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THE PAY TO PERFORMANCE INCENTIVES OF EXECUTIVE STOCK OPTIONS

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ABSTRACT

Detailed data about stock option contracts are used to measure and analyze the pay to performance incentives of executive stock options. Two main issues are addressed. The first is the pay to performance incentives created by the revaluation of stock option holdings. The findings suggest that if CEO stock holdings were replaced by the same *ex ante* value of stock options, the pay to performance sensitivity of the median CEO would approximately double. Relative to granting at the money options, a value neutral policy of regularly granting options out of the money would increase pay to performance sensitivity by approximately 27 percent. The second issue is the pay to performance created by yearly stock option grants. Because most stock option plans are multi year plans, it is shown that different option granting plans have significantly different pay to performance incentives since changes in current stock prices affect the value of *future* option grants in different ways. Four option granting policies are compared and contrasted. Ranked from highest powered to lowest powered, these policies are: 1) LBO-style up-front options, 2) fixed number policies, 3) fixed value policies, and 4) an (unofficial) policy of "back-door repricing." Empirical evidence suggests that (even ignoring the revaluation of past option grants) the pay to performance relationship in practice is stronger for 1) stock option grants relative to salary and bonus, and 2) fixed number plans relative to non-fixed number plans.

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1. Introduction

The dramatic explosion in stock option grants during the past 15 years represents a major change in the financial incentives facing US top executives. CEOs of the largest US companies now receive annual stock option awards that are larger on average than their salaries and bonuses combined. This represents a dramatic change since 1980 when the average stock option grant represented less than 20 percent of direct pay and the median stock option grant was zero. Moreover, the buildup in these option holdings over time has sharply increased the link between CEO pay and performance, where CEO pay is broadly defined to include all direct pay plus stock and stock option revaluations. The pay to performance from equity revaluations swamp changes in salary and bonus (Jensen and Murphy, 1990; Hall and Liebman, 1998). For example, Hall and Liebman (1998)

find that for a given change in firm value, CEO stock and stock option revaluations are approximately 50 times larger than salary and bonus changes. That is, if performance is measured by changes in shareholder value, stock and stock option-based pay accounts for approximately 98 percent of the CEO pay to performance relationship.

Because of the stock option explosion, managerial incentives can no longer be well understood without a deep understanding of stock options and the incentives they create. But the incentives created by stock options are complex. Indeed, it is not clear that the incentives created by executive stock options are well understood by academics, practitioners or even CEOs themselves. To the extent that CEOs are confused by stock options, their usefulness as an incentive device is undermined.

The incentives created by stock option packages are potentially confusing for two primary reasons. First, although the most widely used technique for valuing executive stock options (the Black-Scholes model) is well-understood by financial economists and practitioners, the formula is complex and the intuition behind it is often hard to fully understand. Indeed, option valuation is sufficiently tricky that two Nobel prizes were recently given for the discovery of the option pricing formula. It is not easy to understand how option values and deltas (the derivative of option values with respect to the stock price) vary with changes in the stock price (farther into or farther out of the money) or with volatility or dividend policy. Indeed, even for those with a deep understanding of finance, understanding the magnitudes of such changes requires a computer and the use of an option pricing model.

Second, the incentives created by options are confusing because it is difficult to understand what is the right thought experiment or the right benchmark. For example,

when comparing pay to performance sensitivities of stock and stock options, is the right comparison between the same *number* of options (shares)? Or the same *ex ante value* of options (shares)? How are incentives affected by new option grants? The revaluation of old options? The revaluation of future option grants? The issues are complex, and one of the main goals of this paper is reduce the confusion surrounding these issues by asking and answering well-defined questions about the pay to performance incentives created by stock options.

The approach taken in this paper is slightly unusual. I am analyzing the pay to performance incentives that would be created by stock options if they were reasonably well-understood, but claiming that they are often not well-understood -- by either the boards who grant them or the executives who are supposed to be motivated by them. The basis for this claim is interviews with many CEO pay consultants, company directors (especially those on compensation committees) and a few CEOs. My interviews with them gave me the strong impression that the incentives created by stock options are not well-understood. Indeed, many viewed option valuation, and the incentives they create, as a confusing black box. Some of the insights from these interviews, which are not yet, complete, are summarized in appendix A. The gathering of systematic evidence on the degree and nature of CEO and board understanding of executive stock options is an important topic for future research.

There are two main issues addressed in this paper. The first has to do with the pay to performance incentives created by existing option holdings. Yearly stock option grants build up over time, in many cases giving CEOs large stock holdings. Change in firm market values lead to revaluations – both positive and negative and sometimes dramatic –

of these stock options and can create powerful, albeit sometimes confusing, incentives for CEOs to raise the market value of their firms. Some of the questions that will be addressed include: How do these pay to performance incentives of stock option holdings compare to those created by the holding of shares of stock? How do pay to performance incentives differ between out of the money, at the money and in the money stock options? How do the pay to performance sensitivities differ from downside relative to upside movements in the share price?

With regards to this set of questions, the results suggest that stock option holdings provide about twice the pay to performance sensitivity of stock. That is, if CEO stock holdings were expropriated and replaced with the same *ex ante* transfer of stock options, the sensitivity would approximately double for the typical CEO. Moreover, if the current policy of granting at the money options were replaced by an *ex ante* value-neutral policy of granting out of the money options (where the exercise price is set equal to 1.5 times the current stock price), sensitivity would increase by a moderate amount – approximately 27 percent. Interestingly, although the sensitivity of stock options is higher on the upside than on the downside, for most relative ranges, even the downside sensitivity of stock options is higher than that of stock.

The second issue addressed is how the pay to performance sensitivity of yearly option *grants* is affected by the specific option granting policy. Just as stock price performance affects current and future salary and bonus, performance also affects the value of current and future stock option grants. That is, independent of how stock prices affect the revaluation of old, existing options, changes in the stock price can affect the value of future option grants, creating a pay to performance from option grants that is

similar in nature to the pay to performance from salary and bonus. This is especially true since many option grant policies are multi-year plans. To the extent that the terms on these multi-year plans remain unchanged regardless of performance (which is not always the case), the value of future option awards are tied to current stock price performance (in different ways, which depend on the plan in place) through the multi-year stock option plan.[1]

Four policies are considered and they are shown to create dramatically different pay to performance incentives. LBO style options (all options are given up front) are shown to have the highest pay to performance incentives, followed, in descending order, by a fixed number of options policy, a fixed value policy, and a "back-door" repricing policy[2] (where bad performance this year is "made up for" by a larger grant next year and vice-versa). The two most common policies are the fixed number and fixed share policies and it is demonstrated empirically that fixed share policies have a higher sensitivity than non fixed share policies, suggesting that fixed share policies have a higher sensitivity in both theory and in practice. In addition, the results suggest that, in aggregate, the pay to performance sensitivity of option grants is much larger (by a factor of five to eight) than the pay to performance created by salary and bonus changes. (The pay to performance of stock option grants is in addition to, and independent of, the pay to performance resulting from revaluations of option holdings, which are the result of previous option awards.)

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[1] For an interesting analysis of the merits of tying future pay to current performance, see O'Byrne (1995).

[2] Unlike fixed share or fixed value policies, back-door repricing is not, of course, an official policy.

Finally, CEO holdings of stock options make the CEO non-neutral with respect to dividend policy and risk-taking. The incentive created by stock options to cut dividends and raise volatility is discussed and analyzed briefly.

2. Methodology and Data

The approach taken in this paper is to first characterize the incentives facing a synthetic CEO – the "typical" CEO, with the typical holdings of stock options and with the typical firm characteristics (regarding dividend policy and volatility, both of which affect an option's value). As just one example, the incentives of this synthetic CEO can be examined as an option package moves father into or father out of the money. The next step is to use actual CEO contracts – specifically the option holdings of CEOs – to do a similar analysis. The incentives created by the holdings of stock options for all the CEOs in the sample are compared with the incentives created by alternative (counterfactual) CEO option policies. For example, this methodology is used to compare the incentives created by the actual policy (granting at the money options) with a policy of granting out of the money options.

Such an analysis requires detailed data of the actual stock and stock option holdings of CEOs. The data used for this project includes detailed compensation of the CEOs of 478 of the largest US publicly traded companies over the 15 year period from 1980 to 1994 and is described in detail in Hall and Liebman (1998), some of which comes from Yermack (1995). The most important component of the data is the details about the stock and stock option holdings. In particular, the data set follows CEO stock option grants and sales over time and matches them with company characteristics. This

enabled Hall and Liebman to construct the details (time to maturity, number of options, exercise price, dividend rate, volatility) of the portfolio of stock options of each CEO so that each CEOs option package could be valued using the Black-Scholes model, as amended by Merton (1973). The Black-Scholes formula is:

$$V_0 = Pe^{-dt}N(Z_1) - Xe^{-rt}N(Z_2)$$

Where:

$$Z_1 = \frac{\ln(\frac{P}{X}) + t(r - d + \sigma 2/2)}{\sigma\sqrt{t}}$$

$$Z_2 = Z_1 - \sigma\sqrt{t}$$

and:

	N(z)	=	cumulative normal probability density function
	P	=	stock price
	X	=	exercise price of option
	r	=	risk-free rate of return
	d	=	expected dividend rate over the life of the option
	σ	=	expected standard deviation of the stock return over the life of the option

The Black-Scholes method of valuing options is imprecise because, in practice, executive stock options are typically inalienable, which limits the CEO's ability to hedge in secondary markets, and because, if dividends are positive, there is a difference in the value of European and American call options because of the value of early exercise. [3] Nevertheless, the Black-Scholes method is the most widely used method by both

[3] Low dividend rates render this a less important issue. If a company does not pay dividends, then American options (which can be exercised early) are no more valuable than European options.

academics[4] and practitioners. It has the advantage of being both tractable and much preferred to the many *ad hoc* methods used by companies until recently, which is why the Black-Scholes method has been endorsed by regulators (SEC, 1992, and FASB, 1993) for the purposes of compensation disclosure.

The vast majority of executive stock options have 10 year duration and vest in proportional amounts over a three to five year period. (See Murphy (1998) and Hall and Liebman (1998) for details on the characteristics of executive stock options.) Moreover, virtually all options are granted at the money (i.e. the exercise price is equal to the stock price on the grant date). A small proportion of companies (about two percent) issue options that are in the money ("discount options," where the exercise price is less than the current stock price at the grant date) and an even smaller proportion (less than one percent) are issued out of the money ("premium options," where the exercise price is greater than the current stock price). Indeed, the uniformity in CEO option grant policies is striking. To a first approximation, the only substantive differences between companies in option grant policies involve the amount of the stock option grant and the type of multiple year plan. The vast majority of companies that have a multi-year plan use either a fixed number (or fixed share) plan (granting a fixed number of options each year) or a fixed value plan (granting a fixed value of options each year).

[4] See, for example, Yermack (1995), Dial and Murphy (1995), Antle and Smith (1995), Aggarwal and Samwick (1998) and Hall and Liebman (1998). For a more elaborate method of option valuation, see Carpenter (1998).

3. Total Compensation: Is there downside sensitivity?

The definition of "total compensation" in this paper is broad and includes the revaluation of stock and stock option holdings. Thus, total compensation is defined to include salary and bonus, new stock option grants, new restricted stock grants, other compensation plus the revaluation of existing stock and stock option holdings. The vast majority of sensitivity comes from the last component – the revaluation of stock and stock options (Hall and Liebman, 1998).

Before proceeding to analyze the incentives of stock options, it is helpful to establish that the holdings of CEO stock and stock options give CEOs substantial downside risk. This is demonstrated first with a simple simulation, which highlights the importance of stock and stock option revaluations. The total compensation of each CEO is calculated for 1994, with the counterfactual assumptions that each firm had a negative 30 percent return and that all direct pay (salary plus bonus, plus new stock option grants etc.) are completely unaffected by the poor performance. That is, the compensation of each CEO is assumed to be actual direct pay – salary, bonus, new stock options, new restricted stock, and other compensation – plus the revaluation of existing stock and stock options, which is negative since I impose a negative 30 percent return on each firm. Note that the annual standard deviation of firm returns is approximately 32 percent, which puts into perspective the magnitude of the 30 percent decline in market value.

The total compensation deciles from smallest to largest are shown in the first row. Then, the firms are divided into quartiles by size, and the same decile cutoffs are shown for each of the four sets of companies. A negative entry in the table indicates that the

negative revaluation from stock and stock options is larger in absolute value than the sum of all positive direct pay.

The table highlights several interesting facts. First, for many CEOs, the possibility of large, negative compensation is significant. The median compensation is negative and a large percentage of CEOs would lose many millions of dollars. Second, even the CEOs of the smallest quartile of companies have substantial downside risk. About 45 percent of the CEOs of the smallest companies would lose more than $1 million if their companies lost 30 percent of their value. Third, there is substantial heterogeneity of downside risk. About 35 percent of the CEOs have relatively small holdings of stock and stock options, which leads them to have positive compensation, even if their companies experienced a 30 percent decline in wealth. Indeed, almost 15 percent of CEOs would make more than $1 million.

This analysis demonstrates that CEOs have substantial downside risk because of their substantial holdings of stock and stock options. To further illustrate this point, in Figure 1, the total compensation of all CEOs in the sample is plotted in a histogram for 1994. The year 1994 is an interesting one since the S&P500 was essentially flat that year. Almost half of the companies in our sample in 1994 had a negative return for the year. The compensation is in millions of dollars times 10^7, so the horizontal scale ranges from negative $10 million to positive $10 million. Four negative and five positive outliers are omitted so that the variation in the data can be seen more easily.

The results show that 24 percent of the CEOs actually experienced a wealth decline during the year, with a significant fraction losing several million dollars or more. Note that since all direct pay is necessarily positive (and averaged more than $2.5 million

dollars during the year), these CEOs experienced wealth declines for the year because of the large devaluation of their stock and stock option holdings.

4. Pay to Performance Payoffs: Stock versus Stock Option Holdings

In this section, I compare the incentives of stock and stock options and out of the money options with at the money options. A key focus is how these incentives change as the stock price changes, both in the positive and the negative direction.

4.1 The sensitivity of an option

Figure 2 shows the sensitivity, or the delta, of one executive option holding the exercise price constant and varying the stock price. The delta is the derivative of the option price with respect to the stock price. In this and all future examples in this paper, a standard executive option is defined to be a 10 year option, with a annual volatility (standard deviation) of 32 percent, and a dividend rate of 3 percent. The risk free rate is assumed to be 6 percent, the approximate yield on 10 year bonds.

The delta at the exercise price (which is normalized to $50) is a little less than 0.6, suggesting that, as a rough rule of thumb, the standard CEO option increases (falls) in value by about 60 cents for every $1 increase (decrease) in firm value. Note also that the sensitivity of an option falls as the stock price falls (and it falls dramatically if the stock price falls by more than 50 percent or so) and rises as the stock price increases. It is in this sense that stock options have less sensitivity than stock and out of the money stock options have less sensitivity than in the money options.

4.2 The sensitivity of packages with the same ex ante values

This analysis is misleading, however, because even though options have less sensitivity than stock, they are worth far less. Indeed, the standard at the money stock option is worth approximately 35.5 percent of the share price, suggesting that, for the same *ex ante* value transfer to the CEO, boards can transfer almost three stock options for every one share of stock.

In figure three, the sensitivity of options is shown holding the *ex ante* package of options constant. In this case, the stock price is normalized to 100 and the exercise price varies. Note that an exercise price of zero is equivalent to stock, so the sensitivity at an exercise price of zero is one. What is important about this analysis is that, in this case, the sensitivity rises in moving from stock (P^E=0), to in the money options (0<P^E <100), to at the money options (P^E =100), to out of the money options (P^E >100). This happens because as the exercise rises, more options are needed to produce the same ex ante value of options, and the greater number of options more than offsets the lower sensitivity per option. For example, the same value of at the money options (PE=100 in the figure) has a sensitivity of about 1.7. This sensitivity represents almost three options times a sensitivity that is a little less than 0.6 per option. Thus, for the same value transfer, at the money stock options have a sensitivity that is approximately 70 percent larger than stock and out of the money options have a sensitivity that is larger than at the money options. This demonstrates the leverage effect of options.[5]

[5] See also Lazear (1998) for a discussion of the leverage effect of options. Also, Dial and Murphy (1995) report an example of deleveraging at General Dynamics. The top executives traded their underwater options for the same *ex ante* value of at the money options, which lowered their pay to performance sensitivity. This example provides the basis for a student exercise in a Harvard Business School MBA

In order to illustrate the leverage effect of options for large but plausible stock price changes, Table 2 shows the upside and the downside sensitivity of $1 million worth of stock and options. The table shows the sensitivity for four packages, stock, at the money options, options 50 percent out of the money (the exercise price is equal to 1.5 times the stock price at the grant date) and indexed options (options with an exercise price that is indexed to the S&P 500). The entries in the table then show the change in value for stock price changes for stock price increases – from $100 to $125 and from $125 to $150 – and for downside movements – from $100 to $75 and then from $75 to $50. The sensitivity of the option package relative to the benchmark case of stock holdings (the "relative sensitivities") is also shown.

The leverage effect of options can be seen by comparing the option changes to the stock value changes. For a 25 dollar change in the stock price, the value of stock always changes by exactly $250,000, which is the benchmark. Note that for a price movement from $100 to $75, the at the money package falls by $394,000 and then falls by another $325,000 for a drop in price from $75 to $50. The differential in upside sensitivity is even larger. For example, an increase in price from $125 to $150 increases an at the money option package by about $461,000, which is 84 percent larger than the increase in the stock package. The out of the money packages have even greater sensitivity on both the upside and the downside. For example, a price movement from $100 to $125 increases the value of this particular out of the money package by $499, which is approximately double the increase in the stock package.

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course called "Coordination, Control and the Management of Organizations."

The last package analyzed includes indexed options. Such options, rarely used in practice, remove changes in option values that are solely the result of market wide changes in stock prices. This type of option is often touted for this advantage: with indexed options, CEOs are neither rewarded for market increases in stock prices nor punished for declined in stock prices that merely mimic market wide declines. But indexed options also have the important feature that they are highly leveraged. An indexed option is similar to a premium option in that the (expected) exercise price is higher than the current stock price, the key difference being that the exercise price for indexed options is uncertain at the grant date. Each indexed option is worth much less than stock (by definition, half of them will expire out of the money), so an executive can be given many of them. Indexed options can be priced according to the formula for exchange options (Margrabe, 1978), which gives the value of the option to exhange one asset (the stock of a typical company) for another asset (a share indexed to the S&P 500).[6]

The leverage of indexed options is shown in the bottom rows of Table 2. A 25 percent increase in the stock price increases the value of $1 million worth of indexed options by 53.9 percent or $539 thousand. The sensitivity of indexed options over this range is more than double that of stock. Decreases in the price show similar, albeit slightly smaller, changes in the value of indexed options relative to stock. Indexed options, like premium options and even more than at the money options, are highly leveraged.

[6] The standard deviation of the exchange asset reflects the covariance between the typical (median) stock and the S&P 500 returns and is assumed to be 27 percent. The dividend rate is assumed to be the same for both assets (the typical stock and the S&P500). Thus, both the dividend rate and the risk free rate are set to zero.

4.3 The Range of Downside Sensitivity of Options

Claiming that the downside sensitivity of options is greater than the downside risk of stock, however, is a bit misleading because it depends on the range of stock price movements considered. After all, the downside risk of all packages with the same *ex ante* value is the same if the stock price falls from the current price to zero. In all of these cases, the loss is exactly equal to the *ex ante* value.

In Figure 4, the sensitivity of the same four packages, with the same *ex ante* value is shown for various stock price movements. The packages all have the same *ex ante* value when the stock price is equal to its starting point, which is defined to be $100. Note that as the stock price falls, the sensitivity of the options is higher until the stock price falls below a particular threshold, which is between $40 and $50 in all three cases. Because the sensitivity of options is higher than stock for price movements from $100 to $45 or so, the options have little value remaining, which lowers their sensitivity. The downside sensitivity of options is higher for even large drops in the stock price, but decreases larger than 55 percent or so decrease the delta so much that their sensitivity falls below that of stock, despite the greater number of options. Of course, the analogous effect for upside sensitivity does not hold. The sensitivity of options (especially out of the money options) relative to stock diverges as the stock price increases, exacerbating the leverage effect of options.

4.4 Policy Changes and Actual Contracts

The analysis so far has focused on a representative CEO and a representative option at the grant date. In this section, I use the actual CEO contracts (their total stock and option holdings with all of the details about their options) to determine how

sensitivity changes for all of the CEOs, assuming various counterfactual changes to their option plans.

The first experiment is to determine how sensitivity would change if the current practice of issuing out of the money options were replaced with a policy of issuing options that are 50 percent out of the money at grant date, but have the same *ex ante* value. Thus, I start with each CEO in 1994. I then go back into history and replace the (typically) at the money option grants with a greater number of out of the money options, the number chosen to make equivalent the ex ante values of the packages. The sensitivity of the CEO's option packages holding everything else the same is then examined. The sensitivity of the actual packages for a 30 percent change (positive and negative) is then compared with the sensitivity of the alternative, counterfactual, package of options. The results show this policy change would increase sensitivity by a moderate amount. There would be a 15 percent increase in sensitivity for the downside stock price movement and a 38 percent increase in sensitivity for the equivalent upside price move. The sensitivity for a derivative change in stock prices is about 27 percent.

A policy change of replacing stock with at the money options is, consistent with the earlier analysis, much more dramatic. The precise experiment here is to expropriate all CEO stock, which is then replaced by standard executive options. The option packages have a sensitivity that is more than double that of stock, for both upside and downside movements at the median. Replacing stock with stock options would more than double the sensitivity of the CEO's package. Interestingly, there is a growing use of stock ownership guidelines by companies, which require CEOs to hold a certain amount of stock, typically measured as a multiple (3 to 7 times are typical) of salary or salary and

bonus. In almost all cases, stock option holdings do not count toward the total, despite their having greater sensitivity per dollar of holdings. In fact, the ownership guidelines give CEOs the incentive to sell their options in order to buy and hold stock.

5. Multi-Year Option Plans and Sensitivity

The analysis to this point has focused on the pay to performance that results from the *holding* of executive stock options – that is, from the revaluation of existing options. But the *granting* of new stock options, as opposed to the revaluation of old stock options, also leads to a relationship between pay and performance. That relationship may be negative, positive or zero. But just as academics have focused on the pay to performance relationship from salary and bonus, there is a pay to performance relationship resulting from the granting of stock options.

As before, I proceed by first showing how various option grant policies affect the pay to performance relationship with a stylized, "representative" example. I then proceed to examine this pay to performance empirically with the data on CEO stock option grants. I begin by examining the pay to performance of the two most common option granting policies, which I will refer to as "fixed value" policies and "fixed number" policies. Importantly, the difference between these two policies lies in how current changes in a firm's stock price affects the value of *future* grants.

5.1 Stock price changes and future option grants: four policies

The fixed value policy is a typical multi-year option plan that specifies in advance the value (because of FASB rules, these options are typically valued at Black-Scholes) of the options that will be granted in future years. For example, a board may stipulate that

an CEO will receive an option grant of $1 million per year for the next 3 years. Or the board will stipulate that the option grant in each of the next 3 years is some fraction (or multiple) of salary (or salary and bonus). The key point about these types of policies is that the value of future grants is not tied to current performance (unless there is a link with salary and bonus, which would provide a small amount of pay to performance).

The most transparent way to see how these policies affect future performance is by way of stylized examples, which are shown in Table 4. Imagine a CEO who has a fixed value policy that gives the CEO $1 million for each of the next three years. The CEO receives the $1 million grant at the beginning of the year, and the stock price increases by twenty percent during the year, which raises the value of those (standard) options by approximately $323 thousand. The key is that the value of next year's grant is completely unaffected by this performance. The CEO receives fewer options, each of which is worth more since the stock price has risen, in order to produce a grant value of $1 million. So while there is some pay to performance in the revaluation of this year's beginning-of-year grants, there is no pay to performance in next year's grant. (Of course, if this had been a year in which the old plan had expired, then the CEO may have been granted more options the following year.) The NPV of the total gain to the CEO for the next three years is therefore $305.

A second common policy is a fixed number policy, which stipulates the number of options that will be granted over a certain number of years. Unlike the fixed value policy, under the fixed number policy, an increase in the stock price this year will increase the value of future option grants. Using the analogous example, when the stock price rises by 20 percent this year, the number of options given next year will stay the

same, which increases the value of next year's at the money option grant, and the value of each subsequent year that is a part of the multi-year fixed number plan. As can be seen from the example, the NPV of the gains in all three years for the fixed number plan is more than double that of the fixed value plan. Similarly, a decrease in this year's share price would decrease the value of future option grants under the fixed number policy. The key is that unlike the fixed value plan, the fixed number plan ties changes in this year's stock price to the value of future option grants, increasing pay to performance.

A third type of policy, almost never used in practice for large publicly traded companies, is to issue a large number of (unvested) options up-front, which are granted in lieu of future options. This policy is widely used as an incentive device for managers in LBOs (whose stock is typically not traded publicly immediately after the LBO), which is why I refer to it as an LBO-style option policy. In this case, the comparable example is to grant the CEO options up-front, which have an *ex ante* value equal to the NPV of $1 million. In this case a 20 percent increase in the stock price increases the value of options by a factor that is nearly three times as large as the benchmark, fixed-value case. This is not surprising since this policy essentially holds both the number and the exercise price of option grants constant.

Finally, it is possible that many companies use option grants as a way to buffer current stock price movements. That is, although actual repricing of past stock options is remarkably rare for top executives[7] (although it is more common for non-executives), it may be that boards use future grants to offset past (revaluation) gains or losses as a type

[7] See Hall and Liebman, 1998.

of "back-door" repricing. An example of this, with complete offset, is shown at the bottom of Table 4. In this case, the future value of option grants fall when this year's stock price rises (and would rise if the stock price fell). To the extent that this type of policy is widespread, it would imply a negative correlation between future option grants and current stock price performance.

5.2 Empirical Evidence: The pay to performance of option grants

In practice, companies use a variety of multi-year plans. Most are fixed number or fixed value, and many of the others use a discretionary year by year policy, which could induce either positive or negative relationship between price changes and the future value of option grants. Moreover, the actual pay to performance from multi year plans may deviate from the stylized examples if boards use their discretion to change the rules in the middle of a plan. And even if boards hold the line during the years covering a multi year plan, old plans end, which lead to new plans. A CEO can be rewarded (or punished) for good past performance during each transition year. It is an empirical issue, therefore, as to how strong the pay to performance relationship is for option grants.

In order to test the relationship between current performance and the value of future option grants, I estimate an equation with the log of option grant value as the dependent variable and three lags of firm returns as right hand side variables. (following, among others, Joskow, Rose and Shephard, 1993 and Joskow and Rose, 1994) Year and CEO fixed effects are also included.

Thus, the estimated equation is:

$$COMP_{t,i} = \alpha + B_1 return_{t-1} + B_2 return_{t-2} + B_3 return_{t-3} + \phi_t + \lambda_i + \varepsilon_{t,i}$$

where:

$COMP_{t,i}$ = the option value grant in year t for CEO i

$return_{t-1}$= the firm return in year t-1

ϕ_t = year indicator variable

λ_i = CEO indicator variable

The estimated regression shows how changes in returns affect future compensation (option grants at the beginning of each of the next three years). Because outliers in such regressions can be significant, both OLS and quantile (median) regressions (which essentially estimate the median rather than the mean relationship and therefore do not give disproportionate weight to outliers) are estimated.

The results are shown in the first two columns of table 5. Note that the coefficients of all three lags of performance are significant and positive. The coefficients add to 0.96 and 0.94 in the two specifications. This implies that a 10 percentage point increase in this year's returns leads to about a 9.5 percent increase in the value of future option grants. This is about five times larger than previous estimates of this relationship, with the log of salary and bonus as the dependent variable (Joskow, Rose and Shephard, 1993.) Since previous studies have focused on the relationship between past returns and salary and bonus, I repeat this analysis, with the same exact CEOs, with the log of salary and bonus as the dependent variable. The sum of the coefficients in both cases add to about 0.12, which are smaller but still in the range of previous estimates of about 0.22.

In order to explore this issue further, the same equation is estimated with the log of the number of options as the left hand side variable. The fixed value policy should lead to negative coefficients on the returns while the fixed share policy would lead to zero coefficients on the return variables. Of course, in practice boards can use their discretion to increase or decrease the number of shares in response to a given stock price performance, so even a positive coefficient is possible.

The results are shown in the last two columns of table 5. In both cases the coefficients are small and their sum is very close to zero. The quantile regression, for example, suggests that a 10 percentage point increase in the stock return leads to a 0.3 percent decrease in the number of future options. In aggregate, the estimates suggest that there is little relationship between current stock price changes and the number of future options granted.

Finally, I compare the relationship between returns and option values for CEOs with a fixed number plan and those without a fixed number plan. A CEO is considered to have a fixed number plan if the number of options in any two years is the same. Slightly less than 40 percent of CEOs have such a plan, which is in line with estimates from compensation consultant reports.[8] The expectation based on the previous analysis is that, unless boards use significant discretion to override the actual plans, the relationship between returns and the value of option grants will be stronger for CEOs with fixed number plans relative to those without such plans. The results are shown in the first two

[8] For example, a Towers Perrin CompScan Report (1998) finds that about one-third of the companies surveyed use a fixed number plan. (And nearly half of the largest companies use a fixed number plan.) The remaining companies use some version of a fixed value plan.

columns of table 6 and are consistent with this expectation. The coefficients in the fixed number plans add to 1.18, which is 0.44 larger than the 0.74 coefficient for CEOs without a fixed number plan.

In order to test the robustness of this finding, the same results are estimated without CEO fixed effects, but the dependent variable (the log of the option value) is demeaned. Although CEO fixed effects is the more common specification, fixed effects removes the mean from each variable. Removing "the normal rate of return" leads to a less natural interpretation of the results since the specific test is that larger increase in the stock price (higher returns) lead to an increase in the value of future option grants. In any case, the results are substantively similar. Although the sum of the coefficients is lower in both cases, the sum of the fixed number coefficients is 0.4 larger than the sum of the coefficients for CEOs with no fixed share plan. The relationship between current stock price performance and future stock grants is larger for firms with a fixed number plan.

6. Other Incentives Created by Stock Options: Dividends and Volatility

The focus of this paper is the pay to performance relationship created by stock options -- how and to what extent do option holdings or option grants link monetary payoffs to CEOs with changes in firm share prices. But stock options also affect a CEO's incentives regarding dividend policy and risk-taking, since both dividends and stock price volatility enter into the Black-Scholes equation. These are analyzed briefly, beginning with dividend policy.

6.1 Dividend Policy Incentives

CEOs who hold their company's stock are, to a first approximation, as neutral to dividend policy as other shareholders. A CEO-stockholder can reap gains from either retained earnings and share price appreciation or through dividends.[9] CEOs who hold stock options, however, are not neutral to dividend policy (Lambert, Lanen and Larcker, 1989), unless they have "dividend protection," which is quite infrequent. Murphy (1998) reports that about one percent of CEOs with options have dividend protection.

The value of a stock option falls as dividends increase, *ceteris paribus*. The intuition for this result is straightforward. Efficient markets lead firms to have the same expected, risk-adjusted, total rate of return. That return is some combination of dividends and share price appreciation. Higher dividends, thus, lower the expected rate of price appreciation and vice versa.

The implication of this is straightforward: a CEO with large holdings of stock options prefers, *ceteris paribus*, share buybacks rather than dividends. How large is this effect? Table 7 shows the relationship between the dividend rate and the value of one option, for an otherwise standard executive option. The value of a standard executive option is 57 percent of the share price if expected dividends are zero. If expected dividends are three percent, which is about the average for publicly traded companies, a standard executive option has a value of about 36 percent of the share price. And if the dividend rate is eight percent, an otherwise standard executive option has a value of only 15 percent of one share.

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[9] Of course, taxes, financial distress costs and agency costs complicate this, making owners non-neutral to dividend policy.

This suggests that CEOs may have much to gain by lowering the dividend rate. As with the previous analysis, counterfactual simulations on the actual CEO stock holdings are used to determine the magnitude of the incentive to cut stock options. Table 8 shows how CEO stock holdings change if all companies cut their dividends to zero. The mean (median) increase in the value of CEO stock holdings is 54 percent (35 percent), which represents about $1.4 million ($530 thousand). Moreover, this masks a large variation in changes in the value of stock option holdings. For example, 10 percent of CEOs would stand to more than double the value of their stock holdings, gaining more than $3.3 million. The magnitudes of gains for changes in dividend policy are potentially large.

One objection to this analysis is that cuts in dividends are typically associated with declines in the stock price and vice versa. While this is true, the most obvious interpretation for this result is that dividend policies are an important signal to the market. However, to a first approximation, we can expect that price changes that result from false signals will eventually be reversed. Thus, a dividend cut (or the non-increase in a dividend) that is not associated with any real negative information about a firm's underlying profitability should not decrease share prices permanently.

It is difficult to know how important this incentive is in practice. However, recent evidence by Jolls (1998) suggests that firms that rely more heavily on stock-option based compensation are more likely to repurchase stock than firms that do not rely heavily on stock-option based compensation. Jolls points out that the surge in option based compensation coincides with the rise in share repurchases as a means to returning earnings to shareholders and interprets her results as evidence that the two are linked.

6.2 Risk and Incentives

CEOs can also increase the value of options by increasing the volatility of the stock price. Indeed, it is sometimes argued that one of the main reasons that stock options are used is that they increase the risk-taking incentives of CEOs who take too few risks because of their risk-aversion and stock holdings. While this is an enormously complicated issue beyond the scope of this paper, it is interesting to simply calculate the value of a standard executive option as a function of the volatility of the stock price.

Table 9 shows how the value of a standard stock option varies with the annual standard deviation of the stock price, holding all other factors constant. This relationship is also plotted in Figure 5. As can be seen, the value of a standard executive stock option varies dramatically with the volatility of the stock. The average volatility of publicly traded stocks is slightly above 0.3, in which case one option is worth about 36 percent of the price of one share. However, if the volatility falls to 0.1, the value drops to 21 percent of a share, and if the volatility rises to 0.6, the value of one option increases to 52 percent of the share price. To the extent that CEOs can significantly raise the volatility of their stock price without affecting mean returns, they can raise the value of their stock options substantially.

Although raising the volatility of the stock would raise the value of the options, risk averse CEOs would not necessarily find it optimal to do so. Even though the payoff function of options is convex, granting a CEO more (highly leveraged) risky options could induce less risk-taking, not more. The extent to which option grants increase or decrease CEO risk-taking is a function not only of the convexity of the payoff function,

but also of the CEO's risk aversion, which in turn depends on his wealth and other factors.

The risk aversion of CEOs also has implications for how CEOs are motivated by stock options. This paper has focused on the pay to performance of options in terms of payoffs, which I believe is an important first step. But how do risk averse CEOs view these payoffs? The benefits of options relative to stock in terms of leverage are limited by the risk aversion of CEOs.[10] If CEOs were risk neutral, they could be motivated well (at very low cost) with options with near infinite exercise prices. The optimal contract is somewhere between straight stock grants (which have no leverage) and options that are way out of the money (with enormous leverage). The optimality of various option packages will therefore depend, in complicated ways, on various factors affecting CEO risk aversion and on the characteristics of the options, a topic that Kevin J. Murphy and I are addressing in future work.

7. Conclusion

The dramatic explosion of stock options has, in turn, dramatically affected the pay to performance incentives of CEOs. These incentives are complex and hard to understand for two main reasons. First, the computation of option values and deltas are not straightforwardly intuitive. For example, it seems that many executives do not understand how the value or sensitivity of their option packages change with changing stock prices. Second, the incentives created by stock options are complicated by the fact

[10] Indeed, one of the most basic tradeoffs in economics is between incentives and risk reduction. See Fama and Jensen (1983), for example.

that there are so many potential thought experiments, which jumble and conflate the issues. For example, when comparing stock and stock options incentives, should the same number of shares (options) be compared, or the same *ex ante* value? The different thought experiments lead to opposite conclusions. Likewise, when analyzing the incentives created by options, is it the revaluation of old options that matters? Or the granting of new options? The issues are complex and one of the main goals of this paper is to make both the questions and the answers more transparent.

The main findings in this paper fall into two broad categories. The first issue concerns the pay to performance sensitivity of existing holdings of stock and stock options – that is, the pay to performance created by the revaluation of options and stock. While one standard option has less sensitivity than one share of stock, if packages with the same *ex ante* value are compared, standard executive stock options have a much higher pay to performance sensitivity than stock. For example, the findings in this paper suggest that if all the stock of CEOs were expropriated and replaced with stock options, the sensitivity of that "incentive package" would more than double. Importantly, over most relevant ranges, this sensitivity would double for both large price decreases and large price increases, although it is the case that the upside sensitivity of stock options is greater than the downside sensitivity.

In addition to sensitivity emanating from the revaluation of stock options, the *granting* of stock options creates a relationship between pay and performance. That is, multi-year option plans create a connection between current stock price changes and the value of future stock option grants. In theory, this pay to performance relationship could be positive, negative or zero. For example, with fixed number plans, boards reward good

performance with even larger grants (valued at Black-Scholes) in subsequent years. With fixed value plans, the relationship between stock price performance and future option grants is muted since the value of future option grants is either unaffected by current performance or only weakly related through a relationship with salary and bonus. And boards could create a negative relationship between current performance and future awards by engaging in "back-door repricing:" giving smaller awards following good performance and larger rewards following bad performance in order to shield the CEO from large wealth swings.

The evidence suggests a strong, positive relationship in the aggregate. The value of stock option grants has a strong and statistically significant relationship with past performance. Indeed, the relationship between stock price performance and the value of future option grants is five to eight times stronger than the analogous relationship between stock price changes and salary and bonus. Moreover, consistent with expectations, the pay to performance relationship for CEOs with fixed number plans is higher than that for CEOs without such plans (most of whom have some sort of fixed value plan).

The dramatic increase in stock options is one of the most important corporate governance changes of the past two decades. Despite this explosion, it is not clear that the incentives created by these stock options are well understood by either boards who issue them or CEOs who are meant to be motivated by them. But learning takes place over time, and I hope that this paper contributes to the learning process.

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Appendix A

What follows is a brief summary of the key findings of the interviews, which are not yet complete. I conducted interviews with consultants at most of the major compensation consulting firms including Frederic W. Cook and Company, Stern Stewart, William M. Mercer Inc., Watson Wyatt and Company, Buck Consultants, and Hewitt Associates. I also interviewed two directors (both compensation committee members) and two CEOs, who chose to remain anonymous.

One of the most striking findings was the view that many CEOs and directors found stock option valuation to be a "black box" that they did not understand well. Most believed that CEOs and directors did not understand the basic intuition behind Black-Scholes and often were surprised by the valuations implied by the Black-Scholes model. In particular, there seemed to be a bias toward valuing options according what they would be worth if exercised today. As a result many viewed at the money or out of the money options as near worthless "because they are not worth anything unless the share price goes up."

To the extent that CEOs do value options according to their "value if exercised today"(which is the polar extreme of the bias alleged above), then CEOs underestimate the sensitivity of out of the money options (since in reality their deltas are greater than zero) and overestimate the sensitivity of in the money options (since their deltas are actually less than one). Some of the people I interviewed, however, thought that the black-box confusion surrounding stock options created an overall downward bias in perceived sensitivity since CEOs undervalued them even when they were in the money. In a minority of cases, the compensation consultants believed that CEOs overvalued their

options because of excessive optimism about their company's future. That is, they thought that the market was dramatically undervaluing their stock and therefore their stock options.

With regard to the issue of whether CEOs and directors understood how current changes in the stock price affected the value of future grants, the general view was that many, if not most, did not understand this or look that far ahead. A few compensation consultants made comments to the effect: "They don't understand how price changes affect their current options. How are they going to understand how prices today affect future grants?"

Nevertheless, it was clear that many CEOs understand, at least in a vague sense, that current performance affects the value of future grants. For example, some CEOs felt that fixed value plans were perverse and unfair, especially following stock price increases. CEOs with fixed value plans thought it puzzling that they were given fewer options following good performance. (But fewer options are required to reach the same value in fixed value plans.) The majority view seemed to be that fixed number plans were superior because they weren't perverse or unfair in this way.

Interestingly, most thought that the main obstacle to fixed number plans was the use of compensation surveys, which typically require keeping stock option awards at some value (some fixed value or some value relative to salary and bonus). A pure fixed number plan puts no restriction on the value of the option grant. In this sense, the use of surveys limits the use of fixed number plans and therefore limits pay to performance.

Table 1

Total CEO Compensation, Simulation Using Actual Contracts and Assuming Poor Performance

Assumes a negative 30 percent return. Total compensation is defined to be salary plus bonus plus new option grants plus other compensation plus the change in the value of stock and stock options.

		Decile Cutoffs of Total Compensation ($millions)								
		lowest total compensation						highest total compensation		
		10	20	30	40	50	60	70	80	90
All Firms		-23.5	-6.5	-2.6	-1.3	-0.6	-0.2	0.3	0.7	1.4
Quartiles, by size:										
Smallest	1st	-16.2	-4.5	-1.9	-1.3	-0.6	-0.3	0.1	0.4	0.9
	2nd	-11.6	-2.7	-1.5	-0.6	-0.3	-0.2	0.4	0.7	2.0
	3rd	-49.2	-12.2	-2.8	-1.3	-0.7	-0.2	0.5	1.1	3.0
Largest	4th	-28.1	-12.0	-6.0	-2.6	-1.6	-0.5	0.1	0.9	1.6

Table 2

The Downside and Upside Senitivity of $1 Million of Stock Options ($1,000s)

		Initial Sensitivity: Change in wealth per $1 change in stock price		Downside Risk Price Changes From: 100 to 75	Downside Risk Price Changes From: 75 to 50	Upside Potential Price Changes From: 100 to 125	Upside Potential Price Changes From: 125 to 150
Stock P_E=0	Sensitivity	10	Gain/Loss	-250	-250	250	250
	Relative Sensitivity	1	Relative Sensitivity	1	1	1	1
Options at the Money P_E=100	Sensitivity	16.7	Gain/Loss	-394	-329	434	461
	Relative Sensitivity	1.67	Relative Sensitivity	1.58	1.32	1.74	1.84
Options out of the Money P_E=150	Sensitivity	18.8	Gain/Loss	-431	-333	499	549
	Relative Sensitivity	1.88	Relative Sensitivity	1.72	1.33	2.00	2.20
Indexed Options P_E indexed to S+P 500	Sensitivity	20.1	Gain/Loss	-457	-339	539	595
	Relative Sensitivity	2.01	Relative Sensitivity	1.82	1.51	2.16	2.38

Assumptions: Price of stock is initially $100 per share, duration is 10 years, interest rate is 6%, dividend rate is 3.0%, standard deviation of returns is 32%. Indexed options are priced as options to receive one asset in exchange for another (the S&P 500). The standard deviation of an indexed option for a typical stock is assumed to be 0.27, which adjusts for the covariance between the typical stock's return and the S&P500. The expected dividend rate and the rate of return of the two assets (the typical stock and the S&P 500 index) is assumed to be the same.

Table 3

Pay to Performance changes From Two Policy Changes

Policy	Assumed Return	Actual Median Change with Existing Policies ($millions)	Median Change with New Policy ($millions)	Percent increase in Pay to Performance Sensitivity
Options are issues 50% out of money[1]	-30%	-1.16	-1.33	15%
	30%	1.36	1.88	38%
Stock replaced with at the money options[2]	-30%	-1.16	-2.35	102%
	30%	1.16	2.83	144%

Notes:

[1] The policy change is to go back in time and counterfactually assume that all option grants (which are virtually always issued at the money) were issued 50 percent out of the money (so that $P_E = 1.5$ P). The replacement option package of out of the money options has the same ex ante value as the at the money package of options.

[2] The policy change is to expropriate all CEO stock holdings, which are replaced with the equivalent value of standard executive options.

Table 4

How Stock Price Increases Affect Current and Future Option Grants

(Assumes a 20 percent increase in stock price)

		Stock price				
		Year 1 (Beginning)	Year 1 (End)	Year 2 Grant	Year 3 Grant	NPV of Changes
Policy		**100**	**120**	**120**	**120**	
Fixed Value (Benchmark)[1]	Value of Options	**$1,000,000**	**$1,322,870**	**$1,000,000**	**$1,000,000**	
	Number of Options	28,128	28,128	23,440	23,440	
	P_E	100	100	120	120	
	Change in Value		$322,870	$0	$0	$304,590
Fixed Number[2]	Value of Options	$1,000,000	$1,322,870	$1,200,000	$1,200,000	
	Number of Options	**28,128**	**28,128**	**28,128**	**28,128**	
	P_E	100	100	120	120	
	Change in Value		322,870	$200,000	$200,000	$671,270
LBO: Options are given up front[3]	Value of Options	**$2,833,400**	$3,748,210			
	Number of Options	**79,697**	79,697	0	0	
	P_E	**100**	100			
	Change in Value		914,810			$863,030
Back Door Repricing[4]	Value of Options	$1,000,000	$1,322,870	**$833,842**	**$833,842**	
	Number of Options	28,128	28,128	**19,545**	**19,545**	
	P_E	100	100	**120**	**120**	
	Change in Value		$322,870	**$166,158**	**$166,158**	**$0**

Notes:

[1] The value of future grants is unaffected by current performance.

[2] The number of future grants is unaffected by current performance.

[3] All options are given up-front. The value of the up-front options is equal to the benchmark case -- the net present value of $1 million for three years.

[4] The change in the value of this year's option grants is offset by changes in the value of future grants.

Table 5

Performance and Future Option Grants
1980 - 1994

Independent Variables	Dependent Variables					
	ln (Opt. Val.)		ln (Salary + Bonus)		ln (Opt.Num.)	
return $_{t-1}$	.610	.607	.001	.004	.116	.046
	(.087)	(.038)	(.018)	(.017)	(.038)	(.021)
return $_{t-2}$	.123	.234	.069	.071	-.090	-.060
	(.083)	(.036)	(.017)	(.016)	(.036)	(.021)
return $_{t-3}$	.226	.102	.050	.046	-.021	-.018
	(.079)	(.034)	(.016)	(.016)	(.035)	(.019)
sum of coefficients	0.96	0.94	0.12	0.12	0.01	0.03
Adjusted R^2 or Pseudo R^2	0.03	0.05	0.23	0.11	0.02	0.004
observations	2280	2880	2280	2880	2998	2998
Specification[1]	OLS	quantile	OLS	quantile	OLS	quantile

Note [1] All specifications include year and CEO fixed effects.

Table 6

Option Grants and Performance:
Comparing CEOs with and without fixed share plans

Dependent variable is ln (option value grant). 1980-1994				
Independent variables	No fixed number plan	Fixed number plan	No fixed number plan	Fixed number plan
return $_{t-1}$	.482	.806	.303	.679
	(.056)	(.062)	(.036)	(.059)
return $_{t-2}$	.156	.334	.091	.210
	(.052)	(.059)	(.035)	(.057)
return $_{t-3}$	.107	.042	.031	-.033
	(.050)	(.058)	(.032)	(.057)
sum of coefficients	.74	1.18	.42	.86
	(.10)	(.12)	(.07)	(.11)
Adjusted R^2 or Pseudo R^2	0.03	0.11	0.02	0.09
observations	1781	1099	1781	1099
Specification[1]	CEO fixed effects	CEO fixed effects	Dependent variable is de-meaned	Dependent variable is de-meaned

Note [1] All regressions are quantile and include year fixed effects.

Table 7

How the Value of CEO Option Holdings Change When Dividend Policies Change

Annual dividend	Value of one option
.00	.57
.01	.49
.02	.42
.03	.36
.04	.30
.05	.25
.06	.21
.07	.17
.08	.15
.09	.12
.10	.10

Assumptions: The stock price, which is equal to the exercise price, is normalized to one. The duration is ten years. The standard deviation is assumed to be 32 percent per year

Table 8

Using Actual Contracts: Increases in Option Values if Dividends are Eliminated

	Increase in the value of existing option holdings of CEOs, assuming that the dividends of all firms are cut to zero. (1994)			
	Mean	Median	10th percentile change	90th percentile change
Percent change	54%	35%	0%	116%
Dollar change ($1,000)	$1,351	$530	$0	$3,349

Table 9

Option Values and Volatility

Table shows how the value of a standard CEO option varies with the volatility of the stock price.

Annual Standard Deviation	Value of one option
.1	.21
.2	.27
.3	.34
.4	.41
.5	.47
.6	.52
.7	.57
.8	.61
.9	.64
1.0	.67

Assumptions: The stock price, which is equal to the exercise price, is normalized to one. The duration is ten years. The dividend rate is 3 percent.

Figure 1

Histogram of CEO wealth changes in 1994. The graph ranges from negative $10 million to positive $10 million. Five positive and four negative outliers are not shown. A CEO wealth change is defined as salary plus bonus, new stock option grants, new restricted stock, other compensation, and the revaluation of existing stock and stock option holdings.

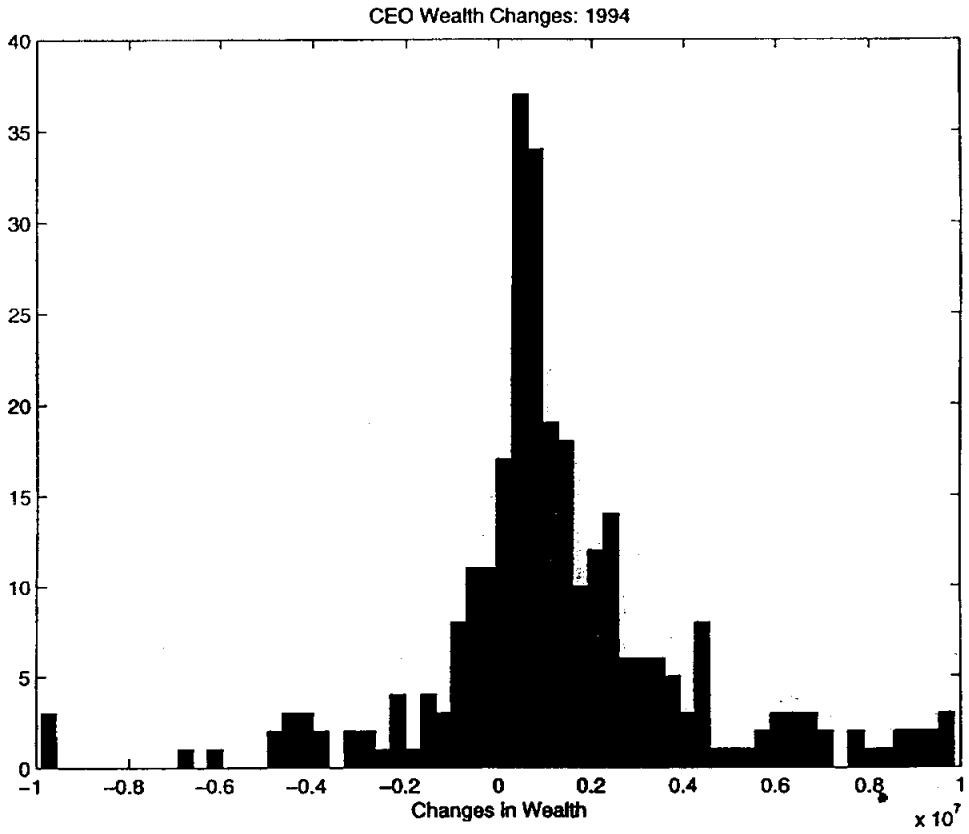
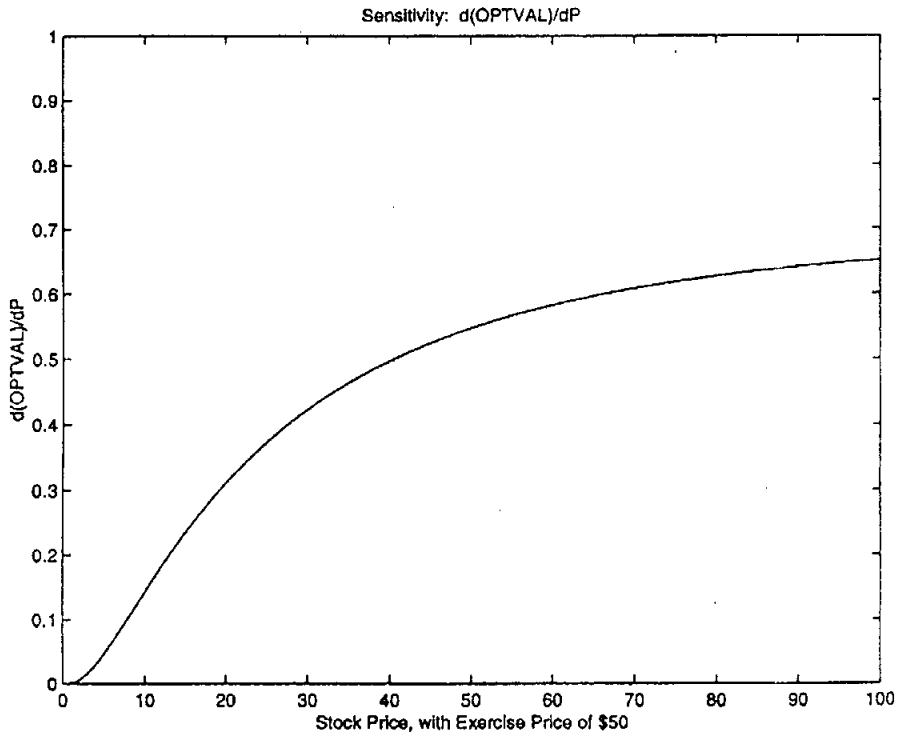


Figure 2

The delta (sensitivity) of one CEO option with the standard characteristics at the grant date



Assumptions: Exercise price equals $50. The annual standard deviation is 32 percent. The maturity is equal to ten years. The dividend rate is equal to 3.5 percent

Figure 3

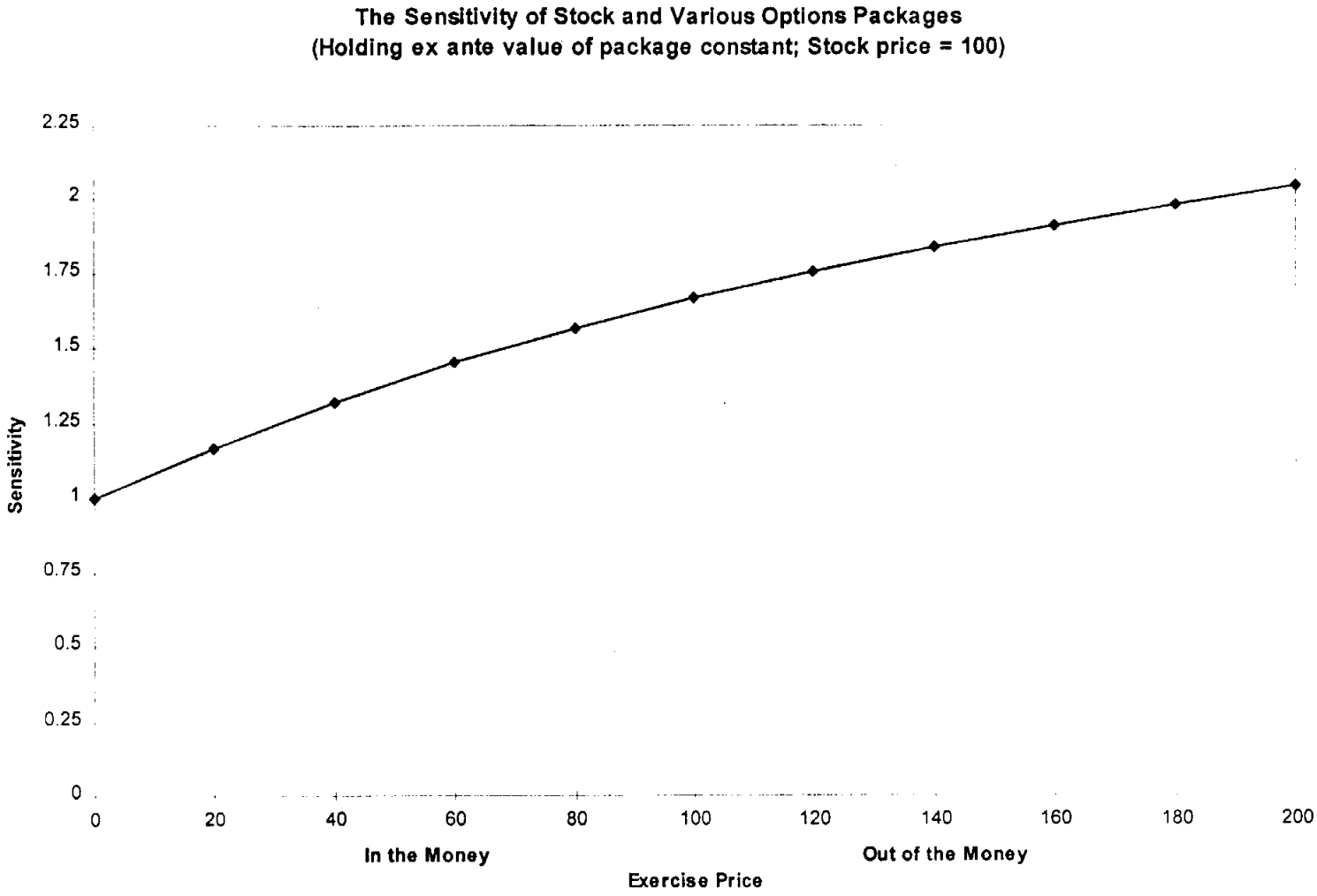

The Sensitivity of Stock and Various Options Packages
(Holding ex ante value of package constant; Stock price = 100)
Sensitivity
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
0
20
40
60
80
100
120
140
160
180
200
In the Money
Out of the Money
Exercise Price

Figure 4

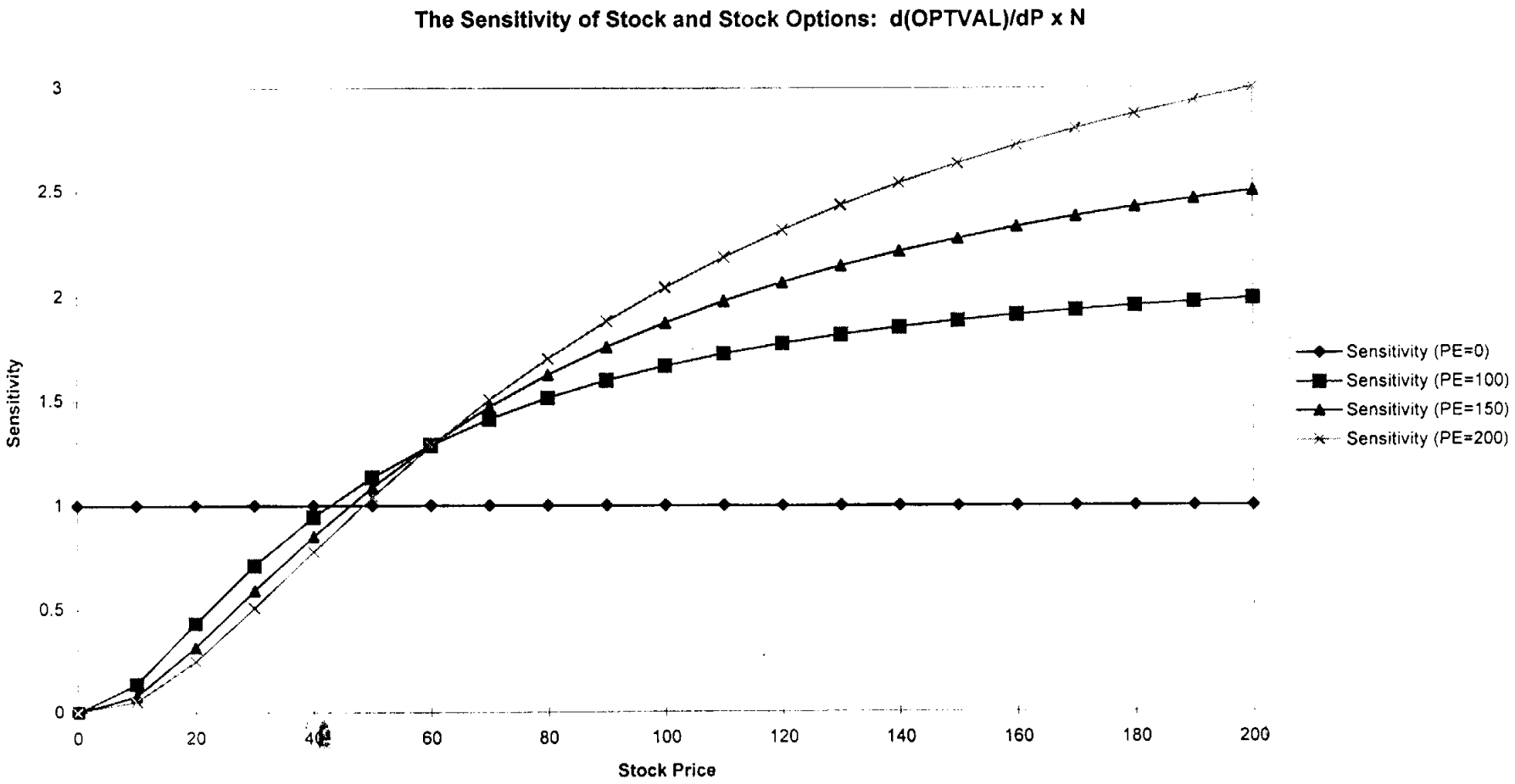
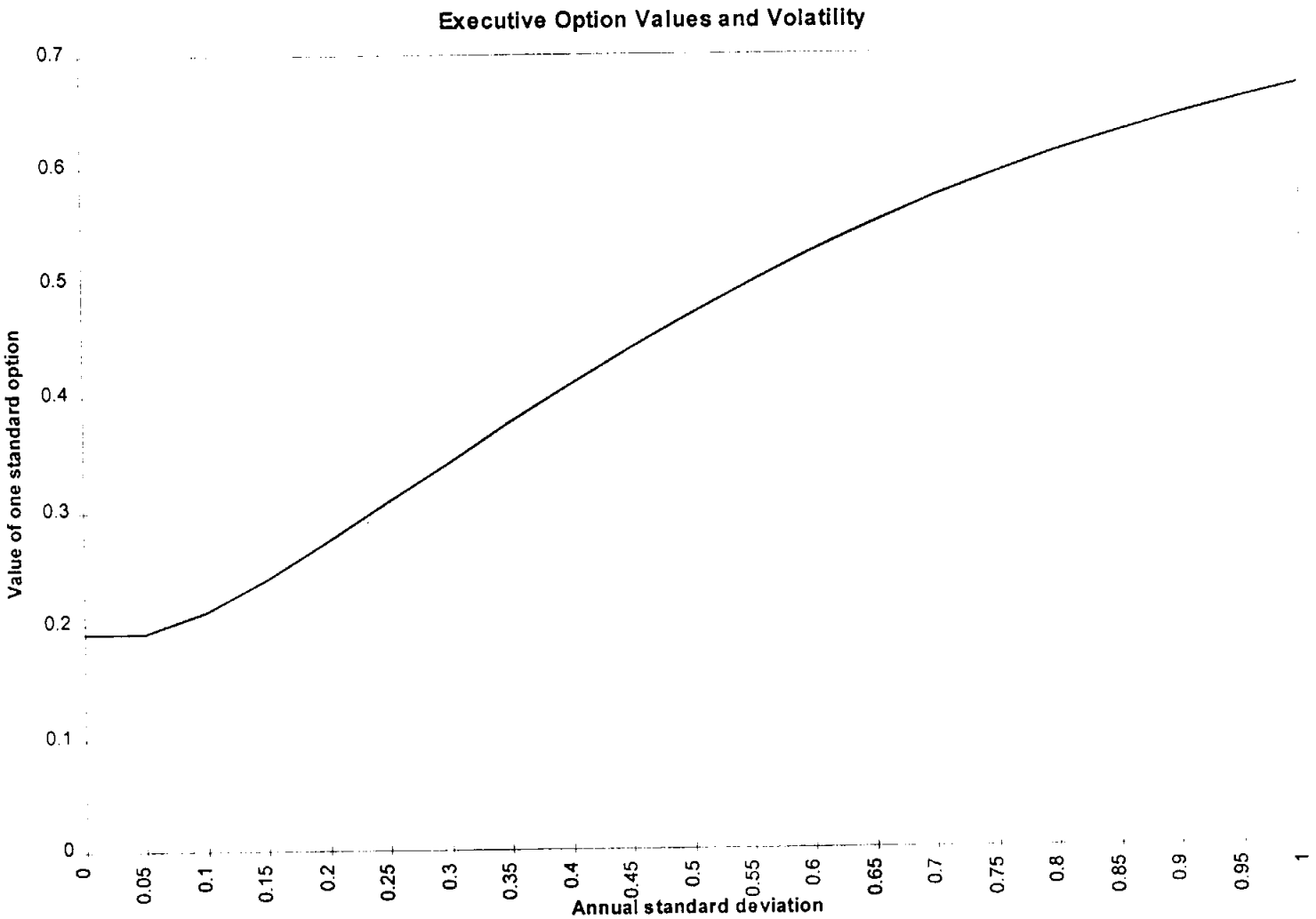

The Sensitivity of Stock and Stock Options: d(OPTVAL)/dP x N
Sensitivity
Stock Price
0
0.5
1
1.5
2
2.5
3
0
20
40
60
80
100
120
140
160
180
200
Sensitivity (PE=0)
Sensitivity (PE=100)
Sensitivity (PE=150)
Sensitivity (PE=200)

Figure 5


Executive Option Values and Volatility
Value of one standard option
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Annual standard deviation