelihood ratio condition or the convexity of distribution function condition. The only assumptions we need are those that guarantee the existence of solutions to problems (3) and (6), such as the continuity of the objective functions and those that ensure that the constraint sets are compact.

[14] Coupled with managerial power theory of Bebchuk et al. (2002), this could be taken as one reason for the proliferation of executive stock options during the 1990s. That is, if the CEO controls the board, and compensation committee in particular, then he should prefer option-based contracts to stock-based contracts as the former allow him to extract more rent from the shareholders.

[15] That is, the slope becomes steeper for stock price above the exercise price.

risks in general, which needs to be compensated for by a commensurate increase in the base salary. However, if the distribution of stock price satisfies standard conditions such as the monotone likelihood ratio condition, then, as the manager increases his effort level, the likelihood of his options being out of the money becomes increasingly small compared to that of his options being in the money. Therefore, we could expect option-based contracts to do better than stock-based contracts unless the manager is very risk averse or the effect of his effort on the firm's stock price is very small.

As mentioned in the previous section, Hall and Murphy (2000, 2002) do not consider the incentive effect of options. That is, the distribution of stock price is assumed exogenously given in their studies. They calculate the cost of at-the-money options to the firm (the Black-Scholes value) and their value to an undiversified, risk-averse executive (the executive value) when the executive cannot trade options. For the coefficient of relative risk aversion ranging from 2 to 3, their calculation shows that the executive value is considerably smaller than the Black-Scholes value. Based on this, they suggest that options are an inefficient way of compensation compared to restricted stock. Lambert and Larcker (2004) question the validity of this conclusion since Hall and Murphy do not solve the optimal contracting problem, but rather look at the cost minimization problem assuming that incentives remain the same. Lambert and Larcker conduct simulation studies based on the owner's optimal contacting problem, assuming that stock price follows a truncated normal distribution and the manager's effort affects the mean of distribution. Their results are in stark contrast with Hall and Murphy's. When the manager is less risk averse (the coefficient of relative risk aversion equal to 0.5), options are shown to be part of the optimal contract. For high risk aversion (the coefficient equal to 2), options are still shown to be optimal when volatility is small.[16] Whether options are an efficient form of compensation for the risk-averse manager is thus an empirical question after all. To say something more than weak dominance, we would need more information on various model parameters.

In case the manager is risk neutral, one side of the tradeoff disappears. Thus option-based contracts can be shown to strictly dominate stock-based contracts. As this case is helpful in understanding the mechanics of incentive provision through option-based contracts, we discuss this next.

3.2. Risk-Neutral Case and Strict Dominance

We assume that both players are risk neutral and the manager's utility function is separable, which is denoted by $y - c(e)$ where y is his monetary payoff and $c(e)$ is disutility of effort satisfying $c'(e) > 0, c''(e) > 0$ for all $e \in E$. We also assume that $F(p \mid e)$ satisfies the monotone likelihood ratio condition (MLRC) and the convexity of

[16] Hall and Murphy justify the size of risk aversion they use based on empirical estimates in the literature. Lambert and Larcker argue that, while no empirical evidence is available, executives in entrepreneurial firms may be considerably less risk averse than the "average" investor, whose risk aversion is the basis of Hall and Murphy's studies.

distribution function condition (CDFC), which allow us to use the 'first-order approach' (Grossman and Hart, 1983; Rogerson, 1985).[17]

If the manager chooses $e,$ then total surplus from the owner-manager relationship is $S(e) \equiv \int pdF(p \mid e) - c(e) - \overline{U}.$ Let us denote the first-best level of effort by e^*, which maximizes $S(e).$ The first-order condition is given by

$$\int pdF_e(p \mid e^*) = c'(e^*) \tag{7}$$

where F_e denotes the derivative of F with respect to $e.$ Since $S(e)$ is strictly concave in e due to (CDFC) and $c'' > 0,$ e^* is a global maximizer of $S(e).$ It is well-known that the owner can easily induce the first-best level of effort if the manager is risk neutral and there are no restrictions on feasible contracts. We consider this case first.

Consider a stock-based contract $(\alpha_s, b_s) \in [0,1] \times \Re$, which implements $e_s \in E$. We do not impose limited liability, hence $b_s \in \Re$. In this case, the owner can simply 'sell' the firm to the manager at a fixed price, which induces the manager to choose the first-best level of effort. The owner can then set the fixed price to extract the entire surplus. Thus the optimal stock-based contract is given by $\alpha_s = 1$ and $b_s = -S(e^*)$. It is straightforward to check that the manager's (IC) implies $e_s = e^*$, and (PC) is binding. Such an optimal contract can be trivially replicated by an option-based contract (α_o, k, b_o) with $\alpha_o = \alpha_s = 1,$ $k = 0,$ and $b_o = b_s = -S(e^*).$ Thus an optimal stock-based contract and an optimal option-based contract are equivalent if there is no limited liability on the base salary.

Obviously the case without limited liability is not all that appealing. So we restrict the base salary to be nonnegative. This implies that the above solution of 'selling the firm' is no longer feasible and, therefore, $\alpha_s < 1.$ In this case, it is possible to show that, for any stock-based contract, there is an option-based contract that leaves the manager's expected utility the same but strictly increases the owner's expected utility. In other words, an optimal option-based contract strictly dominates an optimal stock-based contract. The intuition is again straightforward. With limited liability, the first-best level of effort is not chosen and, therefore, there is room for increasing total surplus if the manager can be motivated to increase his level of effort. Since the manager is risk neutral, the optimal contract need not compensate him for bearing additional risks. Therefore, for any given stock-based contract, there is an option-based contract with strictly positive exercise price that provides stronger incentives at no additional cost of risk-bearing. This is shown formally in several steps below.

Suppose an optimal stock-based contract is given by $(\alpha_s, b_s) \in [0,1] \times \Re$, which implements $e_s \in E$. Since $\alpha_s < 1$, the manager chooses the level of effort below the fist-

[17] (MLRC) states that $\frac{f_e(p|e)}{f(p|e)}$ is increasing in *p* where *fe* is the derivative of *f* with respect to *e*. (CDFC) requires *F(p|e)* to be convex in *e*.

best level, e^*. That is, $e_s < e^*$. This can seen from (IC) for e_s. Thanks to (CDFC), corresponding (IC) can be replaced by its first-order condition.

$$\int \alpha_s dF_e(p \mid e_s) = c'(e_s). \tag{8}$$

Comparing (7) and (8), it is immediate that $e_s < e^*$ for all $\alpha_s < 1$.

Consider now an option based contract (α_o, k, b_o) that implements e_o. Again (IC) corresponding to e_o can be replaced by the first-order condition. Moreover, total differential of the first-order condition leads to $\frac{\partial e_o}{\partial \alpha_o} > 0$ and $\frac{\partial e_o}{\partial k} < 0$. Define

$$\Delta(\alpha_o, k) \equiv \alpha_o \int (p-k)^+ dF(p \mid e_o(\alpha_o, k)) - \alpha_s \int p dF(p \mid e_s) \tag{9}$$

where $e_o(\alpha_o, k)$ is the effort level that satisfies (IC) given (α_o, k). Thus $\Delta(\alpha_o, k)$ is the change in the expected value of the manager's at-risk pay when the stock-based contract (α_s, b_s) is replaced by the option-based contract (α_o, k, b_o). Note that $\Delta(\alpha_o, k)$ is continuous in (α_o, k) and $\Delta(\alpha_o, 0) = 0$. Further, $\Delta(\alpha_o, k)$ is decreasing in k since $\frac{\partial e_o}{\partial k} < 0$ and (MLRC) implies that $F(p \mid e)$ first-order stochastically dominates $F(p \mid e')$ for any pair $e > e'$. Similarly $\Delta(\alpha_o, k)$ is increasing in α_o. Therefore we can find (α_o, k) with $\alpha_o > \alpha_s$, $k > 0$, and $e_o > e_s$ such that $\Delta(\alpha_o, k) = 0$. That is, the incentive component of the stock-based contract, α_s, can be replaced by that of the option-based contract, (α_o, k), leading to a higher level of effort while keeping the manager's at-risk expected pay the same.

Next we adjust the base salary for the option-based contract to compensate the manager for the increased disutility from the higher level of effort. Specifically choose b_o such that the manager's expected utilities are the same under both contracts: $U_s(\alpha_s, b_s, e_s) = U_o(\alpha_o, k, b_o, e_o)$. Since $\Delta(\alpha_o, k) = 0$, such b_o is given by

$$b_o = b_s + [c(e_o) - c(e_s)]. \tag{10}$$

So far we have shown that, for the optimal stock-based contract, there is an option-based contract with strictly positive exercise price, which implements a higher level of effort from the manager while not changing his expected utility. It remains to show that the owner is strictly better off under the chosen option-based contract. Using $\Delta(\alpha_o, k) = 0$ and (10), we have $V_o(\alpha_o, k, b_o, e_o) - V_s(\alpha_s, b_s, e_s) = S(e_o) - S(e_s)$ where $S(e)$ is total surplus from e as defined earlier. Since $e_s < e_o < e^*$ and $S(e)$ is strictly concave with a global maximum at $e = e^*$, it follows that $S(e_o) > S(e_s)$, or equivalently, $V_o(\alpha_o, k, b_o, e_o) > V_s(\alpha_s, b_s, e_s)$. Summarizing, we have

PROPOSITION 2: If the manager is risk neutral and there is limited liability constraint on the base salary, then an optimal option-based contract strictly dominates an optimal stock-based contract.

A corollary to the above proposition is that the strict dominance relation will continue to hold when the manager's risk aversion is small. This is due to continuity of the optimal contract with respect to the manager's risk attitude.

4. Example with Mean-Variance Preferences

The previous section established general dominance results. In this section, we study an example. Given enough structure to preferences and stock price distribution, it is possible to solve for an optimal contract with restricted stock. However it is not possible to solve analytically for an optimal contract based on stock options. Therefore we resort to numerical simulations. The purpose of our example is to show that, when the manager is risk averse, we can find an option-based contract that strictly dominates the optimal contract with restricted stock, for a wide range of parameter values.

Denote the manager's final income by y and effort by e. Assume that the manager's preferences can be represented by a mean-variance utility function: $U(y,e) = m_1 E(y) - m_2 Var(y) - 0.5ce^2$ where $m_1, m_2, c > 0$. Stock price, denoted by p, follows a uniform distribution on $[se, \pi + se]$ where $s > 0$. Thus the manager's effort changes the support of the price distribution. In particular, it affects only the mean, but not the variance, which somewhat simplifies algebra. Moreover, stock-based contracts do not affect the variance of the manager's income in this case, although option-based contracts do. Thus, this example of uniform distribution amplifies the income risk from option-based contracts relative to stock-based contracts. Nonetheless it will be shown that option-based contracts dominate stock-based contracts through providing more work incentives. Given *e*, the stock price has $E(p) = se + \frac{\pi}{2}$ and $Var(p) = \frac{\pi^2}{12}$. In what follows, we ignore the base salary and the participation constraint.

Suppose first that the manager's incentives are provided through stock. Let α be the fraction of the firm awarded to the manager. Given α, the manager's utility is

$$U(\alpha, e) = m_1 \alpha \left(se + \frac{\pi}{2} \right) - m_2 \alpha^2 \left(\frac{\pi^2}{12} \right) - \frac{1}{2} ce^2 . \tag{11}$$

The manager's incentive compatibility constraint requires that the manager choose *e* to maximize $U(\alpha, e)$, which leads to $e = \dfrac{m_1 s \alpha}{c}$. Then the owner's expected payoff is

$$V(\alpha) = (1-\alpha)E(p) = (1-\alpha)\left(\frac{\pi}{2} + \frac{m_1 s^2 \alpha}{c} \right). \tag{12}$$

Then the owner's optimization problem leads to

$$\alpha = \frac{1}{2} - \frac{c\pi}{4m_1 s^2} \tag{13}$$

and the manager's equilibrium level of effort is given by

$$e = \frac{m_1 s}{2c} - \frac{\pi}{4s}. \tag{14}$$

From (13) and (14), it is easy to see how the optimal stock-based contract changes as the parameter values change. First, an increase in the manager's cost of effort (c) increases the cost of providing incentives, thereby reducing the optimal size of stock grant, which in turn reduces the manager's equilibrium level of effort. Second, as the manager's input becomes more valuable, i.e., an increase in s, the optimal size of stock grant also increases, which in turn increases the manager's equilibrium level of effort. Finally, the degree of the manager's risk aversion (m_2) does not change the optimal contract, nor the manager's equilibrium level of effort. This is because, in our example, the manager's effort affects only the mean of stock price distribution, but not the variance.

We now turn to the case the manager is awarded stock options. Let (σ, k) be an option-based contract where σ is the size of the option grant and k is the exercise price. If k is less than se, then the option-based contract is equivalent to the stock-based contract with $\sigma = \alpha$ and $k = 0$. So we focus on the case $k > se$ for all e. Then the manager's utility is

$$U(\sigma,k,e) = m_1 E(\sigma(p-k)^+) - m_2 Var(\sigma(p-k)^+) - \frac{1}{2}ce^2 \tag{15}$$

where

$$E(\sigma(p-k)^+) = \int_k^{\pi+se} \sigma(p-k)\frac{dp}{\pi} = \frac{\sigma(\pi+se-k)^2}{2\pi} \equiv \sigma\mu \tag{16}$$

and

$$\begin{aligned} Var(\sigma(p-k)^+) &= \sigma^2 \int_{se}^{\pi+se} ((p-k)^+ - \mu)^2 \frac{dp}{\pi} \\ &= \sigma^2 \left\{ \int_{se}^{k} \mu^2 \frac{dp}{\pi} + \int_k^{\pi+se} (p-k-\mu)^2 \frac{dp}{\pi} \right\} \\ &= \sigma^2 \left\{ \frac{\mu^2(k-se)}{\pi} + \frac{\mu^3}{2\pi}\left((2\pi\mu)^{\frac{3}{2}} - 6\pi\mu^2 + 3(2\pi\mu)^{\frac{1}{2}}\mu^2 \right) \right\}. \end{aligned} \tag{17}$$

As before, the manager's incentive compatibility constraint leads to the manager's optimal choice of e that maximizes $U(\sigma,k,e)$. Denote this by $e(\sigma,k)$. Then the owner's optimal contracting problem is to choose (σ,k) to maximize her expected payoff

$$V(\sigma,k) = E(p - \sigma(p-k)^+) = se(\sigma,k) + \frac{\pi}{2} - \int_k^{\pi+se(\sigma,k)} \sigma(p-k)\frac{dp}{\pi}. \tag{18}$$

Since the above optimization problem cannot be solved analytically, in what follows, we conduct numerical simulations by assigning the following parameter values as our basic case: $m_1 = c = s = 1$, $m_2 = 0.1$, and $\pi = 1.8$.[18] Then from (13) and (14), the optimal stock-based contract is given by $\alpha = 0.05$, and the manager's equilibrium level of effort is e = 0.05. The owner's expected payoff in this case, denoted by V_s, is 0.9025, and the manager's expected utility, denoted by U_s, is 0.0462. Our purpose is to find an option-based contract, not necessarily optimal, that strictly dominates the optimal stock-based contract. For this, we start increasing σ from 0.05, the optimal value of α, while increasing k as well. For each pair of (σ, k), we calculate the manager's optimal choice of e, and then the corresponding payoff for the owner. For our basic case, an option-based contract that strictly dominates the optimal stock-based contract is given by $\sigma = 0.12$ and k = 1. This leads to e = 0.0568, the owner's expected payoff V_o = 0.9323, and the manager's expected utility U_o = 0.0227. This option-based contract strictly dominates the optimal stock-based contract by a suitable adjustment in the base salary since $V_o > V_s$ and $U_o + V_o > U_s + V_s$.

Next we examine whether the dominance relation is robust to changes in parameter values. First, we analyze the effect of the manager's risk aversion by changing m_2 from $m_2 = 0$ (risk-neutral case) to $m_2 = 15$, while holding other parameter values fixed as in our basic case. As noted before, the optimal stock-based contract is independent of m_2 and the manager's equilibrium level of effort remains constant at e = 0.05. However, given the option-based contract (σ, k) = (0.12, 1), an increase in m_2 decreases the manager's effort level: the manager's optimal effort level decreases monotonically from 0.0571 to 0.0539 as m_2 increases from 0 to 15. This reflects the fact that the manager's income risk becomes relevant and significant with option-based contracts. Nonetheless, the manager exerts more effort than with the optimal stock-based contract. As a result, the owner's expected payoff is larger than with the stock-based contract: V_o changes from 0.9327 to 0.9296, larger than $V_s = 0.9025$. However, as m_2 increases, the manager's utility decreases unless there is compensation for the increased income risk. Thus $U_o + V_o > U_s + V_s$ for lower values of m_2 but the inequality is reversed for a large value of m_2. In our example, the cross-over occurs when m_2 = 11, the case where the manager is extremely risk averse.[19] This is shown in the upper panel of Figure 1. Consequently, the option-based contract dominates the optimal stock-based contract unless the manager is extremely risk averse.

[18] The details of the following calculations are available upon request.

[19] Since the stock price is assumed to be uniformly distributed, we cannot directly relate m_2 to the known measure of risk aversion such as the Arrow-Pratt index of absolute risk aversion. However, if the manager's income were normally distributed, then the mean-variance utility with $m_1 = 1$ implies that the degree of absolute risk aversion is equal to $2m_2$. Thus $m_2 = 11$ corresponds to the coefficient of absolute risk aversion of 22.

— Figure 1 goes about here. —

Second, we increase c from 0.98 to 1.02, while holding other parameter values fixed as in our basic case. As the manager's cost of effort increases, the cost of providing incentives increases as well. This reduces the optimal size of stock grant (α) from 0.059 to 0.041, and decreases the manager's equilibrium level of effort from 0.0602 to 0.0402. In this case, an option-based contract that dominates the optimal stock-based contract is given by $(\sigma, k) =$ (0.12, 0.8). Given the option-based contract, the manager exerts less effort as c increases: the manager's optimal effort level decreases monotonically from 0.0726 to 0.0695 as c increases from 0.98 to 1.02. However, the manager again exerts more effort than with each optimal stock-based contract corresponding to each value of c. As a result, the owner's expected payoff is larger, and the sum of the owner's and the manager's utilities is larger with the option-based contract $(\sigma, k) =$ (0.12, 0.8) than with the optimal stock-based contracts: $V_o > V_s$ and $U_o + V_o > U_s + V_s$. This is shown in the lower panel of Figure 1. Consequently, the option-based contract dominates the optimal stock-based contract for all values of $c \in$ [0.98, 1.02].

5. Conclusion

Recent corporate scandals around the globe have led many to point the blaming finger at executive stock options. Whatever the reasons are, there even seems to be a trend of more and more firms moving away from using stock options as a main incentive component of executive compensation. The leading candidate for the replacement of stock options is restricted stock, or ZEPOs (zero exercise price options). This paper argued that such a move away from stock options may not be entirely justifiable.

Using a simple, but general principal-agent model with moral-hazard, this paper has compared option-based contracts with stock-based contracts. In a general environment without restrictions on preferences or technologies, we have shown that option-based contracts can do at least as well as stock-based contracts. The weak dominance simply stems from the fact that options provide contract designers more flexibility than stock.[20] The weak dominance relation becomes strict if the manager is risk neutral. If one interprets options as those with strictly positive exercise price and if the manager is risk averse, however, the usual risk-incentive tradeoff makes a direct comparison of options with stock difficult. Options provide more incentives but also more income risks compared to stock. Which effect will be more prominent is ultimately an empirical question that requires more information on the manager's risk aversion and how the manager's input affects the firm's performance. Our simulation studies show that the strict dominance relation is likely to be robust. Recent simulation studies also suggest

[20] While our argument was made in a moral hazard setting, the dominance result can be also shown in an adverse selection environment. The same flexibility of options contract enables the owner to design more efficient screening contracts than using stock alone. Oyer and Schaefer (2005) report evidence in support of this.

that, unless the manager is extremely risk averse, options with strictly positive exercise price are optimal.

We have also argued that many of the criticisms against stock options are not about stock options per se. They relate to either poorly designed option-based contracts, or the environment - corporate, market and regulatory - in which stock options are used. Abandoning stock options altogether on this ground would deprive corporations of a valuable vehicle through which high-powered incentives can be provided. While it may be plausible to claim that high-powered incentives such as options exacerbate the problem when there are flaws in the environment, such a claim has yet to be tested both empirically and theoretically. What is certain, though, is that improved corporate governance, more transparent disclosure rules, and regulatory oversight that ensures well-functioning capital markets would all make stock options a more, not less, valuable incentive mechanism than they are currently. It is an irony that efforts are made to redress the flaws in the environment on the one hand, while more corporations are abandoning stock options on the other.

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Figure 1: Stock-Based Contract vs. Option-Based Contract