Managing Option Fragility*

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Abstract

We analyze and explore *option fragility*, the notion that option incentives are fragile due to their non-linear payoff structure. Option incentives become weaker as options fall underwater, leading to pressures to reprice options or restore incentives through additional grants of equity-based pay. We build a detailed data set on executives' portfolios of stock and options and find that executive options are frequently underwater, even when average stock returns have been high. For example, at the height of the bull market in 1999, approximately one-third of all executive options were underwater. We find that, in contrast to the incentives provided by stock, the incentives provided by options are quite sensitive to stock price changes, especially on the downside. Overall, we find that the incentives created by all executive holdings have an elasticity with respect to stock price decreases of about 0.7, and this elasticity is larger for high-option executives and for executives with high percentages of options already underwater. The dominant mechanism through which companies *manage* option fragility is larger option grants following stock price declines; on average, these larger grants restore approximately 40% of the stock-price-induced incentive declines. Option repricings are far less prevalent, despite the attention they have garnered. Interestingly, we find that for positive stock returns, higher returns lead to larger option grants, which raise incentives further. Thus, option grants are largest when companies do very poorly or very well. Executive exercising behavior also affects option fragility. Since executives are much less likely to exercise options following stock price decreases, the natural declines in incentives due to exercises are attenuated on the downside, leading executives to "manage their own incentives" in a way that augments company management of option fragility.

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1. Introduction

One of the more fundamental insights in agency theory is that there are large advantages to linear incentive contracts (Holmstrom and Milgrom, 1987). Linearity makes incentives more robust since the pay-to-performance relationship remains constant over time and as performance changes. Absent a linear relationship between pay and performance, changes in performance can push an agent into a region where incentives are weak or non-existent (Murphy, 1999). Consider a sales commission plan that only pays out above some performance threshold. Although such an incentive plan may create strong incentives beyond the threshold, if sales fall far below the threshold, the incentive effects of the sales plan are greatly diminished. The plan provides fragile incentives because of its non-linearity. Likewise, a cap on an incentive plan creates a "no incentive region" beyond the cap. Such non-linearities not only have the potential to distort incentives, they also provide huge opportunities for "gaming." Healy (1985) and Jensen (2001) provide evidence that non-linearities cause executives to game incentive plans by, among other things, manipulating the timing of accounting profits. For example, executives who have little chance of reaching the performance target necessary to earn a bonus this year push profits into the next period in an attempt to increase their future bonus.

Despite the advantages of linearity, the largest component of pay for U.S. executives—stock options—is highly non-linear. Indeed, the defining characteristic of a stock option is that its payoff—unlike that of a share of stock—is a non-linear function of the underlying stock price. A stock option's pay-to-performance relationship is flat when the stock price is between zero and the exercise price, followed by a positive, linear relationship thereafter. In addition to comprising more than half of all pay for U.S. top executives in 2001, stock options have become a significant component of pay for rank-and-file employees. For example, a recent study[1] found that about 40% of all large U.S. companies grant options to half or more of their employees.

As with other non-linear incentive instruments, options create fragile incentives: stock price declines can push stock options "underwater" (that is, the stock price may fall below the exercise price of the option). This not only decreases the pay-to-performance sensitivity of those options, but also leads to retention problems as executives (and employees) come to believe that their options have little chance of paying off by moving "into-the-money." The poor performance of many U.S. companies' shares in 2000 and 2001 has highlighted the potential fragility of option incentives. As documented in hundreds of articles in the popular business press, a multitude of companies are scrambling to solve their "underwater option problem." The potential fragility of an incentive device that has in the last twenty years become the largest component of top executive pay in the U.S.—in both value and incentive provision—is an issue of obvious importance. Yet there has been little academic research on the topic,[2] and the most basic questions regarding option fragility have not been addressed. This paper attempts to fill that gap.

Specifically, we first explore the magnitude of option fragility. We use a carefully constructed data set to explore the frequency with which options fall underwater. We analyze the magnitude of option incentive declines following stock price declines and compare these incentive changes to stock incentive changes. We also explore the determinants of option fragility. We find that option fragility is both large and significant, and we analyze whether and how companies "manage" option fragility—whether and how they attempt to restore incentives in response to stock-price-induced declines in incentives—through their granting policies. For example, we look for evidence of "management" in the form of: larger-than-average option grants, extra "refresher" grants, option repricings, and new grants of stock. We also explore how the behavior of executives—their patterns of option exercises and net purchases of stock, which we call "executive management"—affects the way incentives change over time. For example, executives may mitigate incentive declines by selling fewer shares or exercising fewer options in response to a stock price decline. Although it is an entirely different mechanism, this type of behavior, like company granting policy, affects the way that incentives change over time—that is, the way that incentives are *managed*.

In conducting our empirical analysis, we make use of a data set that contains each executive's entire portfolio of stock and options, including all of the relevant details required to value such packages (exercise prices, time to maturity, the number of options, etc.). Such a data set is necessary for our purposes since our goal is to precisely measure the incentives generated by each executive's entire equity portfolio, which requires us to understand the degree to which every option in the executive's portfolio is in- or out-of-the-money.

Several studies have demonstrated the importance of adjusting equity pay, holdings and incentives for the fact that risk-averse and undiversified executives value company equity and options at less than market values.[3] Following this work, we employ a technique that enables us to risk-adjust equity incentives by converting executive equity holdings into certainty equivalents (or "executive values"). Our method, described later, is based on the certainty-equivalent approach used by Lambert, Larcker and Verrecchia (1991) and Hall and Murphy (2000, 2002), but is an extension of this method since it enables us to create executive values for an executive's

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[1] Survey by William M. Mercer, 1999.
[2] Jin and Meulbroek (2001) is a recent exception. We discuss their analysis in Section 3.4.
[3] See Lambert, Larcker and Verrecchia (1991), Hall and Murphy (2000, 2002) and Meulbroek (2001), for example.

whole portfolio of stock and options instead of a single option (or stock) grant. In addition, we extend the model to allow executives to optimally invest their outside wealth in the market portfolio and the risk-free asset, as described later.

In the next section, we describe our data and our methodology for building up executive portfolios of stock and options. We also describe our methodology for measuring the incentive strength of an executive's option portfolio, with particular attention to how we calculate risk-adjusted executive values from executives' portfolios.

The third section explores the extent to which options fall underwater. Contrary to the view that rising markets push virtually all options into-the-money, we find a surprisingly high fraction of options underwater. For example, at the height of the bull market in 1999, approximately one-third of all executive options were underwater. We explain these results by showing how the right-skewness of stock returns—resulting from the fact that stock prices have an approximately lognormal distribution—leads to a high percentage of underwater options, even when average stock returns are high. Having established these facts, we explore the degree of option fragility. We use stylized examples to show that option incentives are much more fragile than stock incentives. Using our data, we show that actual year-to-year fluctuations in incentives are quite large and demonstrate that these fluctuations are strongly related to stock-price fluctuations. For our preferred measure of incentives, the elasticity of "equity incentive strength" with respect to stock price changes is about 0.7 when stock prices decline. Moreover, this elasticity is higher for high-option executives, for executives with a high number of options already underwater, and for executives in low-volatility companies.

We explore incentive management in the fourth section. In particular, we find evidence that company granting policies lead to incentive management on the downside (stock-price-induced incentive declines are partially restored, lowering incentive fragility) but *anti-management* on the upside (increases in stock prices lead to larger-than-average increases in incentives in the following year). Incentive management on the downside is quite large: approximately 40% of any stock-price induced decline in incentives is offset—managed—by an above-average option grant the following year. We also find that executive behavior leads to management on the downside but has essentially no significant effect on the upside.

In the fifth section, we explore the mechanisms of management. We show that company management is not driven by option repricings (which are exceedingly rare) or new stock grants. Instead, company management on the downside is almost entirely driven by the fact that companies grant more options in response to large stock price decreases. This is, of course, a form of backdoor repricing—although it reduces option fragility, it also distorts *ex ante* incentives since poor performance is being rewarded. Likewise, company anti-management on the upside is driven by option grants. We also find strong evidence of relative performance evaluation (RPE) in option-granting behavior, using industry stock returns. In addition, we explore the mechanism behind executive management and find that it is driven by less frequent option exercises when stock prices fall. Finally, we discuss implications and potential extensions of our findings in the sixth and concluding section.

2. Data and Incentive Measurement

In this section, we describe the data and the methodology that we use to construct our equity-based incentive measures.

2.1 Data

The data comes from ExecuComp, which contains detailed information on the compensation for the top five executives of every company in the S&P 500, the S&P MidCap 400, and the S&P SmallCap 600 indices from 1992 to 2000. The data include approximately 6,000 executives per year in the later years of the sample. Our goal is to measure incentives—and the evolution of incentives over time—as precisely as possible, including (critically) how incentives are affected when option packages move in- and out-of-the-money. Therefore, we need to have time series of each executive's equity holdings, including details regarding the number of options held, the maturity of the options, the exercise prices of each option grant, and the number of shares held by the executive. Unfortunately, ExecuComp does not provide detailed information about an executive's entire *portfolio* of options, although the data set does provide the details about each option grant in the year in which it is granted, as well as information regarding option exercises and changes in stock holdings.[4]

Thus, we use an approach similar to that of Hall and Liebman (1998) to infer an executive's portfolio of stock and options from past and current-year grants, exercises, and holdings. Although this approach has the advantage of giving us the most precise picture possible of an executive's portfolio given data availability, it does require multiple years of past data since this approach uses yearly data to construct the portfolio over time, "building up" holdings when restricted stock or stock options are granted and "drawing down" holdings when shares are sold or options are exercised. As a result, the final panel data set that we create begins in 1996, even

[4] This is due to the fact that proxy statements only report information regarding option exercises, option grants, stock sales or purchases, and restricted stock grants. More generally, proxies include information on *flows* of equity-based holdings, whereas incentive measurement requires information on the *level* of these holdings.

though the ExecuComp data begins in 1992. The details regarding our methodology for measuring an executive's portfolio of stock and stock options are given in Appendix A.

2.2 Measuring Incentives: Methodology

Two potential complications hamper our attempt to calculate the pay-to-performance incentives of an executive's stock and stock option holdings. First, we must determine the relevant measure of incentive strength. Second, we must adjust the sensitivity of the pay-to-performance relationship for risk since equity is held by risk-averse and undiversified executives. We discuss each issue in turn.

2.2.1 Incentive Strength

A standard measure of pay-to-performance sensitivity is the change in executive wealth for a given dollar change in shareholder value. For example, following Jensen and Murphy (1990), many studies measure incentives as the dollar change in executive wealth for a $1,000 change in firm value. This is effectively the ownership percentage of the executive (multiplied by 1,000).[5] More precisely, it is the delta of the executive's portfolio, divided by the total number of shares outstanding, then multiplied by 1,000.

Another measure of incentives is the change in executive wealth for a given *percent change* in firm value (Hall and Liebman, 1998). This latter measure recognizes the fact that executives of large companies often have large equity stakes, in dollar terms, in their companies—which may provide strong incentives since small percentage changes in the value of the firm may lead to multimillion-dollar changes in executive wealth, even when effective ownership percentages are trivial. Core and Guay (1999, 2001), for example, use this measure of incentives in arguing that companies and firms contract on a certain, optimal, *dollar amount* of equity incentives, which is consistent with contracting on "dollars at stake" rather than "percent owned."

Baker and Hall (2001) argue that both measures are helpful for understanding incentive strength. Specifically, the former measure (percent owned) is most appropriate when analyzing incentives to allocate resources (*e.g.*, the use of a corporate jet) while the latter measure (dollars at stake) is most appropriate when analyzing incentives to embark on strategies that scale with firm size (*e.g.*, corporate reorganization). For this reason, we report results using both measures of incentives. In some cases where the results are quite similar, we report only the results using one of the measures (percent owned) for the sake of brevity.

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[5] If the executive owns only shares, then this is simply the number of shares held by the executive divided by the total number of shares outstanding (multiplied by 1,000, as noted above). If the executive also owns options, then the percent owned is the number of shares plus the number of options divided by the total number of shares outstanding, where the options are adjusted downward—often multiplied by 0.6 or 0.7—to account for the fact that they have a lower *delta* than stock shares (which have a delta of 1 by definition).

2.2.2 *Adjusting Incentives for Risk*

Most studies of equity-based incentives use market values of executives' stock and options—as measured by standard option pricing models such as Black and Scholes (1973) and Merton (1973)—to measure incentive strength.[6] However, as emphasized by Lambert, Larcker and Verrecchia (1991), Hall and Murphy (2000, 2002), Meulbroek (2001) and others,[7] standard option pricing models are based on risk-neutral pricing of tradable securities, and are therefore not appropriate for valuing nontradable options held by risk-averse and undiversified executives. Market value models are therefore also not appropriate for measuring executive incentives since pay-to-performance incentives are based on changes in the value of equity-based holdings in response to changes in company stock price performance.

We therefore risk-adjust executive equity—and equity-based incentives—using a certainty-equivalent approach to executive equity valuation, following Lambert, Larcker and Verrecchia (1991) and Hall and Murphy (2000, 2002). That is, we measure executive incentives as the change in the certainty equivalent—or *executive value*—of the executive's equity-based portfolio in response to a given change in firm value. While difficult to implement, especially for a large portfolio of option grants, each with its own characteristics (*i.e.*, time to maturity and exercise price), it is especially important in a study such as ours to adjust for executive risk aversion when measuring option incentives. Because our focus is on the fragility of option incentives, much of our analysis concerns the incentives provided by equity-based holdings following a stock price decline, and incentives measured using risk-adjusted values decrease more than incentives measured using market values following stock price declines. This is because the executive value of an option far underwater is fairly unresponsive to changes in the stock price since risk-averse executives severely discount options that have little chance of moving into-the-money (Hall and Murphy, 2002).

Thus, while we generally report results using incentives based on both the market value and executive value of executive portfolios, we believe that the results based on executive values are more accurate. The results based on the market value of equity are reported in various places as conservative (lower bound) estimates of how incentives weaken following share price declines.

Our methodology for measuring executive value—and therefore incentives, since incentives are simply the change in executive value for a given change in firm value—extends the approach described in Hall and Murphy (2000, 2002) in two ways. First, rather than looking at the

[6] See surveys by Murphy (1999), Bushman and Smith (2001) and Core, Guay and Larcker (2001) for evidence and analysis.

[7] See especially Abowd and Kaplan (1999), Kulatilaka and Marcus (1994), Rubinstein (1995), Carpenter (1998), Murphy (1999), Smith and Zimmerman (1976) and DeTemple and Sundaresan (1999).

incentives created by a single grant of options, we measure the incentives created by the executive's entire portfolio, including stock and options. Although this complicates the methodology used to measure executive value, it is a necessary complication since we are interested in measuring the incentives generated by the executive's entire portfolio rather than the incentives generated by a single grant. The methodology for calculating executive value is described below, with the details relegated to Appendix B.

Second, to compute executive values of equity-based instruments we must make assumptions about both the amount and the type of outside wealth held by each executive, as noted in the introduction. We assume that executives hold their outside wealth in a combination of the market portfolio and risk-free bonds—in a proportion that maximizes their utility—rather than restricting executives to hold only risk-free bonds in their outside portfolios.[8, 9]

Specifically, the executive value of a non-tradable option to an undiversified risk-averse executive is the certainty equivalent of the option—the amount of riskless cash compensation the executive would accept in lieu of the option to remain indifferent. We assume an executive's outside wealth is w, that he holds s shares of company stock, and that he has been granted k option packages. The packages are indexed by $i = 1, \ldots, k$ so that option package i is composed of n_i options, each on one share of company stock, with a strike price of X_i expiring in T_i years. Let the realized price of company stock in T_i years be $P_{T,i}$. Suppose that there is just one other risky asset available: the market portfolio, each unit of which is normalized to cost one dollar today, with a realized price in T_i years of $M_{T,i}$. Let r_f denote the risk-free rate, and assume that the executive always allocates a proportion p of his discretionary wealth to the riskless asset, with the remainder being allocated to the market portfolio.

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8 Our analysis, therefore, incorporates the insight that the cost of forcing executives to bear market (systematic) risk may not be as great as the cost of forcing them to bear idiosyncratic risk, since executives may hedge their systematic risk exposure by changing how much of their outside wealth they invest in the market portfolio. See Jin (2002) for evidence.

9 Allowing the executive to hold the bonds and the market portfolio (rather than just bonds) in his non-firm portfolio has little effect on executive value when analyzing a single option grant, as in Hall and Murphy (2000, 2002) or Lambert, Larcker and Verrecchia (1991), and thus would do little to change their qualitative results. However, we are analyzing the certainty equivalents of entire portfolios, some of which contain only company stock, which pays a higher return than risk-free bonds. In such cases, failing to model the executive's ability to hold the market portfolio as part of his non-firm wealth causes the executive to value his company stock portfolio too highly. Since we found that modeling the executive's ability to hold the market portfolio had significant effects on executive value in these cases—and in a way

The executive's realized wealth at the end of the horizon is:

$$
\begin{aligned}
W_{T_k} &= w\left(p\left(1+r_f\right)^{T_k}+\left(1-p\right)M_{T,k}\right)+sP_{T,k} \\
&+\sum_{i=1}^{k}\left(p\left(1+r_f\right)^{T_k-T_i}+\left(1-p\right)\frac{M_{T,k}}{M_{T,i}}\right)n_i \max\left\{0,P_{T,i}-X_i\right\}.
\end{aligned} \tag{2.1}
$$

The executive has a utility function over final (*i.e.*, period T_k) wealth, which we denote $U(\ )$. f is defined as the joint density of $\left\{\left(P_{T,i},M_{T,i}\right):i=1,\ldots,k\right\}$, so that the executive's expected utility is:

$$
\int\cdots\int U\left(W_{T_k}\right)f\left(P_{T,1},M_{T,1},\ldots,P_{T,k},M_{T,k}\right)dP_{T,k}dM_{T,k}\cdots dP_{T,1}dM_{T,1}. \tag{2.2}
$$

As described in more detail in Appendix B, the executive optimally balances the proportion of the risky market holdings and the riskless asset by choosing *p* to maximize this expected utility.

The certainty equivalent of the executive's portfolio of company stock and options is the amount of cash payment *V* that makes him indifferent to holding the cash instead of the company portfolio. Specifically, if the executive is given a cash payment of *V* instead of stock and options, his realized wealth at time T_k would be:

$$
W_{T_k}^{V}=\left(w+V\right)\left(p\left(1+r_f\right)^{T_k}+pM_{T,k}\right). \tag{2.3}
$$

The executive value of the executive's company stock and option portfolio is the certainty equivalent V^* that equates the expected utilities in (2.2) and (2.3). So *V* is chosen to equate:

$$
\begin{aligned}
&\int U\left(W_{T_k}^{V*}\right)g\left(M_{T,k}\right)dM_{T,k} \\
&=\int\cdots\int U\left(W_{T_k}\right)f\left(P_{T,1},M_{T,1},\ldots,P_{T,k},M_{T,k}\right)dP_{T,k}dM_{T,k}\cdots dP_{T,1}dM_{T,1}
\end{aligned} \tag{2.4}
$$

In the above expression, *g* is the marginal density of $M_{T,k}$—the distribution of the return on the market portfolio over the entire horizon. Note also that *p*, the amount of the executive's outside wealth invested in the market portfolio, is chosen—separately on each side of the equation—to maximize each expected utility.

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that mattered, since we are analyzing differences in the incentives created by stock and options—we found it necessary to model the executive's portfolio choice regarding non-firm wealth.

In order to operationalize our method, we must assume a functional form for U and for f, which implies a functional form for g. We assume that the executive has constant relative risk aversion ρ, which implies a utility function of the form, $U(x) = \frac{1}{1-\rho} x^{1-\rho}$, when ρ does not equal one and $U(x) = \ln(x)$ when $\rho = 1$. We report results based on $\rho = 2.5$, the midpoint of the two values of relative risk aversion used by Hall and Murphy (2000, 2002), but we conducted extensive robustness checks on the level of risk aversion (and other parameters mentioned later) and none of our results are substantively affected by (reasonable) changes in our assumptions. In making this choice, we were guided by conservatism: we chose a level of relative risk aversion that is at the low end of the reasonable ranges in the literature. Our goal is to adjust for risk aversion since we believe it is important, but to make conservative, yet plausible, assumptions about executive risk aversion.[10]

Following a vast body of financial literature, we assume that the gross returns on the market portfolio and the gross returns on the company stock are independent and identically distributed from one period to the next, with a bivariate lognormal distribution in each period. We also adopt the Capital Asset Pricing Model (CAPM) structure on the raw (not the log) returns. To be precise, we assume that:

$$\left.\begin{pmatrix} \ln\left(P_{T,i}\right) \\ \ln\left(M_{T,i}\right) \end{pmatrix}\right| P_{T,1}, M_{T,1}, \ldots, P_{T,i-1}, M_{T,i-1} \sim N\left(\begin{pmatrix} \mu_{\log,p} + \ln\left(P_{T,i-1}\right) \\ \mu_{\log,m} + \ln\left(M_{T,i-1}\right) \end{pmatrix}, \begin{pmatrix} \sigma^2_{\log,p} & \sigma_{\log,pm} \\ \sigma_{\log,pm} & \sigma^2_{\log,m} \end{pmatrix} \right). \quad (2.5)$$

This assumption fully specifies the distribution of all the random variables (as jointly lognormal) since the initial stock price is known and the initial value of one unit of the market portfolio is normalized to one. Refer to Appendix B for the derivation of the relationships between the parameters given here and the parameters of the CAPM for raw returns. Using the CAPM to obtain the mean, standard deviation and covariance parameters of raw returns, we:

- set $r_f = 6\%$ (the approximate three-month T-bill rate during the period),

[10] Note that the level of risk aversion we chose is quite low relative to estimates in the asset pricing literature. For example, Campbell, Lo and MacKinlay (1997), Kandel and Stambaugh (1991) and others argue that the coefficient of risk aversion must be quite high—in the range of 20—to solve the "equity premium puzzle" (Mehra and Prescott, 1985). But Lucas (1994) and Kocherlakota (1996) state that the "majority of economists" believe the coefficient of relative risk aversion is much lower than that implied by studies of the equity premium puzzle, and argue that estimates in the range of 2.5 are much more convincing. See Hall and Murphy (2002) for a discussion.

- set $\mu_{raw,m} = r_f + 6.5\% = 12.5\%$ (so that the risk premium is 6.5%, which approximates the equity premium since 1926),[11]
- set $\sigma_{raw,m} = 20\%$ (roughly equal to estimates formed from long-horizon U.S. data),[12]
- set $\mu_{raw,p} = r_f + \hat{\beta}\left(\mu_{raw,m} - r_f\right)$ (following the CAPM, where we estimate $\hat{\beta}$ for each stock as discussed in Appendix B),
- estimate $\hat{\sigma}_{raw,p}$ for each stock as described in Appendix B,
- set $\sigma_{raw,pm} = \hat{\beta}\sigma^2_{raw,m}$.[13]

Finally, we must also make an assumption about the level of each executive's outside (non-firm) wealth. We assume that the typical executive holds 50% of his total wealth in company stock and options (based on market values) but we do so in a way that allows for meaningful heterogeneity among executives. The assumption of 50% is consistent with that used by Hall and Murphy (2002). We allow for heterogeneity in these proportions—while keeping the *average* the same as in Hall and Murphy (2002)—since it seems likely that executives with very high (low) levels of measurable compensation have higher (lower) outside wealth. This, combined with our precise estimates of firm wealth, enables us to introduce heterogeneity in the outside wealth proportion.

First we (somewhat arbitrarily) estimate outside wealth as the greater of six times total compensation and $3 million. If this estimate causes the executive to hold more than 90% or less than 10% of his total wealth in company stock and stock options—which we measure using our data—then we then adjust outside wealth so that the fraction of the executive's total wealth that is held in company stock or stock options is 90% (if it was previously above 90%) or 10% (if it was previously below 10%).[14] Using this procedure, the median (average) executive in our sample has 52.5% (50.9%) of his total wealth in company stock and stock options. Note that although we believe that introducing heterogeneity improves the accuracy of our risk adjustment, we also—as a check—re-ran our results making the simplifying assumption (consistent with the literature) that all executives hold the same proportion of wealth in company equity, and the key empirical results that follow are substantively unchanged.

[11] See Siegel (1998).
[12] See Table 8.1 of Campbell, Lo and MacKinlay (1997).
[13] Again, we note that reasonable changes in our assumptions, and our procedures for estimating variances and CAPM regression parameters, do not affect our qualitative results.

3. Option Fragility

Before analyzing the degree to which options are fragile incentive instruments—and the causes and consequences of that fragility—we establish some basic facts regarding equity-based pay-to-performance incentives over time. This will provide some perspective for our later analysis while shedding light on the causes of option fragility.

We begin this section by using our data to document the percentage of options that are underwater over time. We then attempt to understand these results by using various simulations to analyze the likelihood that stock prices fall underwater over time. We connect these stylized facts on the extent to which executive options are underwater to option fragility by estimating the responsiveness (elasticity) of incentive strength to stock price returns.

3.1 The Fraction of Options Underwater

Table 1 shows the fraction of options that were underwater at the end of 1998, 1999 and 2000.[15] Because ExecuComp contains data from company proxy statements (which follow fiscal years), the entries show the number of options at the end of the company's fiscal, not calendar, year.[16]

The entries in the first two rows contain the percentage of options that are underwater by exchange, with each executive weighted equally. Because there were only minor differences between CEOs and the other top executives, we report the results from the combined group of executives. The next two rows contain the same entries, but are value-weighted in order to see how the numbers change when large companies like Microsoft are given weights commensurate with their sizes. That is, the percentage of options underwater for each executive is weighted by company size, based on beginning of fiscal-year market value. In order to show the fraction of options that have fallen far out-of-the-money, the table also contains the fraction of options that are 25%—and then 50%—or more underwater.

As shown in the table, the fraction of options underwater is quite high, and in most cases, above one-third. Not surprisingly, given the NASDAQ decline beginning in March of 2000, there is a significant increase in underwater options in NASDAQ companies between 1999 and 2000. The increase is especially pronounced when we examine value-weighted averages

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[14] Unless this would cause outside wealth to fall below \$3 million, in which case we fix outside wealth at \$3 million.

[15] We show the year 2000 since the stock market declined that year, and we show the two years prior as pre-decline years. Years prior to 1998 look quite similar to 1998 and 1999 and so are not reported for the sake of brevity.

[16] In 59.6% of the firm-years from 1989 to 2000 covered by the CRSP database, the fiscal and calendar years are the same since the company's fiscal year ends in December. In cases where the fiscal year ends in June or earlier of year *t*, we classify the company as being in year *t-1*. When the fiscal year ends in July or later of year *t*, we classify the company as being in year *t*.

(weighted by firm market value and averaged across executives) of the fraction of options underwater, in which case the NASDAQ percentage increases from 10% to about 46%. The same basic pattern holds for NASDAQ companies in the bottom two panels, where the percentage of options 25% and 50% underwater increases sharply, with an especially large increase when the data are value-weighted. For example, while only 1% of (value-weighted) NASDAQ options were 50% underwater in 1999, nearly 20% were 50% underwater in 2000.

The high percentage of NASDAQ options underwater in 2000 is not surprising. What is surprising, however, is the high percentage of options underwater—on both exchanges—in the two years *prior* to 2000. For example, in 1998 more than one-third of options—34% for NASDAQ and 35% for the NYSE—were underwater, even though the aggregate stock price performances of both of these exchanges were quite strong in the preceding years.[17] Although many argue that the bull market of the 1990s pushed virtually all options into-the-money,[18] there was substantial heterogeneity in stock price performance—large idiosyncratic stock price changes within an overall upward trend—leaving many executives with underwater options even at the end of a strong bull market.

3.2 Underwater Options and Lognormality

The surprisingly large fraction of options underwater requires some explanation. To a large extent, the large fraction of underwater options is driven by the fact that stock price distributions are skewed to the right. To a first approximation, stock prices have a lognormal distribution.[19] The long right tail of the lognormal distribution, which becomes longer as volatility rises, can drive positive *expected* returns even when a high percentage of stock prices fall during a given period.

Figure 1A shows the densities of one-year stock returns for distributions with annual standard deviations of 30% and 60%. The volatility of stock price returns for large, Fortune 500 companies is approximately 30%.[20] A volatility of 60%, which is approximately the volatility of small- to medium-sized NASDAQ companies, is shown for comparison.[21] With an expected

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[17] From 1991 to 1997, the annual average value-weighted return (including dividends) on the NYSE was 19.7%, while the annual average value-weighted return (including dividends) on NASDAQ was 24.9%. The annual average equal-weighted returns over the same period were 20.1% and 25.8%, respectively.

[18] This has been a widely reported argument made in the financial press. See *The Financial Times* (1999), The Associated Press (1999), *CFO* (1999), *Business Week* (1998) for a few examples.

[19] This is the assumption behind the option-pricing result of Black and Scholes (1973) and Merton (1973). Campbell, Lo and MacKinlay (1997, Table 1.1, page 21) show that even at a monthly horizon, individual stock returns have significantly positive skewness. Since we employ annual returns, lognormality provides a very good approximation to the distribution of the returns we use.

[20] As mentioned in Section 3.4.1, the median volatility of all NYSE firm-years in our sample is 31%.

[21] As mentioned in Section 3.4.1, the median volatility of all NASDAQ firm-years in our sample is 49%; however, smaller NASDAQ firms tend to have higher volatility.

annual return of 12.5%—which approximates actual stock returns during the past 50 years[22]—the probability that a company stock will have a negative return in a given year—which means that at-the-money options granted at the beginning of the year will be underwater at the end of the year—is about 39%. Because the skewness of the lognormal distribution increases as volatility increases, this probability increases to 51% when volatility is 60%. The large, positive *average* return on stocks is thus reconciled with a very large fraction of options being underwater after one year.

A longer horizon does not substantially increase the probability that options will move into-the-money, even with an expected return of 12.5%. Figure 1B shows the same densities for five-year periods. Although the probability that a low volatility (30%) company will have a negative stock price return falls to 25% (from 39% in the one-year horizon case), the probability that a high volatility (60%) company will have a negative stock price return is essentially the same at 52%.

Under lognormality, the probability that an option granted at-the-money will be in-the-money can increase, decrease, or remain constant as the horizon lengthens. Volatility determines which of these possibilities holds. Figure 2 shows the probability that an option—with the same expected return (12.5%) but different volatilities—will be underwater as a function of the time horizon of the option. In general, for high-volatility companies, a longer time horizon increases the likelihood that an option will mature underwater, while the reverse is true for low-volatility companies. As the horizon increases, both the expected return and the skewness increase. Since greater skewness increases the probability that an option will fall underwater, the longer horizon does not necessarily push options into-the-money. The essential point is that a longer time horizon does not solve the problem of options falling underwater, even with a large, positive expected return. Indeed, for sufficiently high volatility, longer horizons raise the probability of an option being underwater.[23]

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[22] From the beginning of 1952 to the end of 2000, a value-weighted index of all U.S. stocks in the CRSP database grew at an annually compounded rate of 12.2% (assuming dividend reinvestment). An equal-weighted index, again with dividend reinvestment, grew at an annually compounded rate of 13.5%.

[23] Appendix C contains a calculation showing that, under lognormality, the probability that an option (which was at-the-money when granted) is underwater is decreasing in the time since its grant if $\sigma < \sqrt{\mu^4 - \mu^2}$, increasing in the time since its grant if $\sigma > \sqrt{\mu^4 - \mu^2}$, and constant at ½ if $\sigma = \sqrt{\mu^4 - \mu^2}$. In these expressions, σ is the volatility of (raw, not log) returns and μ is the expected (gross raw, not log) return, as usual. If the expected return is 12.5%, for instance, (so that $\mu = 1.125$) the volatility cutoff is roughly 58.2%. Below this volatility level, an option granted at-the-money is increasingly likely to be in-the-money as time passes, while above this volatility level the passage of time increases the probability that the option will be underwater.

3.3 Underwater Propensities and Stock Price Data

Since lognormality is an approximation of the distribution of stock price return, we check our analysis using actual returns, rather than simply imposing lognormality, to determine the likelihood that stock prices fall below their original levels. More precisely, we use actual stock returns to "simulate" the percentage of options that would be underwater for one-, five-, and ten-year horizons, assuming options had been granted at the beginning of each of the years 1989 to 2000, inclusive.

The results are shown for both NASDAQ and NYSE companies in Table 2. For example, consider the row beginning with 1998 in the NASDAQ (top) panel. The results indicate that if the same number of at-the-money options were granted at the beginning of the year to each NASDAQ company, 66.4% of them would be underwater by the end of the 1998. Likewise, 44% of all options granted five years earlier (at the beginning of 1994) would be underwater and 29.5% of all options granted ten years earlier (at the beginning of 1989) would be underwater at the end of 1998. The bottom shows analogous results for NYSE companies.

The table contains two main findings, both of which corroborate our earlier analysis. First, the (simulated) fractions of options underwater are quite substantial despite the large, positive average returns of both exchanges during the decade. The results are consistent both with the simulations based on lognormality (shown in Figures 1A and 1B), and with the high percentage of underwater options that are observed in the ExecuComp data (shown in Table 1). Second, because of the higher volatility of NASDAQ companies, the percentage of options that are underwater in NASDAQ companies are generally higher than those in NYSE companies, even though the average annual equal-weighted NASDAQ return, excluding dividends, during the period 1989 to 2000 was higher at 15.5% than the corresponding NYSE return at 9.2%. Even in bull markets, options are quite vulnerable to falling out-of-the-money. This vulnerability increases with the volatility of the underlying stock price, and can increase or decrease as the horizon lengthens.

3.4 Fragility: Comparing Stock and Options

As emphasized in Hall and Murphy (2002), the fact that options may expire underwater decreases both the value of, and the incentives provided by, options to risk-averse and undiversified executives. That analysis, however, applies to the value of, and incentives provided by, options *at the time of grant*. It is a static analysis. Our focus, instead, is how the incentives of options *change*—how they *weaken* as options fall underwater, and *strengthen* as options move into-the-money. More generally, the claim that options frequently fall—or expire—underwater is not the same as the claim that underwater options provide weak incentives. If a given option has a reasonable chance of moving back into-the-money before expiration—or before the executive plans to leave the company—that option may still provide reasonably strong incentives.

Indeed, the fact that underwater options can provide meaningful incentives is the theme of a recent paper by Jin and Meulbroek (2001). They explore incentive changes following the NASDAQ decline of 2000 and find that many executives did not experience large decreases in incentives. They focus on options with long maturities and companies with very high volatilities, since daily volatilities measured around the period of the NASDAQ decline were quite high. We corroborate their findings, but find—over the several years covered by our data and using the precise maturity measures calculated from our data—a greater degree of option fragility, especially when we adjust for executive risk aversion.

We now turn to examining the sensitivity of option and stock incentives to stock price changes. We begin with a stylized example in order to make more transparent how incentive strength changes when stock prices change using a variety of incentive measures. We then move on to estimating the elasticity of incentive strength with respect to changes in stock prices using the incentive measures based on actual executive portfolios.

3.4.1 Stylized Example

Our stylized example shows how the incentives from different executive portfolios of stock and options, each assumed to have a beginning market value of \$1 million (the benchmark case), change when the stock price increases (by 50%) and decreases (by 25% and 75%). We also assume that each stylized executive holds \$1 million in outside wealth, split optimally between bonds and stock, which implies that the executive holds 50% of his or her wealth in firm stock and options. The options are all at-the-money, but in order to make the example as realistic as possible, the options have a range of remaining maturities. Specifically, the options held expire in three, six, and nine years from the present, with the number of options divided among the three grants so that they have an equal market (Black-Scholes) value before any stock price change. We further assume that each executive's company stock has a CAPM beta of one and a volatility of 31.4% (Table 3, reflecting the NYSE median volatility) or 49.3% (Table 4, reflecting the NASDAQ median), with 10 million shares outstanding. All other assumptions are carried forward from Section 2.2.

We measure executive wealth with both market values and executive values (separately), and show changes in executive wealth in response to a \$1,000 change in firm value (hereafter denoted *b* incentives) and to a 1% change in firm value (hereafter denoted *d* incentives). As mentioned earlier, this creates four measures of incentives, which we carry throughout (most of) the paper.

We begin by showing the incentives for a pure stock portfolio, which facilitates comparison with option incentives while providing a useful benchmark. The results, for a company with a volatility of 31.4%, are shown in the top panel of Table 3. Both the level of the incentive measures, and their change relative to the benchmark stock price of $100, are shown. When incentives are measured in terms of market values, the calculations are quite straightforward and mechanical. The *b* incentive measure remains constant at $1 per $1,000 change while the *d* measure rises and falls in proportion to the value of the stock package. When executive values are used, *b* actually rises (albeit by a trivial amount) as the stock price falls. This counterintuitive result is actually sensible. As the stock price falls, the value of the executive's stock falls, making the executive more diversified, which in turn increases the value of the executive's stock *relative to the falling value of the company*. That is, while the executive's percent ownership in the company remains at 0.1%, the executive's risk-adjusted percent owned rises from 0.096% to 0.098% as the stock price falls by 75%. In response to the same decline in the stock price, *d* falls nearly proportionately since the risk adjustment makes only a small difference.

The middle panel shows the incentives provided by the option portfolio. Using market values, both *b* and *d* fall rapidly—with *d* falling much faster—as the options fall out-of-the-money. But note that the incentive measures using executive value fall even more sharply as options fall out-of-the-money. For example, when the stock price falls by 25%, *b* falls by 21% when market values are used but 32% when executive values are used. For a very large (75%) drop in the stock price, *b* falls by 87% when market values are used and 94% when executive value is used. That is, incentives are virtually destroyed by the stock price decline. Sensibly, there are even larger proportional declines in incentives using the *d* measure. For example, incentives fall by 97% (using market values) and 99% (using executive values) in response to a 75% stock price change. Finally, note that incentive changes are proportionately larger for downside stock price changes than for upside changes. For example, *b* incentives using market values fall (increase) by 54% (19%) in response to a 50% decline (increase) in the stock price.

Since most executives actually hold portfolios that have a mix of stock and options, we also report the incentive changes for a portfolio that has 50% options and 50% stock (weighted by market value when the stock price is $100) in the bottom panel. Not surprisingly, the changes in incentives in response to stock price changes are in between those of a pure stock portfolio and those of a pure options portfolio. But note that the incentive changes are still quite significant in response to stock price changes. For example, when the stock price falls by 25%, *d* incentives fall by 36% (41%) while *b* incentives fall by 15% (21%), using market (executive) values.

For the sake of comparison, Table 4 shows the same stylized example with higher—49.3%—volatility, which approximates volatility for NASDAQ companies. The results are qualitatively similar with two main exceptions. First, executive values are lower, reflecting the fact that risk-averse and undiversified executives dislike higher stock return volatility. Second, the percentage drops in incentive strength are slightly lower for the same fall in stock prices. The intuition for this result is straightforward. When the stock price falls in a high volatility company, it has a greater chance of moving back into-the-money. Thus, incentive strength is less sensitive to a given stock price change in higher volatility companies, a point stressed by Jin and Meulbroek (2001).

Taken together, the results from our example yield the stylized facts that, *ceteris paribus*, in response to stock price changes:

1) incentives provided by stock change less than those provided by options,
2) option incentives (measured in any way) are more responsive on the downside than on the upside for equivalent stock price changes,
3) option incentives measured by executive values change proportionately more than incentives measured by market values, especially on the downside,
4) *d* incentives change proportionately more in response to stock price changes than *b* incentives,
5) incentives changes are proportionately smaller when return volatility is higher, and
6) changes in incentives can be quite substantial—for example, the percent changes in incentives are sometimes larger than the percent changes in the stock return.

3.4.2 Estimation of Elasticities

We now turn to estimating the elasticity of incentives to stock price changes. We perform this estimation primarily to measure the *economic* significance of (1) - (6) above through an empirical examination of actual executives' portfolios. We begin by examining how large incentive changes are from year to year in order to get a feel for the data and to determine the importance of (6) above. In Table 5, we show the mean and median of the (absolute value of) annual percent changes in each of the incentive measures. They are reported in the first column in the table. The second column shows the same mean and median, but under the (counterfactual) assumption that each executive's portfolio did not change during the year. That is, we measured the incentive strength at the beginning of the year, and then, holding the portfolio constant—not allowing new grants by the company, or option exercises or stock sales/purchases by the executive—we measured the incentive strength at the end of the year. This enabled us to isolate the changes in incentives that come from changes in the stock price.[24] We refer to these changes as *unmanaged incentives* since there is no within-year "management" of incentives by either the company (through grants) or the executive (through option exercises or stock purchases and sales). Conversely, *managed incentives* refer to incentives after companies and executives have managed their incentives during the year. That is, they are the actual incentives at the end of the year. The distinction between *managed* and *unmanaged* incentives is crucial to the analysis in the next section.

The basic message of the table is that year-to-year percentage changes in incentives are large, showing the empirical relevance of (6) above. Although the median percentage change of the *b* incentives using the market-value measure is fairly small at 9% per year, the mean is much larger, and the median using the executive-value measure is nearly 20%. Not surprisingly, the percentage changes in *d* incentives are much larger—generally about twice as large—as those of the *b* incentives at the median. Likewise, percentage changes in actual incentives are larger than unmanaged incentives.[25] There is also evidence for the importance of (3) above: executive-value incentive measures are more volatile than market-value measures.

We proceed to estimate the elasticity of incentives with respect to stock price changes under each of the four incentive measures. Since option incentives are expected to have a larger responsiveness on the downside—especially when incentives are measured with executive values—we allow for a differential—presumably larger—elasticity for negative returns than for positive returns.

Some notation is necessary to explain our econometric specifications. Let MI_{it} be the *managed incentives* (or actual incentives) of executive *i* in period *t*. These are the incentives calculated from the portfolio of stock and stock options actually held by executive *i* at the end of year *t*. Critically, we account for the fact that executives' incentives are not linear in the size of the grants they receive: that is, in measuring how incentives change from new grants, we add each grant to the appropriate previously-held portfolio of stock, options, and non-company investments, reoptimize over the executive's portfolio choice of non-company investments, and measure the incentives provided by the new portfolio.

We denote by UI_{it} the *unmanaged incentives* of executive *i* in period *t*, that is, the incentives executive *i* would have had at the end of year *t* in the absence of any selling or purchasing of

[24] To a much lesser extent, changes in volatility and expected return may influence our results, since unmanaged incentives are calculated using updated estimates of volatility and expected return.

company stock or any options exercises and in the absence of any grants by the company of additional options or restricted stock. Let $POSRET_{it} = \ln(1+r_{it})1\{r_{it} \geq 0\}$ and $NEGRET_{it} = \ln(1+r_{it})1\{r_{it} < 0\}$, where r_{it} is the return on the stock of executive *i*'s company in period *t*. We define the "percent change in unmanaged incentives" as $PCUN_{it} = \ln\left(1+\frac{UI_{it}-MI_{i,t-1}}{MI_{i,t-1}}\right)$. More precisely, $PCUN_{it}$ is the natural logarithm of one plus the change in incentives due to stock price behavior, as a percentage of last year's actual incentives. This is the percent change in incentives if there had been no management during the year. Finally, δ_t is a dummy variable equal to one in period *t*, in order to control for year fixed effects.

We begin with unmanaged incentives since we wish to isolate the effect of stock price changes on incentives prior to any company or executive management of incentives. Specifically, we regress:

$$PCUN_{it} = \delta_t + \beta_1 POSRET_{it} + \beta_2 NEGRET_{it} + \varepsilon_{it}. \quad (3.1)$$

An advantage of this specification is that it is unitless, and its coefficients can be interpreted as elasticities. The specification also includes year fixed effects. In order to avoid the influence of outliers, which is virtually always an issue with executive compensation and incentive measures, we perform robust regression and also exclude from our analysis any observation having $POSRET_{it} > 1$ or $NEGRET_{it} < -1$. Note that this does not bias our results, since we are selecting observations on the basis of the right-hand side variables. In addition, we re-ran the regressions with the outliers included and found the coefficients were less stable but had the same signs and statistical significance. The standard errors reported are those generated by the STATA procedure "rreg," which come from a weighted least-squares calculation.

3.4.3 Elasticity Results

The results are shown in the first four columns of Table 6. When the incentives are measured by *b*, the elasticities are relatively small for positive returns but are large and significant for negative returns. As expected, this asymmetry is particularly large when executive values, rather than market values, are used. For example, the elasticity is only 0.05 on the upside, but is 0.69 on the downside, when *b* incentives are measured with executive values. The elasticities are much

[25] We will see below that this occurs because companies grant more options in response to higher returns when returns are positive, which increases the annual percent change in incentives. Thus, this is not inconsistent with our later finding that companies strongly manage—or offset—decreases in incentives.

larger when the *d* measure of incentives is used, but the asymmetry—though still statistically significant at a 5% level—is much smaller.

Evaluating these results, we see that both (2) and (3) above are shown to have economic importance. Incentives are much more responsive on the downside than on the upside and downside responsiveness is larger when incentives are measured with executive values rather than market values. Our analysis also demonstrates the empirical relevance of (4): incentives as measured by *d* are much more responsive to stock price changes than incentives as measured by *b*.

In order to explore (1) and (5), we interact *POSRET* and *NEGRET* with an indicator for whether an executive is a "high option" executive or not. *HIOPT* is an indicator for whether or not an executive-year is in the top quintile of all executive-years in our sample on the basis of the number of options owned relative to the number of company shares owned. This allows us to evaluate not only the empirical relevance of the fact that higher-option executive portfolios induce greater sensitivity of incentives to stock price changes, but also the importance of the fact that incentives are particularly sensitive when executives have many options and their companies experience decreases in stock prices. We interact *POSRET* and *NEGRET* with *VOL*, the calculated volatility of the executive's company stock returns in the given year (see Appendix B), in order to measure how much lower responsiveness is for high volatility firms ((5) above), and to test for any asymmetry in this relationship.

We also include a variable, $POUT_{it}$, which is equal to the percentage of executive *i*'s options that are underwater in period *t*.[26] As with our other variables, we interact *POUT* with *POSRET* and *NEGRET*. We include *POUT* because initial conditions may matter. Since options that are deeply in-the-money begin to have incentive properties similar to those of stock, we expect high-*POUT* portfolios to be more "option-like" and therefore to generate incentives that have greater sensitivities to stock price changes. Finally, we interact *POSRET* and *NEGRET* with *NASDAQ*, a dummy that is one when an executive's company is listed on NASDAQ. We include this variable both as a control, and in order to determine if there are any systematic differences in incentive sensitivity to stock price changes between NASDAQ and NYSE firms, after controlling for volatility.

To facilitate interpretation, we subtract from *VOL* and *POUT* their means over all observations before estimating the regression. Absent demeaning, interpreting the coefficients on *POSRET* and *NEGRET* is difficult: if we do not subtract means from the interaction variables

[26] This variable is set to zero in the small number of executive-years in which executives hold no options.

VOL and *POUT*, the coefficients on *POSRET* and *NEGRET* are the (extrapolated) sensitivities when *VOL* and *POUT* take on the value zero, which is unlikely to be a relevant baseline. Our demeaned approach, however, enables us to interpret the coefficients of *POSRET* and *NEGRET* when *VOL* and *POUT* are at their means.

The results are reported in the next four columns of Table 6. The results show that high-option firms have greater sensitivity ((1) above) and that this sensitivity is larger on the downside ((2) above). For example, analyzing the *b* measure of incentives with executive values, *HIOPT* companies have an elasticity that is 0.26 greater on the downside and 0.08 on the upside. Further, the sensitivity of incentives to returns is lower for executives at high-volatility firms ((5) above). As we expected, incentive sensitivity is higher for executives with a higher percentage of options that are underwater. There are generally statistical differences between NASDAQ and NYSE companies, but these differences are quite small—around 0.03—and therefore economically insignificant. Moreover, they do not have consistent signs.

Finally, as a precursor to our analysis in the next section of how incentive fragility is managed, we estimate the sensitivity of *managed* incentives to stock price returns. We estimate the elasticity of managed (or actual) incentives to changes in the stock price, again allowing for an asymmetric response. The results are shown in Table 7. The key difference between these results and our earlier results using unmanaged incentives is that the elasticities are notably smaller on the downside. These results suggest that when the portfolio management of executives and the granting behavior of companies are both taken into account, the very high sensitivity of incentives to downward stock price changes is markedly attenuated. That is, these results suggest that year-to-year incentive changes are "managed" somewhat, whether by executives, by companies, or by both. In what follows, we explore the issue of incentive management in greater detail.

4. The Management of Option Fragility

Having established in many ways that options are quite fragile incentive instruments, we now turn to the issue of how, and to what degree, this fragility is managed, if at all. Incentives can be managed either by the company or by the executive (or both), and we analyze each separately. We first measure the amount of incentive management using our incentive measures. We then probe more deeply to understand the *mechanisms* of incentive management. That is, what specific granting policies by companies and exercising/buying/selling policies by executives are driving our results?

4.1 Company Management (or Anti-Management)

To the extent that companies manage incentives, they do so through their repricing and granting behavior. If an executive's incentives decline because of a stock price fall, companies can offset that decline by repricing or by offering a larger option (or stock) grant to help restore incentives to the executive. In some cases, companies offer an extra, out-of-cycle grant (called a "refresher" grant) in order to restore incentives following a stock price decline. For example, Microsoft made a well-publicized refresher grant after its stock price declined from $117 at its January 2000 open to a low of $65 on April 24, 2000. Finally, companies can simply reprice the options of their executives—which involves changing the exercise prices of old options rather than granting a larger number of new options—although this practice is very uncommon, especially following FASB Interpretation 44, effective December 15, 1998, which forces firms that reprice to recognize compensation expenses related to their repricing in subsequent years (Carter and Lynch, 2001). As will be shown later, only 1.4% of executive-years in our sample had their options repriced, and this low percentage is consistent with fractions reported in other studies.[27] Although repricing is quite uncommon, we do adjust our data to reflect the impact of repricings using repricing data generously provided to us by Callaghan, Saly and Subramaniam (2000).[28]

Irrespective of the mechanism, equity incentive management by companies leads to proportionately larger (smaller) boosts to incentives in response to stock-price-induced declines (increases) in incentives. In the polar case of perfect incentive management, any decline (increase) in incentives through stock price changes would be offset by a larger (smaller) grant in the next period.

The granting policies of companies can also lead to "anti-management." Equity pay, like all pay, is sometimes granted as a reward for good performance. In such cases, a large stock price increase will be associated with a larger equity grant in the next period—and therefore a greater boost to incentives—than a small (or negative) stock price performance. The natural variations in incentives that result from stock price changes are therefore magnified—a stock-price-induced increase in incentives leads to yet stronger incentives and vice versa—when equity awards are used to reward good performance and punish poor performance.

[27] For example, Brenner, Sundaram and Yermack (2000), Chance, Kumar and Todd (2000), Carter and Lynch (2001, 2002) and Chidambaran and Prabhala (2002).

[28] In the event of a repricing, we make the conservative assumption that all of the executive's options whose exercise prices are above the current stock price are repriced to have exercise prices equal to the current stock price. In response to the finding of Brenner, Sundaram and Yermack (2000) that repricings are typically accompanied by an increase in the time to expiration of the repriced options, we set the expiration dates of all repriced options to ten years from the time of repricing.

As discussed in Hall (1999, 2000), the multi-year granting policies of companies affect the dynamic relationship between stock price performance and option awards. For example, some companies offer fixed-value plans (where the Black-Scholes value of the annual option grant remains constant or a constant fraction of salary over time), which causes the value of options to remain fairly constant over time but induces a negative relationship between stock price changes and the subsequent number of options awarded. Other companies offer fixed-number plans, in which the number of options offered is constant over time. These plans induce a positive relationship between share price changes and the value of future awards. Still others award options on a fairly *ad hoc* basis.

Thus, there can be a positive relationship between stock price performance and subsequent option awards (measured in terms of value or number) if options are used as a reward for past performance, or a negative relationship between stock price performance and subsequent option awards if options are granted as a way to offset or restore incentives following stock-price-induced declines (or increases) in incentives. In short, option-granting policies can either mitigate stock-price-induced incentive changes—which creates incentive "management"—or magnify them—which we call "anti-management." Which effect prevails in practice, and under what conditions, is ultimately an empirical question.

4.2 Empirical Strategy

Our empirical strategy for measuring the degree of management or anti-management by the companies in our sample is to regress company-managed incentive changes, defined as the post-grant change in incentives, on unmanaged incentive changes, defined as the change in incentives absent any new company grant of stock or options. We let CMI_{it} denote the *company-managed incentives* of executive i at time t, and define $POSUN_{it} = PCUN_{it} 1\{PCUN_{it} \geq 0\}$, the percent change in unmanaged incentives if it is non-negative (and otherwise zero); similarly, we define $NEGUN_{it} = PCUN_{it} 1\{PCUN_{it} < 0\}$, the percent change in unmanaged incentives if it is negative (and otherwise zero). We label the percent change in company-managed incentives as *PCCM*, which is defined as $PCCM_{it} = \ln\left(1 + \frac{CMI_{it} - MI_{i,t-1}}{MI_{i,t-1}}\right)$.

We then examine the relationship between company-managed and unmanaged incentives, differentiating between increases and decreases in unmanaged incentives. We thus estimate:

$$PCCM_{it} = \delta_t + \beta_1 POSUN_{it} + \beta_2 NEGUN_{it} + \upsilon_{it}, \quad (4.1)$$

which includes time fixed effects. Our econometric methods are otherwise identical to those employed to produce Table 6, and are described in the headings of Tables 8 through 10.

Figure 3 helps demonstrate the logic of our empirical strategy. If the increment to incentives from the new grants is independent of the change in unmanaged incentives, then there will be a one-to-one correspondence, on average, between the percent change in unmanaged and managed incentives. This scenario is depicted by the "no management line" in the figure. In this case, the coefficient on unmanaged incentives will be equal to one. (The constant term will pick up the increase in incentives due to grants that are not related to changes in unmanaged incentives.)

If, however, companies tend to manage incentives—offsetting declines (increases) in incentives by making bigger (smaller) grants—then the coefficient will be less than one and the relationship will be depicted by a line such as *MOM′*. In the polar case of perfect management, any stock-price-induced decline in incentives is completely offset by future grants. The coefficient will then be equal to zero; managed incentives will always change by a constant (*F* in the diagram).[29]

If anti-management exists, then stock-price-induced increases (decreases) in incentives will be associated with proportionately larger increases (decreases) in incentives. This corresponds to a line such as *AOA′* and will lead to a coefficient on unmanaged incentives that is greater than one. The polar case of anti-management asymptotically approaches the vertical line.

Estimation of 4.1 is helpful in determining the degree of—and any asymmetry in—the company management of incentives. However, in order to further investigate the factors that affect the degree of company management (or anti-management), we employ a richer specification that adds other regressors to the right-hand side of our basic regression. As before, we include $HIOPT_{it}$, VOL_{it}, $POUT_{it}$, and $NASDAQ_{it}$ as right-hand side variables and interact each of these variables with $POSUN_{it}$ and $NEGUN_{it}$ in order to determine whether there are asymmetries in the way that companies manage incentives.

As emphasized in Hall (1999, 2000), there are systematic differences in the way that high-technology companies and "old economy" companies distribute options. In particular, old economy companies are more likely to have annual option plans that are either fixed-value or fixed-number, as described earlier. Companies in the high-technology sector, however, are more

[29] The polar case of perfect management cannot hold for sufficiently large increases in unmanaged incentives, unless the company were to engage in (virtually unheard-of) "reverse repricings" in which the strike price of previously granted options is *raised*. This is because the most extreme possible response to an increase in unmanaged incentives is a grant of zero, which may not be large enough, relative to the average positive grant, to offset a very large increase in unmanaged incentives. Thus, practically, it is

likely to grant options up-front (a large grant when the executive joins) followed by additional grants on a more flexible, *ad hoc* basis. This motivates our inclusion of an interaction with the dummy *NASDAQ* to detect any possible systematic differences between NASDAQ companies and NYSE companies (the interaction is with our unmanaged incentives variable).

Since NASDAQ companies' stock returns tend to be more volatile, we also interact *VOL* with our unmanaged incentives variables (*POSUN* and *NEGUN*) as a control. The coefficient on volatility is of independent interest. We expect higher volatility companies to manage incentives less since, for a given change in incentives, higher volatility companies are more likely to see stock-price-induced changes naturally reversed, and therefore might take a wait-and-see approach in deciding whether to offset incentive changes.[30]

We also test whether high-option companies, which have greater fragility, manage incentives more or less than low-option companies, and for whether any such management is asymmetric. Thus, we interact our key right-hand side variables—*POSUN* and *NEGUN*—with *HIOPT*. Finally, we interact *POSUN* and *NEGUN* with the percentage of options that are underwater, *POUT*, to determine whether or not companies whose executives have options that are already underwater tend to manage more. In particular, we expect companies with a significant fraction of options underwater to manage more in response to downside changes.[31]

Finally, before turning to the empirical results, we discuss the timing of company management. Companies may manage incentives within the same year as the stock price change. For example, if the stock price falls sharply in the first half of the year, a company may give a refresher grant, or give more options than planned, in the latter half of the year. However, since a large fraction of option grants are made in the first quarter the year—in our sample, approximately half of all options are granted in the first quarter of the year—most company management is next year's granting response to this year's stock-price-induced change in incentives.[32] We will report some results for same-year management, but our focus will be on total management (which we will simply refer to as "management"), which includes the

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easier for companies to "manage" incentives in response to stock price declines than in response to stock price increases.

[30] As we have noted in Section 3.4.1, Tables 3 and 4 show that a given stock return changes incentives less in a company whose stock returns are more volatile; however, larger returns are more likely if returns are more volatile, and this latter effect is dominant, so that (unmanaged) incentives are more volatile in a company whose stock returns are more volatile. Thus, a given change in incentives is more likely to be reversed by subsequent stock price variation in a company with more volatile stock returns.

[31] Although there are quantitative differences between the coefficients using risk-adjusted and market-value incentives, the results are qualitatively similar. We include only the results using risk-adjusted incentives in order to save space and because we believe they more closely approximate actual incentives.

increment to incentives from same-year grants (t) and next year's ($t+1$) grants.[33] That is, the dependent variable is formed using the one-year lead of company-managed incentives, $CMI_{i,t+1}$, instead of CMI_{it}. Specifically, the dependent variable is the natural logarithm of one plus the change from actual incentives in $t-1$ to company-managed incentives in $t+1$, as a percentage of actual incentives in $t-1$.

4.3 Empirical Results

Table 8 contains the results of the estimations of equation (4.1), using the same four incentive measures as before. As discussed, we allow for differential responses for positive and negative unmanaged incentive changes since company management is likely to differ depending on whether unmanaged incentives rose or fell. The first four columns show same-year company management and the next six columns show total company management. The results show that there is some anti-management on the upside, especially when we consider total management, but significant management on the downside. For example, in column 5, where incentives are measured using b and executive values, the coefficient on the upside is 1.43 and is statistically different from one at conventional levels, while the coefficient on the downside is 0.61 and also significantly different from one. A similar pattern emerges for same-year management, with a coefficient of 1.22 on the upside and 0.78 on the downside.

The key result is that the granting policies of companies result in anti-management when incentives increase, but company granting policies appear to significantly buffer declines in incentives. This downside management reduces the fragility of executive incentives.[34] That is, while (on average) companies magnify a given increase in incentives, they offset approximately 39% (1.0 – 0.61 in column 5) of a given decrease in risk-adjusted b incentives and 23% (1.0 – 0.77 in column 7) of a given decrease in risk-adjusted d incentives.[35]

Recall (from Tables 3 and 4) that the incentives of high-option executives are more sensitive to stock price changes than those of low-option executives. This raises the question of whether companies' granting policies are used to manage away the incentive sensitivity induced by

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[32] This claim is further buttressed by the fact that refresher grants—extra grants given in response to stock price declines—appear to be a very small part of the story of how incentives are managed. We discuss this in more detail in Section 5.

[33] We found no interesting differences when we defined "management" in narrower ways—for example, only next year's grants—so we do not report these results.

[34] Of course, as discussed in the introduction, the management of incentives on the downside takes away some of the downside risk to executives, which may be harmful to incentives *ex ante*. We return to this issue in the conclusion.

options—that is, to manage away option fragility. The results suggest that they do. Indeed, the degree of management for *HIOPT* executives is large and striking. For example, when *b* incentives are used, the coefficient on the downside falls to 0.20 (0.64 plus -0.44), suggesting that 80% of the incentive drop is managed away. When *d* incentives are used, slightly more than half of the incentive drops are managed away. Interestingly, the results are reversed, in both specifications, on the upside, where we find anti-management in general and more anti-management for *HIOPT* companies. It appears that executives, and especially *HIOPT* executives, are rewarded most when they do very well, creating anti-management on the upside, and when they do very poorly, creating massive management on the downside. We will confirm, and elaborate on, these results in the next section when we look at the mechanisms of management.

The coefficients on the *POUT* interactions show that the fraction of an executive's options that are underwater does not seem to affect company management if unmanaged incentives increase; however, if unmanaged incentives decrease, companies manage incentives more for executives with larger fractions of their options underwater. This accords well with expectations, as discussed above.

Finally, although NASDAQ companies display less company management, the effects appear to be operating mostly through high volatility. For instance, if the volatility interaction is dropped from the regression, results not shown reveal that the coefficients on the NASDAQ interactions become significantly positive. In the full specification reported in columns 9 and 10 of Table 8, only two of the four NASDAQ interactions are significant at a 5% level, and none are large in absolute value. Volatility does, however, have large effects on management. High-volatility firms engage in less management on the downside and much more management on the upside than low volatility firms, regardless of how we measure incentives.

4.4 Executive Management

We now turn to analysis of executive management. Executives sell stock, buy stock, and exercise options. These transactions can magnify stock-price-induced incentive changes, leading to anti-management, or they can mitigate them, leading to management. One factor that should lead to executive management of incentives is option exercise behavior. Executives are more (less) likely to exercise options following stock price increases (decreases). As stock price increases push options into-the-money, early exercise becomes profitable and perhaps optimal, since risk-averse, undiversified executives rationally exercise options early when they move

[35] In addition to checking for asymmetry, we also checked for further non-linearities and found no significant departure from our piecewise linear model.

sufficiently into-the-money.[36] Thus, exercise behavior should tend to mitigate stock-price-induced incentive changes (creating management rather than anti-management), since such transactions decrease incentives when incentives have risen the most (following large increases in stock price).

Less is known about how stock purchases and sales respond to stock price changes. Many companies have formal and informal guidelines that require or encourage executives to accumulate shares of company stock over time. One possibility is that executives tend to accumulate disproportionately more shares following stock price increases, since one convenient way to accumulate shares is to exercise options, though evidence by Ofek and Yermack (2000) suggests that the conversion of exercised options into net new share holdings, at least in the aggregate, is small. On the other hand, many ownership guidelines require executives to hold a number of shares sufficient to maintain the value of holdings above some multiple of salary (or salary and bonus). Thus, stock price increases would tend to push the value of holdings above the required levels, leading to net sales following stock price increases. Stock price decreases would lead to the opposite reaction: holdings would fall below the required levels, triggering mandatory purchasing by the executive. It is, therefore, not obvious whether the net effect of stock purchases and sales leads to management or anti-management of incentives.

4.5 Executive Management or Anti-Management?

Our empirical approach for determining whether executive transactions lead to management or anti-management is analogous to our approach in the case of company management, except that we replace *company-managed* incentives with *executive-managed* incentives. That is, managed incentives now include executive sales, purchases and exercises instead of company grants (which are removed to isolate the effect of *executive* management). We again test for asymmetries in management, and then analyze the determinants of management. Table 9 gives our results for executive management, in the same format used in Table 8. The results for single-year management are not shown since all of the coefficients are quite close to one—there is essentially no management or anti-management from executive behavior within the year.

There is significant executive management, however, in the following year, but only on the downside. These results are shown in the first four columns of the table. For example, using executive value *b* incentives, executives manage away 46% (1 – 0.54 in column 1) of any decline in unmanaged incentives. The executive management effect for risk-adjusted *d* incentives is lower, but still large, at 22% (1 minus 0.78 in column 3). For stock price increases, there is

[36] See Hall and Murphy (2000, 2002) and Huddart and Lang (1996) for evidence and analysis consistent with this. Also, Heath, Huddart and Lang (1999) and Core and Guay (2001) find that executives exercise

evidence of very modest anti-management. In general, however, the coefficients are fairly close to one, suggesting little management or anti-management on the upside.

Including the interaction regressors of our extended specification has little effect on the coefficients on *POSUN* and *NEGUN*, as columns 5 and 6 make clear. However, the coefficients on the interactions reveal interesting contrasts between executive and company management. High-option executives appear to do more management on the upside and less management on the downside than low-option executives, and these differences are statistically significant at a 5% level. These differences show that executive management and company management conflict somewhat for high-option executives: companies manage less on the upside and more on the downside for these executives, while these executives manage more on the upside and less on the downside. Volatility appears to influence executive management less than company management, especially on the upside. The fraction of an executive's options that are underwater seems to be largely irrelevant for executive management on the upside, but decreases management a bit on the downside. As for company management, being a NASDAQ executive appears to make little difference to executive management once volatility and other factors are taken into account. The key result in this table, however, is the fact that executive behavior—much like company behavior, but for different reasons—leads to incentive management on the downside.

4.6 Total Management: Company and Executive Management Combined

We now explore *total management*, the combined management of incentives by companies and executives. Our approach is the same as that used to analyze company and executive management separately, but we now allow for incentive changes generated by both companies and executives. The results are shown in Table 10 and, not surprisingly given earlier results, show significant anti-management on the upside and significant management on the downside. For example, in the case where executive value *b* incentives are used, the coefficient on the upside is 1.26—indicating a 26% boost to unmanaged incentive increases—and is 0.54 on the downside—46% of declines in incentives are offset by combined management. This basic asymmetry is robust to different measures of incentives and the inclusion of the various controls.

The other interesting result in this table is that *HIOPT* executives have more combined management on the downside, which suggests that the effects of company management (from Table 8) tend to dominate the effects of executive management (from Table 9) for *HIOPT* executives. The other results are unsurprising. Tying the key result of our combined management analysis back to Figure 3, the evidence suggests that the relationship between

early following increases in stock prices because of psychological biases.

managed and unmanaged incentives is characterized by a line such as *MOA′*—management on the downside and anti-management on the upside. We now explore the mechanisms that may lead to such a relationship.

5. The Mechanism of Incentive Management

The fact that executive transactions and company granting behavior lead to incentive management on the downside raises a key question: what is the mechanism? Do larger stock price decreases lead companies to grant more options? To be more likely to reprice?[37] What explains executive management? Is it caused by fewer exercises when stock prices fall? Or by more net purchases of shares? In this section we investigate this issue. We begin by showing some medians and distributions of raw data, and then we show some econometric evidence.

Table 11 shows the number and market value of the variables related to executive management for different lagged stock price returns: options granted, stock granted, net shares bought and options exercised. We show the mean, median, 25th and 75th percentile of each variable. In the cases where the median is not zero, we focus on medians in our discussion since means are driven by outliers.

Columns 1 and 2 show the number and value of option grants for different groupings of companies, where the four groupings are separated by negative 10%, 25%, and 50%. The results show that, as expected, both the number and value of options (at the median, and also at the mean for the number) tend to increase as the stock price falls. That is, when the companies perform poorly, executives get larger rewards for worse performance, both in dollar and number terms. These results will be corroborated with regression analysis shortly, and show an important mechanism of how companies manage the fragility of options.

The results for stock grants (in the next two columns) are, not surprisingly, quite different. The median grant is zero for all groupings and the mean grant is dramatically smaller than the size of option grants. While there is modest evidence for company management with the number of mean shares—again, medians are uninformative since they are all zero—the numbers are small relative to those of options. This evidence suggests that it is primarily through option grants, not stock grants, that companies manage incentives.

In terms of executive management, we first look at option exercises, shown in the next two columns. Although exercises are always zero at the median, the pattern at the mean level of exercises is quite consistent with management on the downside. Both the number and value of exercises fall when companies do worse. The results with net share purchases do not show a consistent pattern. (Note that these net share purchases are in addition to shares received from option exercises. That is, if an executive exercised and decided to hold the shares, which the evidence suggests is uncommon (Ofek and Yermack, 2000), it would show up in our data as a purchase of shares.) The means and medians often move in different directions, and the number of shares at the median are nonmonotonic and relatively flat across groupings. Overall, there is no consistent evidence of either management or anti-management for company sales. This is at least suggestive that it is option exercises (which lead to sales of the stock received), and not net stock purchases that lead to executive management on the downside.

We explore these issues further in Table 12, which shows the both the change in the number of options granted and the change in the number of *grants*. Consistent with our level results in Table 11, the number of options granted tends to increase between the year *t* and *t+1* in response to a stock price decline in year *t*. This raises the question: does this reflect an increase in the number of options granted? Or do the results reflect an increase in the number of grants, that is, a refresher grant? As shown in the table, the number of grants rarely changes and does not increase in a significant way from year to year in response to a stock price decline. For example, when companies do very poorly, there is a 0.013 increase in the average number of grants. Note that we also looked for evidence of refresher grants *within* the year (instead of in the following year), and found no such evidence. There is no evidence that extra refresher grants are a significant contributor to company management.

The number of repricings is shown in the third column. As suggested earlier, repricings are quite uncommon and barely increase when companies do poorly. For example, in the year following a 50% decline in stock prices, the percentage of repricings was less than 2%. The number of within-year repricings, not shown, was even lower. This analysis suggests that neither refresher grants nor repricings, although highly publicized when they do happen, are significant drivers of incentive management.

We now explore the key findings with regression analysis. We begin with company management, exploring how option granting behavior changes with company performance. Taken together, our earlier results—both the management results of Tables 8 through 10 and the mechanism median and mean tables—suggest a rather strange relationship between option grants and company performance. Specifically, the results suggest that company granting behavior follows a "V" shape: large stock price increases lead to larger option grants (anti-management on

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[37] See Brenner, Sundaram and Yermack (2000), Chance, Kumar and Todd (2000) and Carter and Lynch (2001) for evidence that repricings are more common following stock price declines. Acharya, John and

the upside) and, large stock price decreases also lead to larger option grants (management on the downside). That is, the way for managers to get the most options—the biggest boost to their incentives—is to do very well and receive a reward, or very poorly and receive an "incentive restoration" grant. We now test this more formally.

Table 13 shows the results of regressing the number of options, and then the value of options, on the log of the stock price return. We interact stock price increases and decreases with the stock price return to check for the "V" shape relationship. We include executive fixed effects and year effects. Executive fixed effects are important here since there are large differences in both the average number and value of options across executives, which may confound our results.[38] The "V" shape is strongly present for both the number and value of options—with a positive coefficient on positive log returns and a negative coefficient on negative log returns—although the negative coefficient for option values is only statistically significant at the 10% level. The elasticity of the option number with respect to negative returns is quite large (in absolute value) at almost (negative) 0.4. When the stock price declines, executives receive 4% more options for each 10% decrease in the stock price return. In order to reduce fragility, executives are rewarded with more options for poorer stock price performance.

Following the large literature on relative performance evaluation (RPE) (Antle and Smith, 1986, Bertrand and Mullainathan, 2001, Gibbons and Murphy, 1990 and Holmstrom, 1982), we also explore whether company granting behavior is affected by industry stock price performance. A key notion behind RPE is that incentives can be improved if executives are not punished (or rewarded) for factors beyond their control, such as industry performance. Indeed, some companies explain the need to "manage" incentives following company stock price declines by appealing to the notion that "it was not the company's fault since the decline was industry-wide."[39] Such logic would lead companies to grant fewer (more) options in response to industry stock price increases (decreases), holding company stock price changes constant.

However, as Oyer (2000) points out, one of the attractive features of stock options is that they have appealing retention characteristics precisely because their values are sensitive to industry stock price performance. For example, when there is an industry-wide stock price decrease, companies may well want to lower wages since retention is less of a concern in less tight labor markets, and stock options provide a nice, automatic mechanism for doing so. To the extent that

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Sundaram (2000) model and analyze the optimality of resetting option prices.

[38] We also included other right-hand side variables such as age and tenure of the executive. Because executive fixed effects largely knocked out their significance, these variables did not affect our main results and were therefore dropped.

[39] See Hall, Lane and Lim (2002a,b) for a case study example of this type of reasoning.

retention considerations are driving incentive management, we expect to find anti-RPE: as industry stock prices decline, labor markets loosen, and companies find less need to restore option value through larger grants.

The results, which now include industry returns,[40] are shown in the next two columns of Table 13. For both option numbers and values, the regressions point strongly to the presence of RPE. Both coefficients are approximately equal to -0.2 and are highly significant. Although only suggestive, the results are more consistent with the view that granting behavior is more affected by incentive considerations than retention considerations.

6. Conclusion

We have introduced the concept of option fragility, which arises from the non-linear payoff structure of options. Our main contribution is to demonstrate both that the incentives provided by executive equity holdings are quite fragile because of options, and that companies actively manage this fragility *without* (explicit) repricing—indeed, approximately 40% of all stock-induced incentive declines are offset by larger-than-average option grants in the following year. Thus, we have uncovered the primary mechanism through which companies mitigate the problem created by option fragility—larger option grants.

But by attacking the problem of option fragility with option offsets, companies create a new problem. Although the media, institutional investors and shareholders routinely decry the perversity of option repricing, such repricings are, in fact, exceedingly uncommon. Our results, however, point to a type of backdoor repricing, which is both large and prevalent, and has nearly identical virtues—in terms of restoring incentives *ex post*—and flaws—in terms of degrading *ex ante* incentives by rewarding poor performance. Given the significant *ex ante* incentive problems created by fragility management *ex post*, our analysis raises the important question of whether the more robust, linear incentives provided by stock would be more effective in a dynamic environment.

Our analysis suggests that the largest future option grants follow large stock price increases *and* large stock price decreases—creating a "V" shape in the relationship between future grant size and stock price performance. This raises important questions regarding the *long-run* pay-to-performance relationship. Most studies of pay-to-performance sensitivities generated by equity holdings base their estimates on yearly changes in pay and performance. (Jensen and Murphy, 1990, Hall and Liebman, 1998, Aggarwal and Samwick, 1999). But our analysis suggests that downside pay-to-performance sensitivity over long horizons may be lower than that measured over one-year horizons since large declines in equity portfolios are partially managed or "cushioned" by larger-than-average future grants. On the other hand, our finding of anti-management on the upside—very good performance today also leads to larger-than-average option grants in the future—suggests that upside pay-to-performance sensitivities measured over long periods may be larger than those measured over short periods. We believe that the way in which company management and anti-management affect *long-run* pay-to-performance represents a fertile ground for future research.

We have focused on the way that companies manage option fragility, which we believe is appropriate given our focus on top executives. However, options are also an important retention device, especially for rank-and-file workers, and we note that much of our evidence and analysis of incentive fragility would have implications for, and shed light on, retention fragility. We have only touched on this issue with our evidence in support of RPE in option-granting behavior, which is suggestive of an incentive, rather than a retention (Oyer, 2000), motivation for executive option grants. The issue of "retention fragility," however, may represent an important extension of this analysis.

Finally, our results have implications for the way that options are valued. Specifically, if an increase or decrease in the company's stock price has a reasonably predictable effect on future option grants, then an executive option implicitly includes contingent claims to options in the future and thus is very different from a standard option. Others, such as Brenner, Sundaram, and Yermack (2000), have developed option-pricing models that take repricing into account. They conclude that the *ex ante* value of the repricing feature is trivial because repricings are so rare.[41] Our results, however, point to a type of backdoor repricing that is quite significant, and therefore, using similar models, likely to have a large impact on *ex ante* option value. More generally, there are potentially high returns to future research that models the value of multi-year options *plans*, rather than individual option *grants*.

[40] Defined as value-weighted returns from two-digit SIC codes.

[41] In a similar vein, Dybvig and Loewenstein (2002) and Saly, Jagannathan and Huddart (1999) model the values of options with reload features.

References

Abowd, J.M., Kaplan, D.S., 1999. Executive compensation: six questions that need answering. Journal of Economic Perspectives 13, 145-168.

Acharya, V.V., John, K., Sundaram, R.K., 2000. On the optimality of resetting executive stock options. Journal of Financial Economics 57, 65-101.

Aggarwal, R.K., Samwick, A.A., 1999. The other side of the tradeoff: the impact of risk on Executive compensation. Journal of Political Economy 107, 65-105.

Antle, R., Smith, A., 1986. An empirical investigation of the relative performance evaluation of corporate executives. Journal of Accounting Research 24, 1-39.

The Associated Press State and Local Wire, 1999. N.C. executives ride stock market to cash in on stock option gains (July 26, 1999).

Baker, G.P., Hall, B.J., 2001. CEO incentives and firm size. NBER Working Paper 6868.

Barr, S., 1999. Pay for underperformance? CFO: The Magazine for Senior Financial Executives, July, 83-85.

Bertrand, M., Mullainathan, S., 2001. Are CEOs rewarded for luck? The ones without principals are. Quarterly Journal of Economics 116, 901-929.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637-659.

Brenner, M., Sundaram, R.K., Yermack, D., 2000. Altering the terms of executive stock options. Journal of Financial Economics 57, 103-128.

Bushman, R.M., Smith, A.J., 2001. Financial accounting information and corporate governance. Journal of Accounting and Economics 32, 237-333.

Callaghan, S.R., Saly, P.J., Subramaniam, C., 2000. The timing of option repricing. Working paper, Texas Christian University.

Campbell, J.Y., Lo, A.W., MacKinlay, A.C., 1997. The econometrics of financial markets. Princeton University Press , Princeton, NJ.

Carpenter, J., 1998. The exercise and valuation of executive stock options. Journal of Financial Economics 48, 127-158.

Carter, M.E., Lynch, L.J., 2001. An examination of executive stock option repricing. Journal of Financial Economics 61, 207-225.

Carter, M.E., Lynch, L.J., 2002. The consequences of the FASB's 1998 proposal on accounting for stock option repricing. Journal of Accounting and Economics, forthcoming.

Chance, D.M., Kumar, R., Todd, R.B., 2000. The "repricing" of executive stock options. Journal of Financial Economics 57, 129-154.

Chidambaran, N.K., Prabhala, N.R., 2002. Executive stock option repricing, internal governance mechanisms, and management turnover. Journal of Financial Economics, forthcoming.

Core, J.E., Guay, W.R., 1999. The use of equity grants to manage optimal equity incentive levels. Journal of Accounting and Economics 28, 151-184.

Core, J.E., Guay, W.R., 2001. Stock option plans for non-executive employees. Journal of Financial Economics 61, 253-287.

Core, J.E., Guay, W.R., Larcker, D.F., 2001. Executive equity compensation and incentives: a survey. Working paper, Wharton School, University of Pennsylvania.

DeTemple, J., Sundaresan, S., 1999. Nontraded asset valuation with portfolio constraints: a binomial approach. Review of Financial Studies 12, 835-872.

Dybvig, P.H., Loewenstein, M., 2002. Employee reload options: pricing, hedging, and optimal exercise. Review of Financial Studies, forthcoming.

The Financial Times, 1999. Wrong way to pluck the goose. (August 21, 1999), 6.

Gibbons, R., Murphy, K.J., 1990. Relative performance evaluations for chief executive officers. Industrial and Labor Relations Review 43, 30-52.

Hall, B.J., 1999. The design of multi-year stock option plans. Journal of Applied Corporate Finance, Summer, 97-106.

Hall, B.J., 2000. What you need to know about stock options. Harvard Business Review 78, 121-129.

Hall, B.J., Lane, H., Lim, J.P., 2002a,b. Akamai's underwater options (A, B). Harvard Business School Case No. 902-069.

Hall, B.J., Liebman, J.B., 1998. Are CEOs really paid like bureaucrats? Quarterly Journal of Economics 113, 653-691.

Hall, B.J., Murphy, K.J., 2000. Optimal exercise prices for executive stock options. American Economic Review 90, 209-214.

Hall, B.J., Murphy, K.J., 2002. Stock options for undiversified executives. Journal of Accounting and Economics 33, 3-42.

Healy, P.M., 1985. The effect of bonus schemes on accounting decisions. Journal of Accounting and Economics 7, 85-107.

Heath, C., Huddart, S., Lang, M., 1999. Psychological factors and stock options exercises. Quarterly Journal of Economics 114, 601-628.

Holmstrom, B., 1982. Moral hazard in teams. Bell Journal of Economics 13, 324-341.

Holmstrom, B., Milgrom, P., 1987. Aggregation and linearity in the provision of intertemporal incentives. Econometrica 55, 303-328.

Huddart, S., Lang, M., 1996. Employee stock option exercises: an empirical analysis. Journal of Accounting and Economics 21, 5-44.

Jensen, M.C., 2001. Paying people to lie: The truth about the budgeting process. Harvard Business School Working Paper Number 01-072.

Jensen, M.C., Murphy, K.J., 1990. Performance pay and top-management incentives. Journal of Political Economy 98, 225-264.

Jin, L., 2002. CEO compensation, diversification and incentives. Journal of Financial Economics, forthcoming.

Jin, L., Meulbroek, L.K., 2001. Do underwater executive stock options still align incentives? The effect of stock price movements on managerial incentive-alignment. Harvard Business School Working Paper Number 02-002.

Kandel, S., Stambaugh, R.F., 1991. Asset returns and intertemporal preferences. Journal Of Monetary Economics 27, 39-72.

Kocherlakota, N.R., 1996. The equity premium: it's still a puzzle. Journal of Economic Literature 34, 42-72.

Kulatilaka, N., Marcus, A.J., 1994. Valuing employee stock options. Financial Analysts Journal 50, 46-56.

Lambert, R.A., Larcker, D.F., Verrecchia, R.E., 1991. Portfolio considerations in valuing executive compensation. Journal of Accounting Research 29, 129-149.

Lucas, D.J., 1994. Asset pricing with undiversifiable income risk and short sales constraints: deepening the equity premium puzzle. Journal of Monetary Economics 34, 325-342.

Mehra, R., Prescott, E.C., 1985. The equity premium: a puzzle. Journal of Monetary Economics 15, 145-162.

Merton, R.C., 1973. Theory of rational option pricing. Bell Journal of Economics and Management Science 4, 141-183.

Meulbroek, L.K., 2001. The efficiency of equity-linked compensation: understanding the full cost of awarding executive stock options. Financial Management 30, 5-30.

Murphy, K.J., 1999. Executive compensation. From O. Ashenfelter and D. Card, eds., Handbook of labor economics, volume 3, North Holland, 2485-2563.

Ofek, E., Yermack, D., 2000. Taking stock: equity-based compensation and the evolution of managerial ownership. Journal of Finance 55, 1367-1384.

Oyer, P., 2000. Why do firms use incentives that have no incentive effects? Working paper, Stanford University.

Reingold, J., Melcher, R.A., McWilliams, G., 1998. Executive pay: Stock options plus a bull market made a mockery of many attempts to link pay to performance. Business Week (April 20), 36-38.

Rubinstein, M., 1995. On the accounting valuation of employee stock options. Journal of Derivatives 3, 8-24.

Saly, P.J., 1994. Repricing executive stock options in a down market. Journal of Accounting and Economics 18, 325-356.

Saly, P.J., Jagannathan, R., Huddart, S., 1999. Valuing the reload features of executive stock options. Accounting Horizons 13, 219-240.

Siegel, J.J., 1998. Stocks for the long run. McGraw-Hill, New York.

Smith, C.W., Zimmerman, J.L., 1976. Valuing employee stock option plans using option pricing models. Journal of Accounting Research 14, 357-364.

Appendix A: Measuring Executives' Total Holdings of Company Stock and Stock Options

We use data from proxies, as assembled in the ExecuComp database, to construct a measure of each executive's holdings of company stock and stock options at each fiscal year-end. Our methodology is based on that of Hall and Liebman (1998), with a few minor improvements that add to precision. Proxies reveal the number, expiration date, and strike price of options, as well as the number of restricted shares, granted to each of a company's top five executives in the preceding fiscal year. Thus, we have data on grants; however, to measure incentives we need data on total holdings. ExecuComp also contains information on option exercises and total executive holdings of company stock, but we must still make assumptions about each executive's initial holdings of options. Given initial holdings of options, we use the data in ExecuComp to build up each executive's portfolio of company stock and stock options over time.

Four complications hinder our measurement of stock and option holdings. First, executives often hold options received prior to 1992, the first year for which data are available in ExecuComp. Second, the exercise price of an option grant is sometimes missing. Third, because proxies report (and thus ExecuComp contains) gains from option exercise as a dollar value and number of options exercised, it is often not possible to determine exactly which options were exercised in a given fiscal year. Fourth, stock splits force us to adjust option exercise prices, since exercise prices are typically changed automatically after a stock split. The data does, however, contain some variables that help us to check our calculations. A count of the total options (or the total number of vested options) held by executives is often available; when it is, we use it to verify and, if necessary, correct our algorithm's results.

Initial Conditions

Because many of the executives in our sample already hold options when they come into our sample, we must make assumptions about these initial holdings. We then take steps to ensure that our results are not overly sensitive to our assumptions regarding initial holdings. First, we note that, although many executives hold company stock prior to becoming part of our sample, ExecuComp contains information on total holdings of company stock, so stock holdings are less troublesome, from a data-preparation viewpoint, than option holdings. ExecuComp often contains information on the total number of options held by an executive when that executive enters our sample. However, our analysis also requires the strike price and the time to expiration of these options, which ExecuComp does not have.

We take the first year in which data on total option holdings is available, then subtract grants and add back option exercises (when necessary; that is, when the first year the executive appears in our sample is not the first year for which total options held is available) to get an estimate of the total number of options held by each executive when that executive enters our sample. We assume that these options expire in seven years, and that they have an exercise price set to the market price a year prior to the first grant for the executive in our sample (if this is missing, we use the price at the end of the previous fiscal year as provided by ExecuComp; if even that is missing, we use the price at the end of the previous fiscal year as calculated from the CRSP stock file). Since ExecuComp data begins in 1992, but we do not use any incentives prior to 1995, our results should be very robust to changes in assumptions regarding initial conditions. To check this, we reran our algorithm on 100 randomly-selected firms under the assumption that initially held options expired in three years, and then under the assumption that they expired in ten years. The results were not appreciably different from those obtained under the assumption outlined above.

Missing Exercise Prices

When an exercise price is missing, we follow a procedure similar to that described above for initial conditions. We first use the market price at the grant date, as provided by ExecuComp. If this is also missing, we use the price at the end of the fiscal year in which the options were granted, also as provided by ExecuComp. If both of these two attempts result in an exercise price that is missing, we use the price at the end of the fiscal year in which the options were granted, as calculated from the CRSP stock file.

Estimating Which Options Were Exercised

Because ExecuComp (and company proxies) report only the number of options exercised and the dollar gain from exercising them, we cannot, in general, infer exactly which options were exercised. If we knew the exact date on which the options had been exercised, we could get very good estimates of which options were sold by using the stock price on that date in combination with the number of options exercised. However, our data on exercises is at an annual frequency (unlike our data on grants; we know the precise dates on which grants were made). We thus disregard the dollar-gain data as having little information of interest to us (since we do not know the stock price at the date of exercise), and focus on the data on the number of options exercised.

We assume that executives exercise their deepest-in-the-money (lowest exercise price) options first; between option grants with a given exercise price, they exercise those that expire soonest first; between option grants with the same expiration date and exercise price, they exercise those that were granted longest ago first; between option grants with the same grant date, expiration date, and exercise price, they exercise those from the largest grant (in number of options) first. This is our initial estimate of the options that have been exercised. We then use the information provided by ExecuComp on the total number of options held by the executive to make sure that we have not subtracted too many options; if we have, we add back options to a random grant in the most recent year. (Note: this is evidence of a data discrepancy, not an error in our estimates, since our algorithm cannot make a mistake in calculating the number of options exercised). We do this recursively, so that the discrepancy between our total and ExecuComp's could only have arisen in the most recent year; thus, our procedure for correcting the discrepancy is reasonable and internally consistent.

Adjusting for Stock Splits

Because ExecuComp's data give the exercise price of the options in a grant when that grant was made, they are no longer valid after a stock split. Executive stock options typically adjust automatically to stock splits: their exercise prices and the number of options in the grant are changed to take the split into account. For a two-for-one stock split, for instance, an executive's stock options would double in number and their exercise price would be halved.

To take this fact into account, we construct split adjustment factors from CRSP stock file price data. If the current month's closing stock price, divided by last month's closing stock price, differs from the gross monthly return listed in CRSP by at least 25% of that gross monthly return, and if the change in shares outstanding is at least 25% from the end of the previous month to the end of this month, we assume that a stock split occurred. We divide price by lagged price, then divide the result by gross return, to arrive at an adjustment factor. The adjustment factor is then rounded to the closest whole number between one and ten, or 1.5 (to allow for three-for-two splits). We then cumulate (take the product of) all adjustment factors between the present date and the grant date. We multiply the number of options in the grant by this cumulative adjustment factor and divide the exercise price of each option in the grant by the cumulative adjustment factor.

Appendix B: Risk-Adjusted Incentives Calculations

Although Section 2 describes the methods we employ to calculate incentives, it omits some critical but cumbersome details, which we delve into here. First, we show how to get log parameters from raw means, standard deviations, and CAPM betas. Next, we discuss the dimensionality problems that afflict us, and how we approach them. Finally, we give an explanation of how we numerically approximate the integrals given in Section 2.

For each executive, we begin with the following five quantities: $\hat{\beta}_p, \hat{\sigma}_{raw,p}, \mu_{raw,m}, \sigma_{raw,m}, r_f$. These are our estimate of the CAPM β of the executive's company stock, our estimate of the standard deviation of returns on the company stock, the mean return on the market portfolio, the standard deviation of returns on the market portfolio, and the risk-free rate, respectively. We assume that $r_f = 6\%$, $\mu_{raw,m} = r_f + 6.5\% = 12.5\%$, and $\sigma_{raw,m} = 20\%$. As mentioned in the footnotes to Section 2.2, this matches long-term historical data fairly well. We use 60-month company-by-company ordinary least squares regressions to compute estimates of the CAPM β_p, but we constrain our estimates to lie in the interval [0,2]. We then calculate $\hat{\mu}_{raw,p} = r_f + \hat{\beta}_p\left(\mu_{raw,m} - r_f\right) = 6\% + \hat{\beta}_p \times 6.5\%$. Our estimate $\hat{\sigma}_{raw,p}$ of $\sigma_{raw,p}$, the standard deviation of returns on company stock, is obtained by taking the square root of the usual (unbiased) variance estimator computed over the most recent 36 months of returns.

Under our assumption of lognormality, we must now translate our parameters into log terms. We do so as follows:

$$\hat{\sigma}_{\log,p} = \sqrt{\ln\left(1 + \frac{\hat{\sigma}^2_{raw,p}}{\hat{\mu}^2_{raw,p}}\right)},\ \hat{\mu}_{\log,p} = \ln\left(\hat{\mu}_{raw,p}\right) - \frac{1}{2}\hat{\sigma}^2_{\log,p},\ \sigma_{\log,m} = \sqrt{\ln\left(1 + \frac{\sigma^2_m}{\mu^2_m}\right)},$$

$$\mu_{\log,m} = \ln\left(\mu_m\right) - \frac{1}{2}\sigma^2_{\log,m}, \text{ and } \hat{\sigma}_{\log,pm} = \ln\left(1 + \frac{\hat{\beta}_p \sigma^2_{raw,m}}{\mu_{raw,m}\hat{\mu}_{raw,p}}\right).$$ We can now employ a grid to approximate the joint distribution of the natural logarithms of market portfolio and company stock returns. But here we collide with the dimensionality of the problem: if the executive has options expiring in each of the following ten years, we require a grid over twenty dimensions (one dimension each for the market and company return in each of the ten years), jointly. If we asked for the crudest possible grid, a two-point approximation, that would still entail $2^{20} = 1,048,576$ grid points. We would then be forced to sum over these grid points each time we desired to evaluate expected utility, which we must do several times for each executive.

Doing this for 48,746 executive-years (much larger than our regression sample sizes due in part to the fact that we lose one year for each executive by calculating changes in incentives) is computationally infeasible, and would be even more so with a more realistic grid size.

In order to calculate incentives, then, we need a more tractable approximation to the integral that gives expected utility. We obtain this approximation by grouping grants that expire in nearby years together into one expiration year. Although each grant keeps its own exercise price, their expiration dates may be shifted slightly. If fewer than three years of the following ten have an options package expiring in them, we alter nothing. If there are four separate expiration years, we do not alter the grants expiring in the first two of the four expiration years, but we group the final two grants together, so that both are given the same expiration year (the average of the actual expiration years), but each maintains its separate strike price. If there are five separate expiration years, we group the four final grants into two pairs in a similar fashion; if there are six, we group them into three pairs on the basis of expiration year; if there are seven, we group the four earliest grants into two pairs and the final three grants into one triple; if there are eight, we group the first two into a pair and the next six into two triples; if there are nine, we group them into three triples, and if there are ten, we group the earliest six into two triples and place the final four into one quadruple.

We have thus reduced the dimensionality of the space we must grid over to six, which is still fairly high-dimensional for numerical integration; we shall have to accept a reasonably coarse grid (a ten-point grid for each return at each time would result in a 1,000,000 point overall grid, which is intractable). Somewhat arbitrarily, we use a 100-point grid for each return if there is only one expiration year, a ten-point grid for each return in each year if there are two expiration years, and a six-point grid for each return in each year if there are three expiration years after our grouping approximation. Note that the total number of points in the joint grid is thus 10,000 if there are one or two expiration years, and is $6^6 = 46,656$ if there are three expiration years.

In all of the possible cases, the grid points are placed in an "equiprobable" fashion: the interval between any two adjacent grid points has the same probability as the interval between any other two adjacent grid points (for these purposes, $-\infty$ and $+\infty$ are considered grid points). Thus, the integral can be approximated by simply averaging over the grid points (due to their placement, which allows us to avoid explicitly weighting by density values).

In the executive's expected utility calculation, Section 2 above notes the fact that we assume the executive to be optimizing over the fraction of his outside wealth he holds in the market portfolio versus the fraction he holds in the riskless asset. Computationally, we perform the optimization through a simple grid search. Again, computational constraints limit the size of the grid we may use; we choose to check every decile, so that the executive calculates his expected utility if he holds 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% of his outside wealth in the market portfolio (note that we do not permit short-selling or buying on margin, though only the latter constraint is binding in practice). He then chooses the percentage, of these eleven possible percentages, that maximizes his expected utility.

We have checked the quality of our approximations by doubling all grid sizes and checking each 5% increment for outside wealth investment using a randomly-selected subsample of 50 firms. No significant difference in results was found.

Appendix C: The Implications of Lognormality for the Probability of an Option Being Underwater

Let $\mu = E\left[1+r_t\right] = 1 + E\left[r_t\right]$ be the expected (gross) return on the stock of interest, and let $\sigma = \sqrt{Var\left[1+r_t\right]} = \sqrt{Var\left[r_t\right]}$ be the standard deviation of the return on that stock. If the return on the stock is lognormally distributed (and i. i. d. over time), then $\ln\left(1+r_t\right)$ is normally distributed with standard deviation $\sigma_{\log} = \sqrt{\ln\left(1+\frac{\sigma^2}{\mu^2}\right)}$ and mean $\mu_{\log} = \ln\left(\mu\right) - \frac{1}{2}\sigma_{\log}^2$. We now see that $\Pr\left(\prod_{t=1}^{T}\left(1+r_t\right) \geq 1\right) = \Pr\left(\sum_{t=1}^{T}\ln\left(1+r_t\right) \geq 0\right)$ since the natural logarithm is a monotonic function; the latter quantity is, by i. i. d. lognormality, equal to $\Pr\left(Z \geq 0\right)$ for a random variable $Z \sim N\left(T\mu_{\log}, T\sigma_{\log}^2\right)$. This, in turn, is equal to $\Pr\left(V \geq \frac{-\mu_{\log}}{\sigma_{\log}}\sqrt{T}\right)$ for a standard normal random variable V. We have thus shown that

$\Pr\left(\prod_{t=1}^{T}\left(1+r_t\right) \geq 1\right) = 1 - \Phi\left(\frac{-\mu_{\log}}{\sigma_{\log}}\sqrt{T}\right)$, where $\Phi(\ )$ is the standard normal cumulative distribution function. Using the relationships developed above between the moments of returns and log returns, we see that this probability is $1 - \Phi\left(\left[\frac{1}{2}\sqrt{\ln\left(1+\frac{\sigma^2}{\mu^2}\right)} - \frac{\ln\left(\mu\right)}{\sqrt{\ln\left(1+\frac{\sigma^2}{\mu^2}\right)}}\right]\sqrt{T}\right)$.

With some manipulation, this expression shows that the probability of an option granted at-the-money being in-the-money will increase monotonically with the time since grant if $\sigma < \sqrt{\mu^4 - \mu^2}$, but will decrease monotonically with the time since grant if $\sigma > \sqrt{\mu^4 - \mu^2}$. If $\sigma = \sqrt{\mu^4 - \mu^2}$, then the probability of being in-the-money is constant, does not depend on the time since grant, and equals ½.

Table 1

Fraction of Executive Options That Are Underwater

An option is defined as underwater if the stock price is below its exercise price. An option is 25% underwater if the stock price is 75% of the exercise price, and is 50% underwater if the stock price is half of the exercise price. Each executive's portfolio has a certain fraction (ranging from 0% to 100%) of its options underwater. We average this fraction over executives, equally weighting each executive unless value-weighting is indicated, to obtain the entries below. The years represent fiscal years as described in the text.

Fraction Underwater	**1998**	**1999**	**2000**
NASDAQ	34.3%	28.8%	37.0%
NYSE	34.9%	46.0%	35.4%
NASDAQ (value-weighted)	18.6%	10.3%	45.9%
NYSE (value-weighted)	21.2%	33.8%	35.4%
Fraction 25% (or more) Underwater			
NASDAQ	17.4%	14.1%	22.5%
NYSE	14.1%	20.2%	16.6%
NASDAQ (value-weighted)	7.7%	3.8%	27.1%
NYSE (value-weighted)	5.5%	12.2%	14.1%
Fraction 50% (or more) Underwater			
NASDAQ	6.6%	5.8%	11.6%
NYSE	4.2%	5.6%	6.7%
NASDAQ (value-weighted)	2.8%	1.1%	19.7%
NYSE (value-weighted)	1.1%	1.8%	4.6%

Annual NYSE sample sizes vary from 4,076 to 5,160; annual NASDAQ sample sizes vary from 1,752 to 2,464.

Table 2

The Equal-Weighted Realized Percentage of Companies Whose Options Would Have Been Underwater After One, Five and Ten Years

The entries below show the percentages of companies whose stock prices are below their starting point (so that an option granted at-the-money at the starting point would be underwater) for each of the time periods below. The percentages below were calculated using actual CRSP stock returns data, with returns calculated excluding dividends. All percentages were calculated at year-end: for example, the first row of the table shows that at the end of 1989, 49.1% of the options granted at the end of 1988 would have been underwater. The top entry in the five-year column (of NASDAQ) indicates that 34.6% of all options granted five years earlier than 1993 (at the end of 1988) would have been underwater as of the end of 1993. The "Return" column gives the one-year, equal-weighted return on the appropriate exchange, excluding dividends.

1. NASDAQ (equal-weighted return[A] = 15.5%, median volatility = 49.3%)

Ending Year	Return	One Year	Five Years	Ten Years
1989	7.9%	49.1%		
1990	-22.9%	78.6%		
1991	57.3%	32.3%		
1992	29.9%	40.8%		
1993	27.6%	39.2%	34.6%	
1994	-6.4%	60.5%	38.7%	
1995	33.0%	35.1%	23.6%	
1996	15.1%	44.1%	33.9%	
1997	17.0%	43.2%	35.3%	
1998	-2.1%	66.4%	44.0%	29.5%
1999	53.6%	49.7%	37.6%	28.7%
2000	-23.3%	67.3%	51.4%	27.2%

2. NYSE (equal-weighted return[A] = 9.2%, median volatility = 31.4%.)

Ending Year	Return	One Year	Five Years	Ten Years
1989	12.3%	34.2%		
1990	-21.1%	77.5%		
1991	34.4%	23.3%		
1992	14.6%	38.0%		
1993	16.0%	32.8%	27.8%	
1994	-6.9%	67.2%	42.2%	
1995	19.5%	24.6%	19.3%	
1996	16.6%	29.4%	26.6%	
1997	21.5%	23.8%	20.0%	
1998	-5.0%	58.1%	32.2%	20.7%
1999	1.8%	62.6%	32.8%	30.9%
2000	6.8%	45.3%	40.7%	21.6%

Annual sample sizes vary from 3,350 to 4,585 over one-year NASDAQ samples, from 2,160 to 2,306 over five-year NASDAQ samples, from 1,067 to 1,174 over ten-year NASDAQ samples, from 1,587 to 2,706 over one-year NYSE samples, from 1,456 to 1,825 over five-year NYSE samples, and from 1,045 to 1,071 over ten-year NYSE samples.

[A] This is the average annual equal-weighted return excluding dividends during the full period, from 1989 to 2000.

Table 3

Incentives Following Stock Price Changes
Stylized Example—Assuming σ = 31.4% (NYSE median volatility)

The firm is assumed to have an initial stock price of $100 (the "benchmark" case below), 10,000,000 shares outstanding, a volatility of 31.4%, and a CAPM β of 1. The risk-free rate is 6%. The market portfolio has an expected return of 12.5% and a volatility of 20%. The executive is assumed to have $1,000,000 in outside wealth, and the market value of the total package, options and stock, is assumed to be $1,000,000 at the initial stock price of $100. All options are assumed to be struck at the initial stock price of $100, with an equal market value of options (at the initial stock price of $100) expiring in three, six, and nine years from the present. All other assumptions are carried over from Section 2 of the text, and the procedure used to obtain executive values is described in Section 2.2.2 and Appendix B.

	Stock Price as Percentage of Exercise Price								
	150%	% chg. from benchmk.	**Benchmark 100%**	75%	% chg. from benchmk.	50%	% chg. from benchmk.	25%	% chg. from benchmk.
Stock Only									
Market value*	$1,500		**$1,000**	$750		$500		$250	
Change in MV wealth per $1,000 change in firm value (*b*)	$1.00	0%	**$1.00**	$1.00	0%	$1.00	0%	$1.00	0%
Change in MV wealth per 1% change in firm value* (*d*)	$15.0	50%	**$10.0**	$7.5	-25%	$5.0	-50%	$2.5	-75%
Executive value*	$1,453		**$974**	$733		$491		$247	
Change in EV wealth per $1,000 change in firm value (*b*)	$0.96	0%	**$0.96**	$0.97	1%	$0.97	1%	$0.98	2%
Change in EV wealth per 1% change in firm value* (*d*)	$14.4	50%	**$9.6**	$7.2	-25%	$4.9	-49%	$2.5	-74%
Options Only									
Market value*	$2,200		**$1,000**	$515		$176		$21	
Change in MV wealth per $1,000 change in firm value (*b*)	$2.57	19%	**$2.16**	$1.70	-21%	$1.00	-54%	$0.28	-87%
Change in MV wealth per 1% change in firm value* (*d*)	$38.5	78%	**$21.6**	$12.7	-41%	$5.0	-77%	$0.7	-97%
Executive value*	$1,414		**$524**	$235		$64		$4	
Change in EV wealth per $1,000 change in firm value (*b*)	$2.09	54%	**$1.36**	$0.93	-32%	$0.44	-68%	$0.08	-94%
Change in EV wealth per 1% change in firm value* (*d*)	$31.3	130%	**$13.6**	$6.9	-49%	$2.2	-84%	$0.2	-99%
Stock and Options									
Market value*	$1,850		**$1,000**	$632		$338		$136	
Change in MV wealth per $1,000 change in firm value (*b*)	$1.78	13%	**$1.58**	$1.35	-15%	$1.00	-37%	$0.64	-59%
Change in MV wealth per 1% change in firm value* (*d*)	$26.8	70%	**$15.8**	$10.1	-36%	$5.0	-68%	$1.6	-90%
Executive value*	$1,363		**$699**	$439		$246		$112	
Change in EV wealth per $1,000 change in firm value (*b*)	$1.45	26%	**$1.15**	$0.91	-21%	$0.63	-45%	$0.46	-60%
Change in EV wealth per 1% change in firm value* (*d*)	$21.7	89%	**$11.5**	$6.8	-41%	$3.2	-72%	$1.2	-90%

**** in thousands***

Table 4

Incentives Following Stock Price Changes
Stylized Example—Assuming σ = 49.3% (NASDAQ median volatility)

The firm is assumed to have an initial stock price of $100 (the "benchmark" case below), 10,000,000 shares outstanding, a volatility of 49.3%, and a CAPM β of 1. The risk-free rate is 6%. The market portfolio has an expected return of 12.5% and a volatility of 20%. The executive is assumed to have $1,000,000 in outside wealth, and the market value of the total package, options and stock, is assumed to be $1,000,000 at the initial stock price of $100. All options are assumed to be struck at the initial stock price of $100, with an equal market value of options (at the initial stock price of $100) expiring in three, six, and nine years from the present. All other assumptions are carried over from Section 2 of the text, and the procedure used to obtain executive values is described in Section 2.2.2 and Appendix B.

	Stock Price as Percentage of Exercise Price								
	150%	% chg. from benchmk.	**Benchmark 100%**	75%	% chg. from benchmk.	50%	% chg. from benchmk.	25%	% chg. from benchmk.
Stock Only									
Market value*	$1,500		**$1,000**	$750		$500		$250	
Change in MV wealth per $1,000 change in firm value (*b*)	$1.00	0%	**$1.00**	$1.00	0%	$1.00	0%	$1.00	0%
Change in MV wealth per 1% change in firm value* (*d*)	$15.00	50%	**$10.00**	$7.50	-25%	$5.00	-50%	$2.50	-75%
Executive value*	$1,356		**$918**	$696		$471		$240	
Change in EV wealth per $1,000 change in firm value (*b*)	$0.87	-1%	**$0.88**	$0.89	1%	$0.91	3%	$0.94	7%
Change in EV wealth per 1% change in firm value* (*d*)	$13.00	48%	**$8.80**	$6.70	-24%	$4.60	-48%	$2.30	-74%
Options Only									
Market value*	$1,919		**$1,000**	$601		$275		$63	
Change in MV wealth per $1,000 change in firm value (*b*)	$1.94	13%	**$1.71**	$1.48	-13%	$1.11	-35%	$0.56	-67%
Change in MV wealth per 1% change in firm value* (*d*)	$29.10	70%	**$17.10**	$11.10	-35%	$5.60	-67%	$1.40	-92%
Executive value*	$660		**$307**	$165		$58		$7	
Change in EV wealth per $1,000 change in firm value (*b*)	$0.79	23%	**$0.64**	$0.53	-17%	$0.32	-50%	$0.10	-84%
Change in EV wealth per 1% change in firm value* (*d*)	$11.90	86%	**$6.40**	$4.00	-38%	$1.60	-75%	$0.20	-97%
Stock and Options									
Market value*	$1,710		**$1,000**	$676		$387		$156	
Change in MV wealth per $1,000 change in firm value (*b*)	$1.47	9%	**$1.35**	$1.24	-8%	$1.06	-21%	$0.78	-42%
Change in MV wealth per 1% change in firm value* (*d*)	$22.10	64%	**$13.50**	$9.30	-31%	$5.30	-61%	$2.00	-85%
Executive value*	$753		**$441**	$302		$182		$86	
Change in EV wealth per $1,000 change in firm value (*b*)	$0.66	12%	**$0.59**	$0.53	-10%	$0.43	-27%	$0.35	-41%
Change in EV wealth per 1% change in firm value* (*d*)	$10.00	69%	**$5.90**	$4.00	-32%	$2.20	-63%	$0.90	-85%

**** in thousands***

Table 5

Yearly Changes in Equity Incentives

Each entry represents the mean (median) of the (absolute value of) percent changes in the incentive measure. The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively, as discussed in more detail in the text. Unmanaged incentives are calculated under the assumption that no changes have occurred within the year to executive holdings of stock or options. Managed incentives do include changes during the year (company and executive management) and therefore are the actual percent changes in incentives. The parenthetical descriptions "Market value" and "Executive value" mean, respectively, that incentives are measured using market values (Black-Scholes values) and executive values.

	Managed Mean (Median)	Unmanaged Mean (Median)
b (Market value)	44% (14%)	19% (9%)
b (Executive value)	44% (21%)	27% (19%)
d (Market value)	80% (37%)	48% (34%)
d (Executive value)	71% (38%)	49% (37%)

Annual sample sizes vary from 1,207 to 6,222.

Table 6

The Sensitivity of Unmanaged Incentives to Returns

The dependent variables (*PCUN*$_{it}$) are single-year log percent changes in unmanaged incentives. The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively. "MV" indicates incentives measured using market values, while "EV" indicates incentives measured using executive values. "*POSRET*" is the natural logarithm of one plus the return observed, if that return is non-negative (and zero otherwise). "*NEGRET*" is the natural logarithm of one plus the return observed, if that return is negative (and zero otherwise). "*HIOPT*" is an indicator that is one if the executive is in the top quintile of executives in our sample on the basis of the fraction: number of options held divided by number of shares held plus number of options held. "*VOL*" is volatility, which is calculated using monthly returns over the past 36 months. "*POUT*" is the fraction of an executive's options that were underwater at the end of the previous year. "*NASDAQ*" is an indicator that is one if the executive's company is listed on NASDAQ. *VOL* and *POUT* were demeaned (that is, grand means were taken over all of the data and then subtracted from the corresponding variable in each observation) in order to allow interpretation of the main effects of *POSRET* and *NEGRET* on unmanaged incentives. The main effects (the first two coefficients reported in each column) are interpretable in columns 5 through 8 as the elasticities, at the mean values of *VOL* and *POUT* and if the company is neither high-option nor NASDAQ, of percent changes in unmanaged incentives with respect to returns. Binary variables (*HIOPT* and *NASDAQ*) were not demeaned. Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg." This procedure implements robust regression using first Huber, then biweight weighting schemes to downweight the effects of outliers. In addition, observations with a log return of greater than 1 or less than –1 were dropped. Since this is a right-hand side variable, such censoring does not induce bias. Year fixed effects were included in each regression.

Independent Variable		Dependent Variable							
		b **(EV)**	***b*** **(MV)**	***d*** **(EV)**	***d*** **(MV)**	***b*** **(EV)**	***b*** **(MV)**	***d*** **(EV)**	***d*** **(MV)**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
POSRET	coeff.	0.05	0.07	1.09	1.08	0.50	0.11	1.20	1.08
	t-stat.	*5.22*	*19.47*	*238.72*	*880.10*	*27.69*	*17.58*	*131.67*	*503.29*
NEGRET	coeff.	0.69	0.24	1.17	1.11	1.10	0.26	1.21	1.13
	t-stat.	*83.04*	*72.3*	*270.3*	*952.99*	*66.65*	*44.47*	*145.2*	*572.66*
HIOPT *	coeff.					0.08	0.06	0.08	0.05
POSRET	*t-stat.*					*5.52*	*11.27*	*10.7*	*25.41*
HIOPT *	coeff.					0.26	0.17	0.21	0.12
NEGRET	*t-stat.*					*17.5*	*31.46*	*28.51*	*68.9*
VOL *	coeff.					-1.27	-0.25	-0.42	-0.07
POSRET	*t-stat.*					*-35.7*	*-19.86*	*-23.51*	*-16.05*
VOL *	coeff.					-1.29	-0.26	-0.29	-0.11
NEGRET	*t-stat.*					*-35.85*	*-20.36*	*-16.05*	*-25.17*
POUT *	coeff.					0.27	0.22	0.16	0.16
POSRET	*t-stat.*					*17.01*	*39.00*	*20.38*	*86.24*
POUT *	coeff.					0.06	0.22	0.65	0.28
NEGRET	*t-stat.*					*3.68*	*35.66*	*74.99*	*139.14*
NASDAQ *	coeff.					-0.06	-0.04	-0.02	-0.02
POSRET	*t-stat.*					*-4.36*	*-7.50*	*-3.54*	*-10.08*
NASDAQ *	coeff.					0.03	0.01	-0.07	-0.03
NEGRET	*t-stat.*					*1.91*	*2.81*	*-10.1*	*-19.65*

N = 27,379

Table 7

The Sensitivity of Managed Incentives to Returns

The dependent variables (PCM_{it}) are single-year log percent changes in managed incentives. The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively. "MV" indicates incentives measured using market values, while "EV" indicates incentives measured using executive values. "*POSRET*" is the natural logarithm of one plus the return observed, if that return is non-negative (and zero otherwise). "*NEGRET*" is the natural logarithm of one plus the return observed, if that return is negative (and zero otherwise). Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg." This procedure implements robust regression using first Huber, then biweight weighting schemes to downweight the effects of outliers. In addition, observations with a log return of greater than 1 or less than –1 were dropped. Since this is a right-hand side variable, such censoring does not induce bias. Year fixed effects were included in each regression.

Independent Variable		Dependent Variable			
		***b* (EV)**	***b* (MV)**	***d* (EV)**	***d* (MV)**
		1	**2**	**3**	**4**
POSRET	coeff.	-0.05	0.02	0.98	1.06
	t-stat.	*-3.57*	*2.08*	*71.08*	*90.07*
NEGRET	coeff.	0.29	0.20	0.94	0.87
	t-stat.	*24.4*	*20.34*	*71.57*	*77.72*

N = 26,815

Table 8

Company Management of Executive Incentives

The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively. "MV" indicates incentives measured using market values, while "EV" indicates incentives measured using executive values. "*POSPCUN*" is *PCUN* if it is non-negative (and is zero otherwise). "*NEGPCUN*" is *PCUN* if it is negative (and is zero otherwise). "*HIOPT*" is an indicator that is one if the executive is in the top quintile of executives in our sample on the basis of the fraction: number of options held divided by number of shares held plus number of options held. "*VOL*" is volatility, which is calculated using monthly returns over the past 36 months. "*POUT*" is the fraction of an executive's options that were underwater at the end of the previous year. "*NASDAQ*" is an indicator that is one if the executive's company is listed on NASDAQ. In columns 1 through 4, the dependent variables are single-year log percent changes in incentives (the natural logarithm of one plus the following quotient: incentives if only the company acted to affect the executive's portfolio, minus actual incentives in the previous year, all divided by last year's actual incentives), while in columns 5 through 10, the incentive measures are "total," that is, measured over two years (so that the base on which the percent change is calculated is the actual incentive value two years ago). The volatility and percent-underwater variables were demeaned (that is, grand means were taken over all of the data and then subtracted from the corresponding variable in each observation) in order to allow interpretation of the main effects of *POSPCUN* and *NEGPCUN* on company-managed incentives. The main effects (the first two coefficients reported in each column) are interpretable in columns 9 and 10 as the elasticities, at the mean values of *VOL* and *POUT* and if the company is neither high-option nor traded on NASDAQ, of percent changes in company-managed incentives with respect to changes in unmanaged incentives. Binary variables (*HIOPT* and *NASDAQ*) were not demeaned, because the coefficients seem interpretable without demeaning. Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg." This procedure implements robust regression using first Huber, then biweight weighting schemes to downweight the effects of outliers. In addition, observations with a *PCUN* of greater than 1 or less than –1 were dropped. Since this is a right-hand-side variable, such censoring does not induce bias. Any observation that does not have data for the corresponding incentive measures in the executive- and combined-management regressions is dropped. Year fixed effects were included in each regression.

		Dependent Variable									
		$PCCM_t$ Using:				**$PCCM_{t+1}$ Using:**					
Independent Variable		***b* (EV)**	***b* (MV)**	***d* (EV)**	***d* (MV)**	***b* (EV)**	***b* (MV)**	***d* (EV)**	***d* (MV)**	***b* (EV)**	***d* (EV)**
		1	2	3	4	5	6	7	8	9	10
POSPCUN	coeff.	1.22	1.43	1.01	1.02	1.43	1.57	1.16	1.17	1.42	1.14
	t-stat.[A]	*13.37*	*16.11*	*1.40*	*2.45*	*9.55*	*8.18*	*8.09*	*8.23*	*6.90*	*5.72*
NEGPCUN	Coeff.	0.78	0.52	0.94	0.83	0.61	0.49	0.77	0.70	0.64	0.82
	t-stat.[A]	*39.43*	*79.25*	*9.28*	*22.29*	*26.49*	*34.13*	*12.64*	*15.44*	*19.95*	*8.38*
HIOPT *	coeff.									0.35	0.35
POSPCUN	*t-stat.*									*3.88*	*10.15*
HIOPT *	coeff.									-0.44	-0.36
NEGPCUN	*t-stat.*									*-15.13*	*-10.18*
VOL *	coeff.									-1.05	-0.14
POSPCUN	*t-stat.*									*-3.94*	*-1.47*
VOL *	coeff.									1.08	1.01
NEGPCUN	*t-stat.*									*14.46*	*10.9*
POUT *	coeff.									-0.07	-0.02
POSPCUN	*t-stat.*									*-0.83*	*-0.66*
POUT *	coeff.									-0.21	-0.12
NEGPCUN	*t-stat.*									*-5.45*	*-2.94*
NASDAQ *	coeff.									-0.07	-0.12
POSPCUN	*t-stat.*									*-0.7*	*-3.61*
NASDAQ *	coeff.									0.06	0.05
NEGPCUN	*t-stat.*									*2.51*	*1.68*
	N	26,278	27,003	24,958	25,425	15,790	16,159	15,255	15,492	15,790	15,255

[A] Indicates a *t*-ratio testing the null hypothesis that the coefficient is equal to one.

Table 9

Executive Management of Executive Incentives

The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively. "MV" indicates incentives measured using market values, while "EV" indicates incentives measured using executive values. "*POSPCUN*" is *PCUN* if it is non-negative (and is zero otherwise). "*NEGPCUN*" is *PCUN* if it is negative (and is zero otherwise). "*HIOPT*" is an indicator that is one if the executive is in the top quintile of executives in our sample on the basis of the fraction: number of options held divided by number of shares held plus number of options held. "*VOL*" is volatility, which is calculated using monthly returns over the past 36 months. "*POUT*" is the fraction of an executive's options that were underwater at the end of the previous year. "*NASDAQ*" is an indicator that is one if the executive's company is listed on NASDAQ. The incentive measures used in the dependent variable are "total," that is, measured over two years (so that the base on which the percent change is calculated is the actual incentive value two years ago). The volatility and percent-underwater variables were demeaned (that is, grand means were taken over all of the data and then subtracted from the corresponding variable in each observation) in order to allow interpretation of the main effects of *POSPCUN* and *NEGPCUN* on executive-managed incentives. The main effects (the first two coefficients reported in each column) are interpretable in columns 9 and 10 as the elasticities, at the mean values of *VOL* and *POUT* and if the company is neither high-option nor traded on NASDAQ, of percent changes in executive-managed incentives with respect to changes in unmanaged incentives. Binary variables (*HIOPT* and *NASDAQ*) were not demeaned, because the coefficients seem interpretable without demeaning. Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg." This procedure implements robust regression using first Huber, then biweight weighting schemes to downweight the effects of outliers. In addition, observations with a *PCUN* of greater than 1 or less than –1 were dropped. Since this is a right-hand side variable, such censoring does not induce bias. Any observation that does not have data for the corresponding incentive measures in the company- and combined-management regressions is dropped. Year fixed effects were included in each regression.

		Dependent Variable					
		$PCEM_{t+1}$ Using:					
Independent Variable		***b*** **(EV)**	***b*** **(MV)**	***d*** **(EV)**	***d*** **(MV)**	***b*** **(EV)**	***d*** **(EV)**
		1	2	3	4	5	6
POSPCUN	coeff.	1.07	1.10	1.04	1.01	1.09	1.07
	t-stat.[A]	*1.80*	*1.76*	*2.26*	*0.56*	*1.69*	*3.18*
NEGPCUN	coeff.	0.54	0.40	0.78	0.75	0.54	0.75
	t-stat.[A]	*36.12*	*48.93*	*13.43*	*14.92*	*6.24*	*12.98*
HIOPT * POSPCUN	coeff.					-0.15	-0.08
	t-stat.					*-1.96*	*-2.61*
HIOPT * NEGPCUN	coeff.					0.12	0.15
	t-stat.					*4.76*	*4.97*
VOL * POSPCUN	coeff.					0.11	-0.06
	t-stat.					*0.46*	*-0.71*
VOL * NEGPCUN	coeff.					0.85	0.63
	t-stat.					*13.11*	*7.62*
POUT * POSPCUN	coeff.					-0.07	-0.18
	t-stat.					*-0.90*	*-5.57*
POUT * NEGPCUN	coeff.					0.16	0.29
	t-stat.					*4.85*	*7.88*
NASDAQ * POSPCUN	coeff.					0.18	0.05
	t-stat.					*2.16*	*1.86*
NASDAQ * NEGPCUN	coeff.					0.01	0.00
	t-stat.					*0.43*	*0.01*
	N	15,790	16,159	15,255	15,492	15,790	15,255

[A] Indicates a *t*-ratio testing the null hypothesis that the coefficient is equal to one.

Table 10

Combined Management of Executive Incentives

The incentive measures "*b*" and "*d*" are "effective fraction owned" and "dollars at stake," respectively. "MV" indicates incentives measured using market values, while "EV" indicates incentives measured using executive values. "*POSPCUN*" is *PCUN* if it is non-negative (and is zero otherwise). "*NEGPCUN*" is *PCUN* if it is negative (and is zero otherwise). "*HIOPT*" is an indicator that is one if the executive is in the top quintile of executives in our sample on the basis of the fraction: number of options held divided by number of shares held plus number of options held. "*VOL*" is volatility, which is calculated using monthly returns over the past 36 months. "*POUT*" is the fraction of an executive's options that were underwater at the end of the previous year. "*NASDAQ*" is an indicator that is one if the executive's company is listed on NASDAQ. The incentive measures used in the dependent variable are "total," that is, measured over two years (so that the base on which the percent change is calculated is the actual incentive value two years ago). The volatility and percent-underwater variables were demeaned (that is, grand means were taken over all of the data and then subtracted from the corresponding variable in each observation) in order to allow interpretation of the main effects of *POSPCUN* and *NEGPCUN* on combined-managed incentives. The main effects (the first two coefficients reported in each column) are interpretable in columns 9 and 10 as the elasticities, at the mean values of *VOL* and *POUT* and if the company is neither high-option nor traded on NASDAQ, of percent changes in combined-managed incentives with respect to changes in unmanaged incentives. Binary variables (*HIOPT* and *NASDAQ*) were not demeaned, because the coefficients seem interpretable without demeaning. Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg." This procedure implements robust regression using first Huber, then biweight weighting schemes to downweight the effects of outliers. In addition, observations with a *PCUN* of greater than 1 or less than –1 were dropped. Since this is a right-hand side variable, such censoring does not induce bias. Any observation that does not have data for the corresponding incentive measures in the company- and executive-management regressions is dropped. Year fixed effects were included in each regression.

Independent Variable		Dependent Variable: PCM_{t+1} Using: **b (EV)**	**b (MV)**	**d (EV)**	**d (MV)**	**b (EV)**	**d (EV)**
		1	2	3	4	5	6
POSPCUN	coeff.	1.26	1.42	1.12	1.13	1.21	1.13
	t-stat.[A]	*5.06*	*5.33*	*5.32*	*5.49*	*3.00*	*4.65*
NEGPCUN	coeff.	0.54	0.36	0.72	0.64	0.54	0.74
	t-stat.[A]	*27.62*	*38.15*	*13.36*	*16.09*	*22.55*	*10.56*
HIOPT *	coeff.					0.22	0.16
POSPCUN	*t-stat.*					*2.16*	*4.15*
HIOPT *	coeff.					-0.19	-0.18
NEGPCUN	*t-stat.*					*-5.75*	*-4.37*
VOL *	coeff.					-1.52	-0.44
POSPCUN	*t-stat.*					*-4.96*	*-4.06*
VOL *	coeff.					1.52	1.37
NEGPCUN	*t-stat.*					*17.74*	*12.92*
POUT *	coeff.					0.10	-0.04
POSPCUN	*t-stat.*					*1.01*	*-1.01*
POUT *	coeff.					-0.29	-0.09
NEGPCUN	*t-stat.*					*-6.56*	*-1.85*
NASDAQ *	coeff.					0.05	-0.07
POSPCUN	*t-stat.*					*0.48*	*-1.79*
NASDAQ *	coeff.					0.03	0.04
NEGPCUN	*t-stat.*					*0.95*	*1.04*
	N	15,790	16,159	15,255	15,492	15,790	15,255

[A] Indicates a *t*-ratio testing the null hypothesis that the coefficient is equal to one.

Table 11

Company and Executive Reaction to Poor Stock Price Performance in the Previous Year

“Opts.” is an abbreviation for “options.” The dollar value of options granted is determined according to the Black-Scholes formula. The dollar value of options exercised is simply the cash gained from option exercises. The numbers of observations for the categories below are: 10,252 (for lagged return ≥ -10%), 2,396 (for lagged return < -10% and ≥ -25%), 2,646 (for lagged return < -25% and ≥ -50%) and 910 (for lagged return < -50%).

		Variable							
Lagged Return		**# Opts. Granted**	**\$ Opts. Granted**	**# Shares Granted**	**\$ Shares Granted**	**Net # Shares Bought**	**Net \$ Shares Bought**	**# Opts. Exercised**	**\$ Opts. Exercised**
		1	2	3	4	5	6	7	8
≥ -10%	**mean**	**95,380**	**$1,502,916**	**8,050**	**$299,842**	**70,060**	**$3,990,281**	**54,884**	**$1,667,440**
	25th %ile	7,000	$44,294	0	$0	-2	-$62	0	$0
	median	**29,750**	**$295,623**	**0**	**$0**	**1,825**	**$53,221**	**0**	**$0**
	75th %ile	80,000	$1,024,610	0	$0	20,287	$669,206	32,163	$747,949
< -10%	**mean**	**81,352**	**$965,121**	**4,777**	**$160,296**	**76,398**	**$5,799,773**	**37,703**	**$1,068,042**
and	25th %ile	4,080	$26,290	0	$0	-2,199	-$52,540	0	$0
≥ -25%	**median**	**28,542**	**$244,695**	**0**	**$0**	**599**	**$12,970**	**0**	**$0**
	75th %ile	76,160	$801,529	0	$0	11,674	$317,118	15,000	$260,118
< -25%	**mean**	**109,607**	**$1,203,890**	**6,453**	**$191,656**	**29,459**	**$1,102,409**	**45,019**	**$1,178,987**
and	25th %ile	10,000	$63,246	0	$0	-2,600	-$51,843	0	$0
≥ -50%	**median**	**37,278**	**$290,825**	**0**	**$0**	**500**	**$9,714**	**0**	**$0**
	75th %ile	100,000	$937,124	0	$0	9,332	$203,283	18,500	$254,840
< -50%	**mean**	**109,913**	**$962,233**	**7,196**	**$117,013**	**-9,572**	**-$22,851**	**39,537**	**$876,995**
	25th %ile	15,000	$70,255	0	$0	-2,295	-$42,424	0	$0
	median	**47,625**	**$325,381**	**0**	**$0**	**562**	**$7,321**	**0**	**$0**
	75th %ile	120,000	$901,713	0	$0	14,053	$227,365	16,799	$234,600

Table 12

Changes in Company Behavior in Response to Poor Stock Price Performance in the Previous Year

"Opts." is an abbreviation for "options." "Change" refers to the current value of the variable, minus the value of the variable ***two*** years ago. The number of option grants made is the number of separate grants received by the executive from the company during the year. The repricing indicator is one if an executive's options were repriced during the year, and is zero otherwise. The numbers of observations for the categories below are: 3,558 (for lagged return ≥ -10%), 947 (for lagged return < -10% and ≥ -25%), 1,118 (for lagged return < -25% and ≥ -50%) and 394 (for lagged return < -50%).

Lagged Return		Variable: Change in # Opts. Granted (1)	Change in # of Option Grants Made (2)	Repricing Indicator (3)
≥ -10%	**mean**	**50,886**	**0.080**	**0.011**
	25^{th} %ile	-1,787	0	0
	median	**9,000**	**0**	**0**
	75^{th} %ile	49,500	0	0
< -10% and ≥ -25%	**mean**	**39,111**	**-0.004**	**0.013**
	25^{th} %ile	0	0	0
	median	**10,000**	**0**	**0**
	75^{th} %ile	47,000	0	0
< -25% and ≥ -50%	**mean**	**37,811**	**-0.021**	**0.022**
	25^{th} %ile	0	0	0
	median	**16,000**	**0**	**0**
	75^{th} %ile	55,000	0	0
< -50%	**mean**	**56,513**	**0.013**	**0.018**
	25^{th} %ile	2,991	0	0
	median	**25,770**	**0**	**0**
	75^{th} %ile	100,000	0	0

Table 13

The Mechanism of Incentive Management and Relative Performance Evaluation

All regressions are run using executive fixed effects, year fixed effects, and robust regression. "# Opt. Grant." is the natural logarithm of one plus the number of options granted during the year. "$ Opt. Grant." is the natural logarithm of one plus the market (Black-Scholes) value of the options granted during the year. "# Opt. Exer." is the natural logarithm of one plus the number of options exercised during the year. "$ Opt. Exer." is the natural logarithm of one plus the number of dollars gained by the executive through option exercises during the year. "Log return" is the natural logarithm of one plus the lagged return observed. "Log ind. ret." is the natural logarithm of one plus the lagged return on the value-weighted portfolio of all stocks in the same two-digit SIC code as the executive's company. Coefficient estimates and *t*-statistics were obtained using the STATA procedure "rreg," which corrects for the effects of outliers. Observations were included only if both return variables, for company and for industry, were less than 1 (or 100%) in absolute value. Since these are independent variables, this should not bias our estimates.

Independent Variable		Dependent Variable					
		# Opt. Grant.	**$ Opt. Grant.**	**# Opt. Grant.**	**$ Opt. Grant.**	**# Opt. Exer.**	**$ Opt. Exer.**
		1	2	3	4	5	6
Log return	coeff.	0.05	0.11	0.07	0.12	0.18	0.25
if positive	*t-stat.*	*1.98*	*3.54*	*2.60*	*4.11*	*5.33*	*7.11*
Log return	coeff.	-0.38	-0.04	-0.36	-0.02	-0.01	0.12
if negative	*t-stat.*	*-15.77*	*-1.42*	*-14.70*	*-0.59*	*-0.37*	*3.75*
Log ind. ret.	coeff.			-0.20	-0.21		
	t-stat.			*-5.94*	*-5.58*		

N = 16,157 (except for $ opt. exer., for which N = 16,155)

Figure 1A

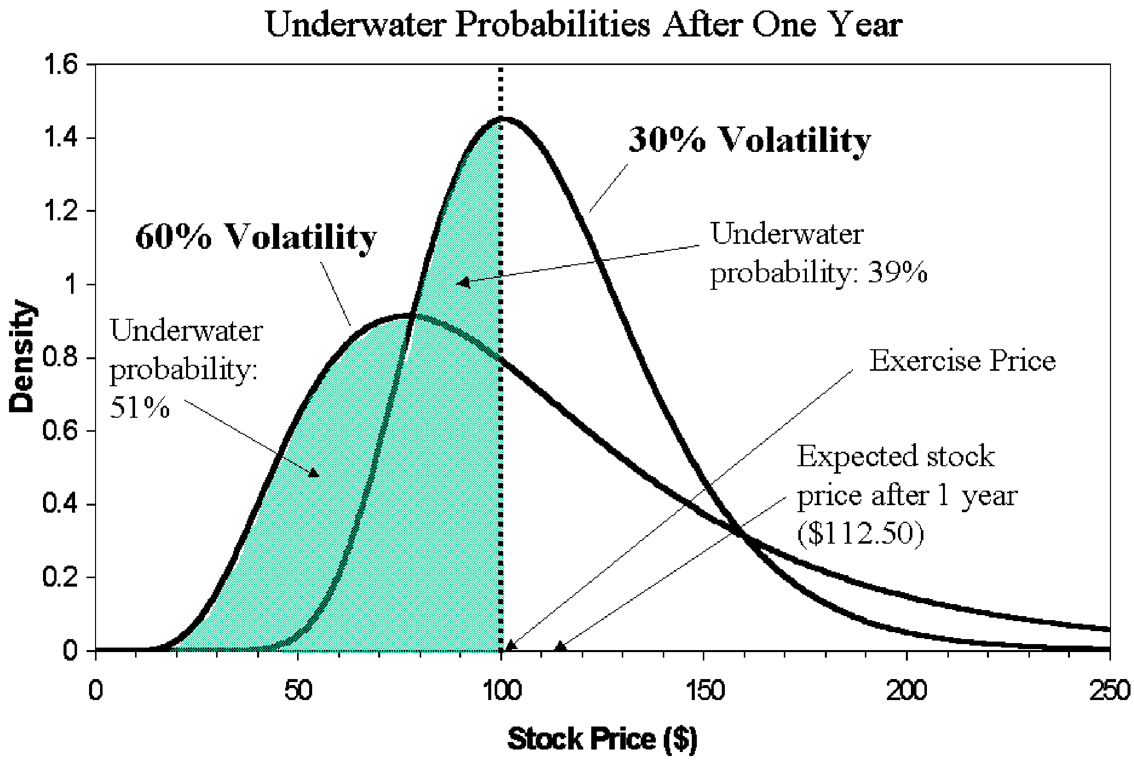


Figure 1B

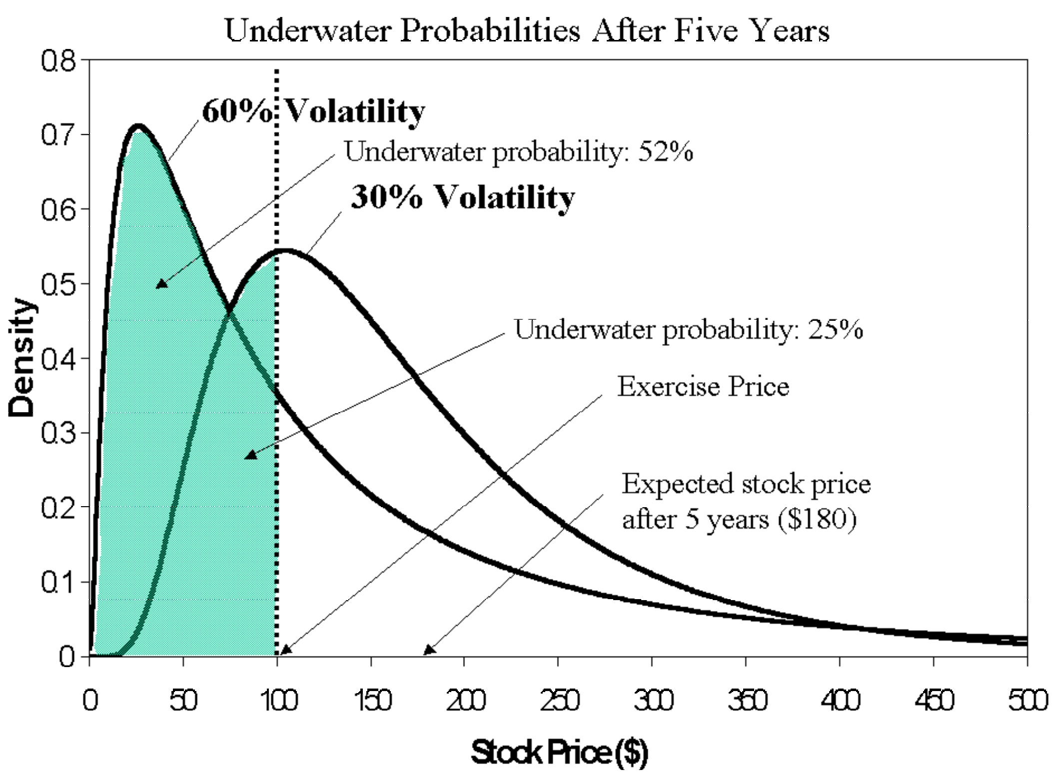
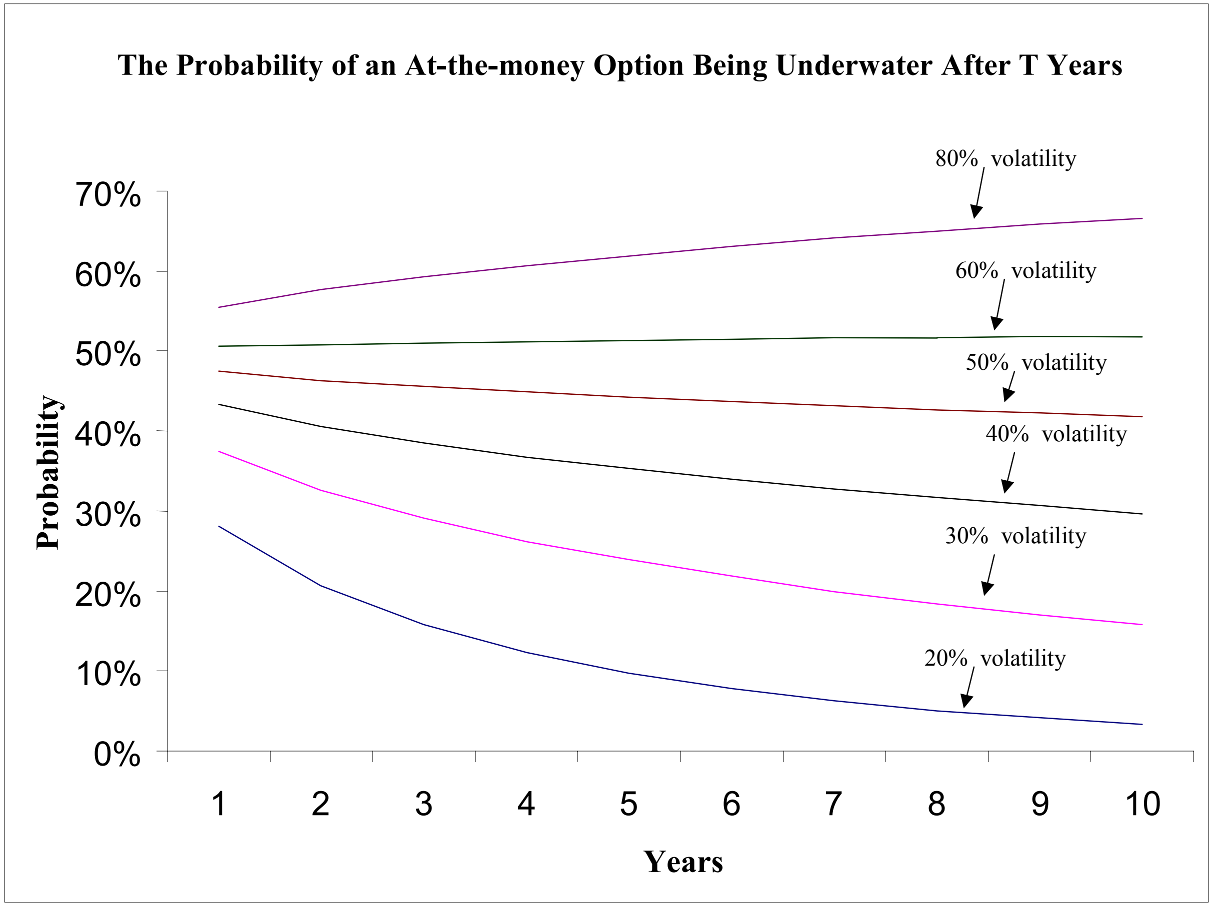


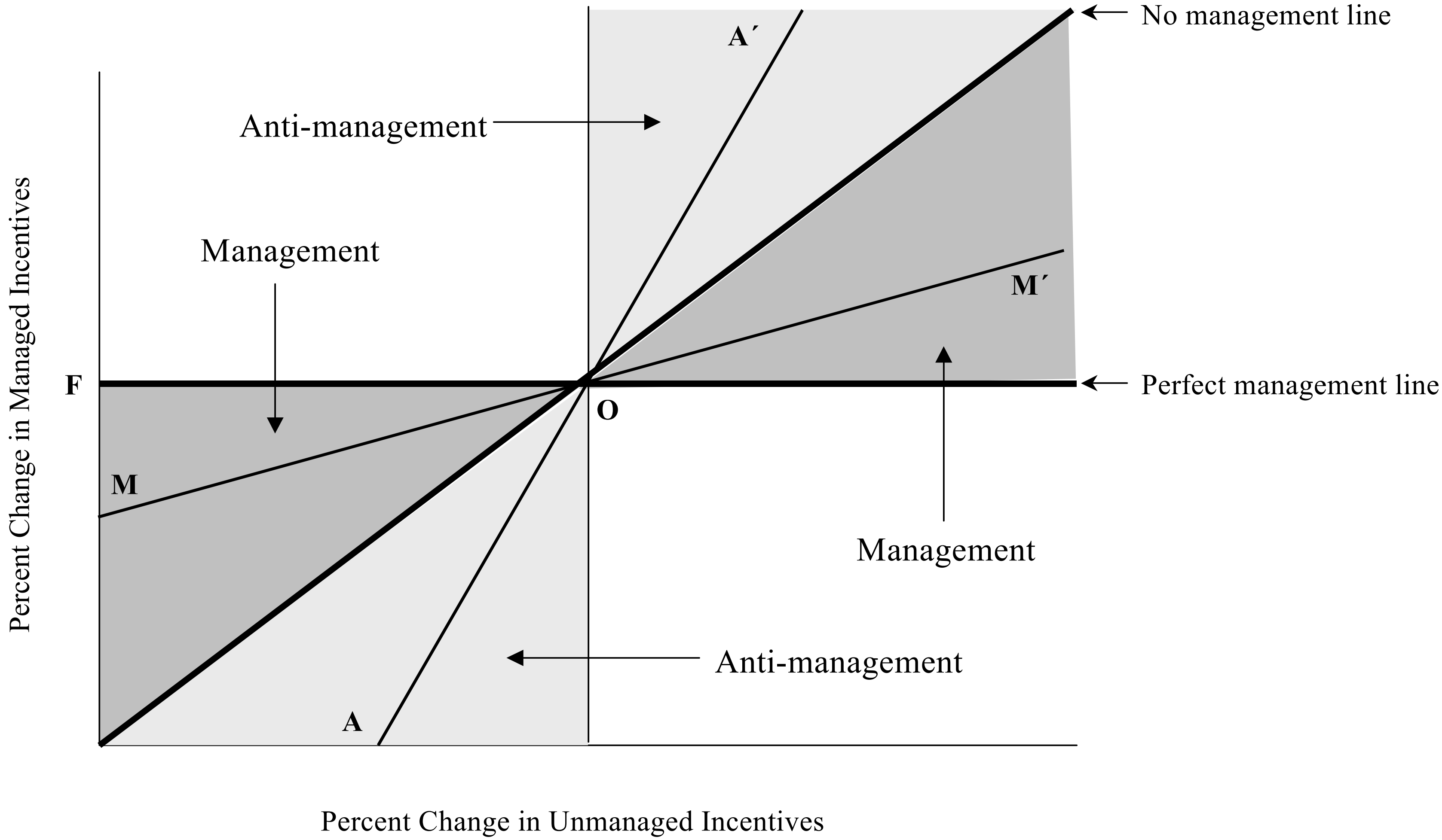
Figure 2



Note: The probabilities in this figure are based on expected returns of 12.5% per year.

Figure 3

The Relationship Between Changes in Managed and Unmanaged Incentives



Notes: **F** is equal to the increase in incentive strength from new grants of stock or options, absent any change in the stock price between *t* and *t+1*.