Why Do Some Firms Give Stock Options To All Employees?: An Empirical Examination of Alternative Theories[¤]

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Abstract

Many ¯rms issue stock options to all their employees, leading to ine±cient risk bearing by risk averse workers. We consider various economic justi¯cations for this practice. We focus on three types of models { incentive, sorting, and retention. We derive empirical implications of each model. We ¯t these models to data on option grants to middle managers. We ¯nd that for any ¯rm with about ten or more workers, stock options have trivial incentive e®ects on any employees below the highest executive levels. In general, we ¯nd little support for a moral hazard justi¯cation for issuing stock options to non-executives. Models where ¯rms use options to select on agents with relatively optimistic beliefs about a ¯rm or where options keep agents relatively close to their participation constraint appear to be consistent with the contracts we study. Patterns in cross-¯rm variation in adoption of broad-based stock option programs are also consistent with sorting and retention models.

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1 Introduction

Stock options have attracted increased attention in recent years as industries where options are a ¯xture in compensation plans (especially the high technology sector) have become a larger share of the economy and as options have become more prevalent at ¯rms generally. While stock options had historically been limited to top executives at most ¯rms, they have ¯ltered down to lower levels of many organizations in recent years.

While economic theory and many managerial practitioners preach that \pay for performance" enhances productivity, the use of stock options is not without costs. By issuing stock options to their employees, ¯rms are essentially using their employees as ¯nanciers. Assuming workers are risk averse (and, given that their human capital is tied up with their employers, they may be especially risk averse regarding securities issued by their employers), employee stock options impose a relatively high cost of capital on ¯rms. These costs can be overcome if stock options increase workers' e®ort (as in Holmstrom (1979) or any of many other principal-agent models), if they help to select workers of higher ability or high ¯rm/worker match quality (as in Lazear (2001)), or if they lower the costs of turnover and/or of contracting with employees (as in Oyer (2001).) We derive simple versions of each of these models and generate empirical implications from each.[1] For example, both the incentive and sorting models suggest that the incidence of stock options is decreasing in ¯rm size, though the contracting cost model does not make this prediction.

We use data from a survey conducted by the National Center for Employee Ownership (NCEO) and from publicly available ¯rm-level accounting data. The NCEO dataset contains an unusually rich set of information about the stock options programs o®ered to workers at all levels in over 200 ¯rms. It allows us to determine, at the ¯rm level, fairly precise estimates of several key parameters for each of the models we study. We can then infer estimated values for other key parameters under an arguably reasonable set of assumptions and then determine whether each model is likely to be contributing to the sample ¯rms' decisions to issue stock options to all employees. More speci¯cally, we estimate the incentive e®ects of options, the retention e®ects (that is, the value of options that employees would forfeit if they left the company), and agent's utility as a function of their expectations of the ¯rms' prospects. In addition to directly estimating model parameters at the ¯rm level, we relate cross-¯rm variation in the incidence of stock option plans to such factors as ¯rm size, industry, and local labor market conditions. However, the NCEO sample is not a

[1] We focus our attention on models of incentives, sorting, and retention devices because we think that these three classes of model can capture nearly all the possible economic justi¯cations for the use of stock options. As we discuss below, even "behavioral" models where agents misunderstand the value of options or their e®ect on ¯rm value can generally be captured by one of these three frameworks. We brie°y discuss one exception in the conclusion.

representative or random sample so this cross-¯rm analysis presents sample selection issues that lead us to be quite conservative in drawing conclusions.

The dataset of accounting information, which we gathered from SEC disclosures using the EDGAR web site, is a random sample of approximately 1,000 publicly traded companies. We gathered details on ¯rms' stock option plans from their 10-K and proxy statements. Unlike most empirical work based on disclosure statements (which typically use data on just the ¯ve highest-paid executives), we estimate the use of stock options at non-executive levels from ¯nancial statements. Though this dataset is more representative (at least of publicly traded companies) than the NCEO data, it is much less detailed in terms of the information about stock option plans. While neither of these datasets is su±cient to allow us to draw strong conclusions about ¯rms' reasons for issuing stock options to all employees, patterns emerge from the combination of these data.[2]

Our results from both datasets are consistent with sorting and costly adjustment (retention) contributing to ¯rms' o®ering stock options widely. We ¯nd that, for example, a somewhat risk averse employee who expects his ¯rm's stock to increase by about 25% annually would prefer some amount of stock options as part of his compensation to a cash-only compensation plan that costs the employer the same amount. We also ¯nd that, if spot labor wages for middle managers °uctuate by $25-30K within a few years and if the costs of lowering a middle manager's wage (or replacing him) are $10-25K, ¯rms may ¯nd it more cost e®ective to issue stock options to middle managers than to try to adjust wages as market wages °uctuate. We show that broad-based stock option plans are more common at smaller ¯rms, ¯rms with more volatile stock returns (and especially ¯rms in more volatile industries), and ¯rms that are generating negative pro¯ts. We interpret these results are largely consistent with storing and costly adjustment, but we ¯nd almost no evidence to support the belief that ¯rms issue stock options broadly as a means of providing incentives. Our estimates suggest that a typical ¯rm with a broad-based stock option plan can expect to compensate a middle managers $12,100 for the risk of those options. But the ¯rm can expect the manager to provide as much additional e®ort from those options as he would have been willing to provide if e®ort were contractible and the ¯rm paid him $15.

While there has been a tremendous amount of analysis of executive stock options and quite a bit of research on employee choices in exercising stock options (see, for example, Heath, Huddart and Lang (1999) and Huddart and Lang (1996)), the only other study of the determinants of broad-based stock option plans of which we are aware is Core and Guay (2001). They analyze the determinants of stock option grants to employees who are not among the top ¯ve paid employees at

[2] In future drafts, we will also include analysis of a recent proprietary Bureau of Labor Statistics survey on the use of stock options.

the firm. They find that options grants and the number of options held by non-executives increases in firm size, idiosyncratic risk, and financing constraints. They interpret this as evidence consistent with firms using their employees as sources of capital and issuing options to provide incentives.

We revisit some of Core and Guay's (2001) conclusions by looking at the implications of models that generate their predictions and by taking advantage of some of our data that contains much more detail on stock option contracts than are available from disclosure data. In particular, we find a negative relationship between firm size and the incidence of broad-based stock option plans. Also, we find no evidence that broad options plans provide enough incentive to affect workers' on-the-job behavior.

There have been numerous studies of employee profit sharing (see, for example, Kruse (1993) and Weitzman and Kruse (1990).) Like stock options, profit sharing links compensation to firm performance. This literature has generally found small to negligible incentive and retention effects of stock options and drawing any causal inference is difficult. Some of our analysis is similar to the profit sharing literature in that we establish characteristics of firms that issue stock options broadly. We do not uncover any large differences between profit sharing and stock option firms, other than that stock option firms are relatively likely to be earning negative profits. However, we examine and estimate individual agent behavior in a more detailed manner than has typically been done in the profit sharing literature.

Before proceeding with our analysis, we need to provide a brief aside on how taxes and financial disclosure affect (or are affected by) employee stock options. Firms issue two types of stock options to employees – “incentive stock options” (ISOs) and “non-qualified stock options” (NQSOs). ISOs create significant tax complications because they have the potential advantage of recognizing more income as capital gains, but they can lead to Alternative Minimum Tax consequences. This only has minimal effect on our analysis because there are significant IRS restrictions on issuing ISOs and, therefore, the vast majority of stock options issued to individuals below the top executive level are NQSOs. Tax treatment of NQSOs is similar to that of cash compensation (though see Section 2.2 below for consideration of one important difference) for both the employer and the employee.[3] We proceed under the assumption that the options we analyze are NQSOs. One commonly proposed reason for firms issuing employee stock options is that they do not affect current earnings. This

[3] For ISOs and other stock options, there are important cost differences in issuing options. See McDonald (2001). If firms choose options policies based on the tax consequences of ISOs, and then issue NQSOs as part of a consistent firm-wide plan, then our analysis could be affected. However, we believe the tax consequences of ISOs are small relative to the costs and benefits of broad-based stock option plans and that firms are unlikely to make firm-wide option plan choices on this basis.

explanation requires a significant departure from a belief in rational stock markets and a justification for why, if investors can be fooled in this manner, all firms do not adopt broad-based stock option plans.

2 Models and Their Empirical Predictions

In this section, we outline several models that have been developed elsewhere. We then summarize the empirical predictions of each of these models to motivate the empirical analysis that follows.

2.1 Basic Moral Hazard Model

We begin with a standard moral hazard justification for incentive pay such as stock options. That is, by contracting with employees so that they receive some portion of the value of their output, employees put forth more effort than they otherwise would. Largely following the logic and notation in Holmstrom (1979), we begin by assuming a risk neutral, profit-maximizing principal hires an agent. The principal receives a payoff of $x(a;\theta)$ with arguments, respectively, an unobservable effort level of the agent and an unobserved state of nature. Let x be drawn from a random distribution $F(x;a)$ and density $f(x;a)$. The risk-averse agent's additively separable utility function is increasing and concave in income and decreasing and convex in the agent's effort.

Because we focus on stock options that are almost invariably offered "at the money", we limit attention to contracts where the employee is paid a base salary (s) and a share (b) of any appreciation in firm value. Let the agent's utility given income w and effort a be $H(w;a) = U(w) - ca^2$ and assume that the agent has an alternative job offer with expected utility $\overline{H}$. Under these assumptions, the optimal stock option package will solve:

$$\max_{s;b} \int x f(x;a)dx - \int_0 bx f(x;a)dx - s \qquad (1)$$

subject to

$$\int U(s + I(x > 0)bx) f(x;a)dx - ca^2 \geq \overline{H} \qquad (2)$$

and

$$a = \frac{\int U(s + I(x > 0)bx) f_a(x;a)dx}{2c}. \qquad (3)$$

After making reasonable assumptions about the agent's utility function and the form of f, we find that the agent's share increases as:

- the variance of the distribution of stock returns decreases,

- the agent's cost of effort increases,
- the agent's effect on expected return (that is, $\frac{d}{da}\int x f(x;a)dx$) increases.

While the second of these relationships is hard to measure empirically, the first and third are standard empirical predictions of agency theory. The negative risk-incentive relationship has been widely explored, though it is generally not confirmed by prior empirical work (see Prendergast (1999).)

2.2 Sorting Model

We now consider stock options as a means of sorting workers into the most appropriate employment matches. Lazear (2001) derives a model where pay is tied to firm performance as a means of attracting able employees to work at the firm. Changing Lazear's (2001) notation for consistency within this paper, Lazear (2001) considers contracts where the worker earns $w = s + bx$. As in the previous section, firm value (x) is a function of the worker. However, instead of x being affected by the agent's effort, Lazear (2001) assumes that x is a function of the agent's ability. The free-rider issues that appear to make stock options for low level employees inefficient in a moral hazard setting also apply here. That is, though options could potentially relate the worker's ability to his compensation, even a slight bit of risk aversion would make the risk costs of options dwarf the benefits of sorting on the highest quality workers. This leads Lazear (2001) to conclude that his model "does not explain why some firms give stock options even to very low-level workers."

We therefore consider a slight variant on the Lazear (2001) model where agents vary in their beliefs about the prospects of the firm. If potential employees vary in their expectations about the future prospects of the firm and/or its industry, then the firm may be able to use stock options to attract the most optimistic employees. That is, the employees may value the stock options offered by the firm at more than the financial markets would. In the absence of distortions and if the firm is publicly traded, the agent could just buy the stock of the firm without taking a discount in terms of compensation. But the employment relationship generates at least two advantages. First, the employment relationship allows the agent to "invest" in the firm's options in a slightly tax-advantaged manner because he pays no taxes on the options until he exercises them. This allows the options to compound tax free. The tax advantages of this are not large, but they may be enough to swing the optimal compensation from all cash to cash plus options at some firms. Second, employees may gather inside information that enhances the value of the options they are granted.[4]

[4] See Huddart and Lang (2001) for evidence that even relatively low-level employees appear to exercise their stock

Formalizing this idea, suppose the market value of an option in a given firm is $\bar{z}$, but that any given individual i's valuation of this option is drawn from a distribution with cumulative density $F(z_i)$.[5] Though the expected discounted value of the option is z_i, the agent must hold the option until time t, at which point he expects the rest of the stock market will share his valuation. The agent therefore bears some risk that his valuation will not be correct, so the discounted value of the option when exercised at time t, v_i, is drawn from the distribution $g(v_i)$ where $E[v_i] = z_i$.

Assume the firm pays the agent a fixed wage (s) and options of the firm's stock (b) where he values these at z_i each, that the agent's income tax rate is τ, and that the agent has concave utility from income ($U((1-\tau)(s+bz_i))$). Relationship-specific value may be created by the agent's higher valuation of the option than the market and by the fact that, if he receives these options as compensation, they are tax-advantaged. That is, $\frac{d(\frac{v_i}{z_i})}{d\tau} > 0$. Given heterogeneous valuations of the options and that we do not want to consider the details of how the relationship-specific value is split between the parties, we assume for the time being that all agent's who value the options greater than the market does have similar valuations and that the firm can extract all the value. Therefore, the agent will accept any s, b combination such that $E[U((1-\tau)(s+bv_i))] \geq \overline{H}$.

The firm's problem, therefore, is

$$\min_{s;b} s + b\bar{z} \tag{4}$$

subject to

$$\int U((1-\tau)(s+bv_i))g(v_i)dv_i \geq \overline{H}: \tag{5}$$

Solving for the optimal agent level of stock options, b, we find that the agent's share increases as:

- the agent's tax rate increases,
- the variance in agents' beliefs about value of the options increases, and

options based on non-public information. Note that employees can still use this information (and optimize given their individual risk tolerance) without the firm issuing options. So this "inside information" explanation only makes sense as a complement to the tax advantages or if the firm lowers the overall transaction costs by acting centrally.

[5]Note that this framework supports imperfectly informed or irrational agents. Factors that could contribute to agent heterogeneity in agent valuations include overestimating the importance of "momentum" in stock prices or simply overestimating expected stock returns. In a more rational setting, our description here can perhaps be justified using insights from the literature on noisy rational expectations equilibria in financial markets (see, for example, Hellwig (1980)). In these models, risk-averse traders receive private signals regarding the value of a risky asset. Equilibria in such models typically feature prices that are not fully revealing; hence, it is rational for traders to make use of their private signals in making trades.

- the variance of the firm's stock return that is not related to choice of valuation methods (that is, macroeconomic shocks and shocks that arise from new information that becomes available between the time the options are issued and time t.)

The distinction between these two types of variance is likely to be difficult to disentangle empirically.

2.3 Costly Adjustment Model

Oyer (2001) derives a model that attempts to explain firm-performance-based pay as a means of relatively efficiently adjusting an agent's compensation to keep it in line with the agent's market wage. In each of two periods, the firm and its employees observe an outside option for the employee, $\overline{H} \in \{\overline{H}_h; \overline{H}_l\}$ (where $\overline{H}_h > \overline{H}_l$ and $\Delta\overline{H} = \overline{H}_h - \overline{H}_l$). Define q to be the unconditional probability that $\overline{H} = \overline{H}_h$. After observing the first period value of $\overline{H}$, the firm offers the agent a contract $w = s + bx$ for each of the two periods with s and b constrained to be constant for the two periods. After observing second period $\overline{H}$, the firm can change the terms of the contract, but at a cost of k. Assume that x is distributed normally with variance σ^2 conditional on $\overline{H}$, that the agent has exponential utility in each period with risk aversion coefficient r, and that the agent cannot borrow or save. Let $E[x|\overline{H} = \overline{H}_l] = x_l$, $E[x|\overline{H} = \overline{H}_h] = x_h$, and $\Delta x = x_h - x_l$.

Oyer (2001) shows that, depending on the values of the various parameters, the firm will choose one of three types of contracts:

1. "Spot Labor Markets" – If the costs of adjusting the contract (k) are not too large relative to the risk induced by tieing the agent's pay to firm performance, then the firm will set $w = \overline{H}$ in the first period and, if necessary, pay k to adjust w to the new $\overline{H}$ in the second period.

2. "Dual Binding Participation Constraint" Contract – If the risk of performance based pay and the variation in the agent's reservation wage are not too high, then the agent can be kept on his second-period participation constraint through a contract that sets $b = \frac{\Delta\overline{H}}{\Delta x}$.

3. "Single Binding Participation Constraint" Contract - If the risk or reservation wage variance gets too high, but the adjustment costs are also fairly high, the firm may find it optimal to design a contract where the agent is paid above his second period reservation wage when $\overline{H} = \overline{H}_l$. In this case, the firm chooses a contract where $b = \frac{(1-q)\Delta x}{4r\sigma^2}$.

Whether the firm chooses to use stock options (that is, does the firm set $b > 0$) and how many stock options to give the agent (that is, what level of b does it choose) depends on which of these three contracts is preferable and the level of the exogenous parameters. Oyer (2001) derives comparative statics with respect to ¢x, ¾^2, ¢s, r, and k. He interprets the comparative statics as having the following empirical implications:

1. The adoption of broad-based stock options plans increases in the ¯rm's costs of replacing workers.

2. As shocks common to the ¯rms employing a set of workers increase, volatility of shocks idiosyncratic to an individual ¯rm decrease, and/or agents become less risk averse, the adoption of stock options becomes more attractive and the amount of stock issued to each agent (weakly) increases.

3. Greater variation in local market wages leads to an increase in the amount of options per agent, though extreme variation discourages the adoption of stock option plans.

4. Stock options are relatively attractive in strong economies and tight labor markets.

3 Fitting the Models to Contract Data

In this section, we ¯t data from a survey of ¯rms' stock option plans to the models discussed above. The data allows us to determine some key parameters in the model and to estimate others. Then, after making reasonable assumptions (and running sensitivity checks on these assumptions) about other parameters, we can infer the value of the key parameters in each model that we cannot estimate or assume. We can then assess the validity of each model by determining how realistic the inferred parameter values are.

Our data source is the 2000 Survey on Current Practices in Broad-Based Stock Option Plan Design conducted by the National Center for Employee Ownership (NCEO). The NCEO is a private, non-pro¯t organization that provides members with information about employee ownership programs. In March of 2000, they sent questionnaires to compensation administrators at approximately two thousand companies seeking detailed information about their stock option plans. The surveyed companies were compiled from several sources and all were thought to be likely to have a stock option plan that covered at least half the company's employees. The NCEO received 247 detailed responses from ¯rms that had stock option plans covering the majority of employees and 222 responses from ¯rms that did not have a broad-based stock option plan in place at the time of the survey and did not expect to have such a plan in place within two years of the survey.

The NCEO survey, both by design and due to the fairly low response rate (approximately 20-25%), does not cover a random sample of ¯rms with or without stock options plans. We therefore primarily use the survey as a tool for analyzing the plans of those firms that have stock plans. However, in an attempt to determine what drives firms to adopt stock option plans, we also perform some comparisons of the firms that have plans with those that do not. We discuss the effects of non-randomness in our analysis below. We used the 2000 Ward's Business Directory to gather basic firm-level data, such as primary SIC code, number of employees, year founded, and annual revenue.

3.1 Moral Hazard

In order to fit the model from section 2.1 to the NCEO contract data, we need to make some assumptions about the distribution of the stock price, the agent's utility function, and how the agent's effort affects the stock price of the firm.[6] We assume that the value of the firm at time t, v_t, is drawn from a log normal distribution with mean $v_0 * (1 + r^*)^t * (a - 1) * m$ where a is the agent's effort and m is set such that increasing a by one unit increases expected v_t by twice the agent's annual cash salary (s). The volatility of v_t, given v_0, is $\sigma\sqrt{t}$. In this section, we look at the incentive effects over a one year span, so t = 1 throughout. We use this formulation to normalize the model such that the optimal level of agent effort is one unit and we therefore set m such that the effect of the optimal level of stock options, relative to having no stock options, is to induce the agent to take as much effort as increases the firm's value by twice his annual cash compensation. This seems to us to be a reasonable estimate for the incentive effects of optimal options, but we experiment with higher returns to effort.[7] We assume that the utility of the agent at t = 1 is $[\frac{1}{1-\rho}(s + BS(bv_1))]^{1-\rho}$ (or $\ln(s + BS(bv_1))$ if $\rho = 1$) where b is the fraction of the firm's shares to which the agent holds options, $BS(\cdot)$ is the Black-Scholes valuation function, and ρ is the agent's CRRA risk aversion parameter.

We use the firm's stated s for middle managers. When possible, we calculate b by dividing the number of options the firm typically provides to middle managers by the number of shares outstanding. When the firm does not provide a specific number of shares or, as with most private companies, when the number of shares outstanding is not available, we approximate b as twice the

[6] See Hall and Murphy (2001) for a similar analysis of the (much stronger) incentive effects of executive stock options. They also use their numerical estimates to propose explanations of many standard features of executive stock option contracts.

[7] Justifications for an individual agent being able to, on average, increase firm value substantially include mutual monitoring and peer pressure, though the incentive to sanction co-workers is subject to the same free rider concerns as the basic effort decision. Another explanation, formalized in Zabojnik (2000), relies on firms organizing work so that the output of a large group of people requires high levels of output from each member of the group. Alternatively, workers may systematically overestimate their impact on firm value.

¯rm's \run rate" (percentage of shares issued as new options each year) divided by the number of employees in the ¯rm. Run rate/employees provides the average fraction given to each employee annually. This needs to be multiplied by four (because most options vest over four years and have approximately the same incentive e®ects for four years) and then divided by two (we found that the average \middle manager" share is about half the average share due to the large shares of top managers.) We assume that the risk-free rate (for the Black-Scholes model) is 5%. For public companies, we estimate ¾, both for calculating the v_1 value distribution and the Black-Scholes value, using stock return data from the Center for Research in Securities Prices (CRSP) from 1995 through 2000. For the 84 companies that are private or the return variance otherwise unavailable, we assign ¾ using the predicted level from a regression of ¾ on employee size using the 130 companies where ¾ is available. We assume all options expire ten years after the grant date.[8] The ¾ used in the Black-Scholes valuation should be the expected volatility over the life of the option, rather than the historical volatility. Implied volatilities from options markets show that future and past levels are similar in short forward-looking horizons (a year or two), but markets going out ten years do not exist. We assume that future volatilities will be 75% as high as past volatilities.

To solve the model, we begin by numerically approximating (3) to solve for c, the cost to the agent of exerting the one unit of e®ort (that is, enough to increase ¯rm value by twice his annual cash compensation.) We then numerically approximate (2) to ¯nd $\overline{H}$. We then decompose the agent's total compensation into e®ort compensation, risk premium, and payments to reach his reservation wage. Table 1 displays the results of this exercise for representative publicly-traded small and large ¯rms, as well as the average and median of the NCEO sample. Before analyzing the incentive e®ects of stock options, note the Black-Scholes value of options granted in the sample. The median and average value of options granted to a middle manager is $114,300 and $149,600, respectively. This is well over a year's base salary. At the large ¯rm detailed in column 2, middle managers receive options grants, upon starting work at the ¯rm, worth over a quarter of a million dollars { or approximately three times their annual salaries.

The numerical estimates of the base case, which assumes r¤, ½ = 3, and that a unit of agent e®ort increases ¯rm value by twice the agent's annual salary, show the e®ects of these large option grants in terms of risk borne by the agent. If the agent is on or near his participation constraint, the options can be a substantial contribution towards meeting his market wage demands. In the case of the column 2 large ¯rm, we estimate that the middle manager, while paid $90K, has a market wage of nearly $150K. He actually receives more than this, however, because he must be

[8] A few ¯rms grant options that expire ¯ve years after vesting or ¯ve years after the grant date, but over 80% of ¯rms primarily use options that expire ten years after grant.

compensated \$17K for the risk he takes by holding his options. For the sample as a whole, the average risk premium is approximately \$20K and the median \$12K. This suggests that option grants come at considerable cost. However, our cost of e®ort estimates suggest that they do not generate considerable bene¯ts in terms of incentive e®ects. For example, at the large ¯rm, the agent requires a risk premium of \$17K to accept enough options to induce him to supply enough marginal e®ort to generate \$200K in ¯rm value. But we estimate that he would be willing to provide this e®ort if paid 7 cents! This suggests that, given the assumptions in these numerical calculations, the inability to contract on e®ort leads the ¯rm to spend \$17K where 7 cents would be just as e®ective if e®ort were observable. It seems unlikely to us that this ¯rm cannot ¯nd a more e±cient way to encourage the worker to expend 7 cents worth of e®ort. As the bottom three rows of column 2 show, using assumptions that are much more generous to accepting the moral hazard model, we ¯nd that the ¯rm pays a risk premium of about \$7K to induce 20 cents worth of agent e®ort. This is still clearly not a very e±cient incentive mechanism.

Column 1 shows that, though the incentive e®ects of stock options are especially trivial at very large ¯rms, even middle managers at a ¯rm of 78 employees draw very little motivational value from its stock options under standard moral hazard assumptions. Under the base scenario, the ¯rm must pay the worker a risk premium of over \$16K to compensate him for e®ort he values at \$13. Under the alternative set of assumptions, the risk premium is \$11,500 to compensate for \$64 worth of e®ort. For the ¯rm in our sample with the strongest middle manager incentives and using the alternative set of assumptions as well as setting ρ down to 0.5, the agent values one unit of e®ort at almost \$3K, but still requires an \$8K risk premium. In general, we believe our numerical estimates con¯rm that the incentive e®ects of stock options cannot possibly explain ¯rms issuing them to middle managers except at the very smallest (under about ten employees) levels.

3.2 Sorting

We now consider the variant on Lazear's (2001) model discussed in Section 2.2, where agents vary in their beliefs about the expected return of the ¯rm and options provide a tax advantage in that they provide the agent with investments in his own ¯rm that compound tax free. To analyze how this model might work in practice, we vary our analysis somewhat from the prior section while retaining most of the same basic assumptions. We assume that the ¯rm's stock price t years after options are granted (v_t) is log normally distributed with mean $v_0 * (1 + r^*)^t$ and standard deviation $\sigma\sqrt{t}$. We determine the options' value when issued (which we use as the cost to the ¯rm) using Black-Scholes and assuming expiration in ten years. However, we assume that the shares vest fully in four years and that, at that point, the agent either exercises the options and sells the shares or, if the shares are below the issue price, he leaves the firm and the options are worthless to him.[9] By assuming this option exercise strategy, we do not let the agent maximize the return on the option. However, given risk aversion and the fact that the agent cannot sell the options, it seems a reasonable assumption. At the public companies in the NCEO sample, survey respondents indicated that approximately 25% of options were exercised immediately upon vesting, an additional 31% were exercised within a year after vesting, and 21% were exercised between one and two years after vesting. In addition, Aboody (1996) showed that, in a sample of 478 firms with relatively large numbers of outstanding options, most firms issue options with a ten-year term and most of these options were exercised in the first four years after the grant date. Aboody (1996) found that, in a sample of eight firms, about half of all options were exercised in the first half of the options' term. Given the NCEO, Huddart and Lang (1996), and Aboody (1996) evidence, assuming a holding time of four years seems reasonable.

We apply the utility function used in the previous section to the agents' sum of cash salary and option profits over the four year period.[10] We need tax rates for three types of income — current salary, options profits, and additional cash salary the agent would receive if he got no stock options. Current salary is not marginal in this analysis, so we apply τ_s = 20% to capture an estimate of average tax rates in calculating utility. The other two types of earnings are marginal, so we apply τ_b = 40%.

Table 2 shows our results using varying assumptions about the agent's expectations of the annual stock return (r^*) over the four year vesting period and his level of risk aversion (ρ). The top row of the table shows the total cost to the firm of employing a middle manager, including four years of salary and the Black-Scholes value of options issued when the manager starts working at the firm. If this cost is below the value the agent gets from this package, then, if the agent is at or near his participation constraint, the firm would have to pay him more if it paid entirely in cash. To make the cost to the firm comparable to the value received by the employee, we express both in after-tax dollars. The underlying salary and Black-Scholes values that determine these costs to the firm are the same as those in Table 1.

The first estimate of agent value from these options and salary packages assume r^* = 10% and ρ = 3. At both firms and for the mean and median firms, the agent values this package at less than it costs the firm and, therefore, would prefer an all cash package at the same cost. In all, of the 214

[9] Four years is the most common vesting period in the NCEO sample, though a substantial number of firms grant options that vest over three years. Four year vesting is by far the most common in Huddart and Lang's (1996) sample, as well.

[10] We do not discount because we assume that discounting will be roughly offset by increases in s.

firms in the sample, the agents at 26 value the options package at more than the cash equivalent. These are firms where options make up a small portion of the total compensation package and where the stock volatility is low. These two factors keep the risk premium below the expected gains from holding options on a stock expected to grow 46% over four years. This suggests that options can be efficiently used, if employed in moderation, even if agents are fairly risk averse and expected returns merely reflect historical market average returns.

The next set of estimates shows that the conclusions do not change much simply by making the agent less risk averse. Lowering ρ to 1 does not justify the use of options at either of the two firms or for the average or median firms in the sample. For example, at the large firm in column 2, lowering ρ from 3 to 1 reduces the risk premium by more than half (to under $50K spread over four years), but the agent still values the options and salary package at $33K less than an all cash package of equivalent cost to the firm. Of the 214 firms in the sample, the agents at 38 prefer the options package to the all cash package. From these first two exercises, we conclude that the sorting model cannot be the primary reason firms give middle managers stock options if those managers believe the firm's stock will rise by 10% per year. However, given that the stock of many of the firms in this sample had been rising at much higher rates, this likely underestimates the expectations of many of the agents.

In our next exercise, we keep the agent's risk aversion relatively low, but assume he expects 25% annual stock appreciation (four-year appreciation of 144%.) The agent at the large firm now prefers the option package to the cash-only package while the small firm agent still prefers the cash-only package. This reflects the extra risk at the small firm (σ = 148%) relative to the large firm (σ = 30%). As column 3 shows, given these parameter estimates, the mean of the agent's valuation of the options package is nearly equal to that of the cash package. The same is true for the median. It appears that this set of assumptions makes the agent roughly indifferent at many of the sample firms. The agents at 128 of the 214 firms value the options package at more than the cash package.

Finally, we raise the expected stock return to 40% (284% for four years). Though this seems like excessively optimistic expectations, it is well below the average return at these firms in 1999. Even at this high rate, the extreme volatility of the small firm's stock makes the agents prefer the all cash package. But the large firm agents value this package at over a half million dollars greater than the cash package. The mean and median agent option valuations in the sample also exceed their comparable all-cash packages by a significant amount. Agents at 191 of the 214 firms prefer the option package at these parameter values. If the agents are assumed to be risk neutral, the options package dominates the all cash package at any expected annual return greater than 11%.

One troubling feature of our simulations is that the tax advantages are fairly minimal. The critical expected annual stock gain (that is, the point above which the agent prefers the option and cash package to an equivalent cost all cash package) decreases by about 1%. For example, assuming $\rho = 1$ and $\tau_b = 40\%$, the agent prefers the option package to all cash for any $r^* > 13.1\%$. When there are no tax effects (that is, $\tau_b = 0\%$), the critical r^* increases to 14.4%. Given that the agent can invest in the firm or the industry without risking all this investment on one firm (and with the flexibility to liquidate the position whenever he chooses) by taking a job that pays all cash, it is hard to believe the agent chooses a job to increase his expected investment returns by about one percent per year. Nonetheless, if the agent has a high tolerance for risk or faces barriers to participating in some investment markets, the additional return could come at relatively low costs.

In general, we believe the results in Table 2 suggest that the sorting/tax model could be at least a contributing factor in explaining why some firms offer stock options to lower level employees. If firms can find potential employees who are not highly risk averse and who have optimistic views about the future of the firm, then they may be able to issue stock options at lower cost than the cash equivalent to provide these employees with the same amount of utility. However, confirmation of this model needs to look at the cross-firm variation in who uses stock options. Our simulations indicate that, holding the agent's risk aversion constant, firms with lower stock volatility can more efficiently use stock options. But the firms in this sample are, on average, very high volatility. This implies that there either must be a large amount of variation in valuations of these stocks or that these firms are employing highly risk tolerant employees.

3.3 Costly Adjustment

We now consider the model where adjusting compensation parameters is costly, as detailed in Section 2.3. We assume that the agent takes a job at the firm at $t = 0$, that he receives an outside offer at $t = 1$ based on the market wages at that time, and that his options vest fully at $t = 4$. If he accepts the outside offer, he realizes the profits on one quarter of his options immediately (options typically expire within a month of the end of the employment relationship) but forfeits the other three quarters. We start with the same volatility (σ) as we used in the prior subsections, but decompose this volatility into a common and idiosyncratic component. We start by assuming that 60% of σ^2 is common to the other firms that might employ a given agent.[11] At $t = 1$, the

[11] This is based on regressions we ran of several firms in the sample on what we thought were relevant "market" indexes. For some large technology firms, we used the NASDAQ composite index. For newer, e-commerce businesses, we used the Dow Jones Internet Commerce and Internet Service Indexes. The r-squares of these regressions varied from quite low up to 70% or more. Because a given index provides the lower bound on the optimal "market" index

common shock is a binomial variable that either drives the expected firm's stock price higher (with probability $q = 0.5$ for most of the analysis) or lower (with probability $1 - q$). The size of this common shock is calculated such that its variance represents 40% of σ^2 and such that the expected value of the common shock is r^*. We then apply the idiosyncratic shock to these two possible expected values of the stock price to generate "good economy" and "bad economy" distributions of firm value.

For the firm to want to use options to avoid turnover or renegotiation costs, it must be the case that, over the four-year vesting period, $BS(bv_0) + 4s \leq E_0[4\overline{H}] + qk$. That is, the total cost to the firm of employing the person for four years (in salary and Black-Scholes value of options issued) must be less than the expected value of paying the (evolving) market wage in each period plus the expected value of turnover/renegotiation costs.[12] At $t = 1$, we assume for simplicity that the common shock sets the market wage for the next three years. If the shock has been positive, the employee receives an offer of S^h and will neither leave nor renegotiate if $E[U(3s + BS(v_1))] \geq 3S^h$. Similarly, if the shock has been negative, the employee receives an offer of S^l and will neither leave nor renegotiate if $E[U(3s + BS(v_1))] \geq 3S^l$. These three inequalities allow us to bound S^h, S^l, and k. We display our estimates of these bounds in Table 3. The table also shows estimates of the Black-Scholes value that an agent would forfeit, on average, if he left the firm after the first year, conditional on the direction of the common shock.[13]

The first set of estimates, with $r^* = 10\%$ and $\rho = 3$, suggest that the spread between the high and low market wage would have to be fairly significant to justify the firms in the sample issuing as many option as they do to middle managers. The small firm's middle managers, for example, would have to have a spot wage of \$134K in a good economy and \$103K in a bad economy. However, stock options are very effective at generating a correlation between the state of the economy and the value to the agent of staying at the firm. A middle manager at the small firm can expect to

for a given firm, we start with 60% common volatility. In any case, we experimented with other values and found that it made surprisingly little difference. The curviture of the option value/stock value relationship roughly offsets the curviture in the agent's utility function when $\rho = 3$. In most cases when $\rho = 1$, an increase in idiosyncratic risk actually makes options more cost effective.

[12] This understates the importance of turnover costs by assuming the agent's position only can turn over once in the four year period.

[13] The expected returns are slightly understated because we impose a floor on the negative common shock of -80%. Stocks with the highest volatility therefore have slightly higher average returns. Also, in calculating the Black-Scholes option value to the firm, we use the same estimated volatility we used in Tables 1 and 2. But we use the idiosyncratic volatility ($\sqrt{0.4 * \sigma^2}$ for most of the analysis) when calculating the value to the employee, assuming that the agents would be exposed to the common volatility if paid the spot market wage each year.

forfeit $150K of Black-Scholes value if he leaves after one year when the economy is healthy, but only $11K if he leaves in a down economy. The turnover cost estimates, which suggest that options are only efficient in this scenario if renegotiating wages or replacing workers cost $40K or more, strike us as implausibly high.

The second set of estimates, which assumes the worker is risk averse but less so ($\rho = 1$), lead to much more plausible estimates of the turnover costs necessary to justify the use of options. Though these costs are still sufficiently high that they average $44K in the sample, the median is $27.2K. Practitioners in human resources often suggest turnover costs are 25-50% (or more) of a manager's salary. So to find that the large firm's use of stock options can be justified if lowering its middle managers wage and/or replacing him costs the firm $20.6K does not seem unrealistic. This second set of estimates suggests to us that the costly adjustment model can justify the use of stock options if market wages for managers in this sample really vary by as much as Table 3 suggests. That is, the turnover cost estimates seem quite plausible, as do the amount of retention value the firm appears to be creating under the two possible common shocks. But the large implied differences between the possible spot market wages require further empirical validation.

The final set of estimates basically combines the sorting and costly adjustment models. These estimates continue the same assumptions except we increase the expected annual stock return to 25%. This continues to generate sizable differences in spot wages and retention value based on the common shock, but considerably lowers the hurdle turnover cost to justify these firms' use of stock options. For most firms in the sample and for the two firms in columns 1 and 2, any savings in turnover and renegotiation costs are a bonus on top of already positive benefits from taking advantage of the agents' optimistic outlook. Note that the assumptions underlying the costly adjustment model reinforce the sorting model because, by assuming stock options only expose the agent to idiosyncratic risk on the margin, they lower the risk premium the agent would otherwise need to be paid. We therefore believe that the last two subsections and the bottom part of Table 3 provide evidence that some combination of sorting and costly adjustment could be contributing to decisions to issue stock options firm-wide. However, getting the models to fit does not prove they really apply, so we now look for evidence by empirically examining the adoption of broad-based stock option plans.

3.4 Cross-Firm Variation in Adoption and Level of Option Grants

As noted previously, the NCEO dataset is not a random or representative sample. The NCEO sent its questionnaire to firms that it thought had a broad-based stock option plan. However, nearly as many firms replied saying they did not have such a plan as said they had one. So we now analyze the differences between these two groups, keeping in mind that we are comparing a group of firms with plans to a group that was thought likely to have one. The non-plan group is especially unrepresentative of all firms with no such plan because we believe the motivation for many firms who returned the questionnaire was to seek information about such plans, possibly because they were considering adding one. We therefore think that the sample non-plan firms are likely to be less distinct from the plan firms than general non-plan firms would be. Therefore, any distinctions we find between the two groups are likely to be magnified in a broader sample. However, that is a very speculative argument. Also, the plan firms may be more enthusiastic than average non-sample plan firms because somebody at the firm was willing to take the time to fill out a fairly lengthy survey and because NCEO members are over-represented. Therefore, we think our analysis of distinctions between sample plan and non-plan firms should be interpreted cautiously and we will not push any conclusions that cannot be validated in our later analysis.

Table 4 displays summary statistics for all firms that responded to the NCEO survey, as well as separating the averages out for plan and non-plan firms. The table shows some stark and interesting differences between the two groups. Plan firms are much smaller and newer than non-plan firms. Sales and employees of the plan firms are only 10-20% as high as non-plan firms. However, at least as of the end of 1999, public plan firms had market values that basically equaled those of the larger non-plan firms. As the stock returns show, this was largely due to dramatic average market value increases in 1999. The average public plan firm more than doubled in value that year, while the average non-plan firm's value grew by only 14%. The relative positions reversed in 2000, however, with non-plan firm returns only dipping to 13% while plan firms averaged negative stock returns. The monthly volatility measures confirm the more erratic behavior of plan stocks. Plan firm volatility, at 22.5%, is 73% greater than non-plan firms. Finally, note that nearly half of the plan firms are in the software industry, compared to less than 6% of the non-plan firms.

Table 5 shows the results of logits where the dependent variable is 1 for plan firms and 0 for non-plan firms. Displayed coefficients are the marginal effect on this variable. Several correlations with plan adoption emerge from the table. Most notably, firms with more employees are significantly less likely to have a broad stock option plan. An increase of 10% in the number of employees is associated with about a 1.3% lower probability of having a plan. Once we control for employees, firm sales and (though we do not display this result) public/private status are irrelevant. We also find that higher volatility firms are significantly more likely to have an option plan. Though this effect is not significant when we control for 2-digit industry, we believe this reflects the fact that more volatile industries are more likely to include plan adopters. We also find that firms in the software industry and firms founded in the 1990's are significantly more likely to have option plans.

The coe±cients on each of these are quite large, indicating that either one of these characteristics are associated with a 30% increase in the likelihood that a ¯rm will adopt an options plan.

We believe that Table 5 provides little reason to update our conclusions from the analysis where we ¯t NCEO contracts to data. Though the negative association between employees and option plans would lend some support to the moral hazard explanation of option use, our previous numerical analysis suggests that the marginal e®ects of the number of employees on incentives dissipate quickly as a ¯rm grows and that these ¯rms are generally above the level where we would expect such an association between size and incentives. Also, the dramatically higher volatility of plan ¯rms contradicts every \informativeness" agency model, unless plan ¯rms can somehow select on signi¯cantly more risk tolerant employees than non-plan ¯rms.

The negative correlation between number of employees and plan status, as well as the positive correlation between volatility and plan status, can be interpreted as consistent with the sorting model in that higher volatility may re°ect more variation in agents' beliefs about the ¯rm and smaller ¯rms may ¯nd it easier to attract enough employees with favorable opinions of the ¯rm's prospects. Also, there may be more variation in agents' beliefs about new ¯rms and, at least in the late 1990's, about ¯rms in the software (and especially internet-related) industry. The fact that ¯rms with higher volatility and in the software industry are more likely to have option plans could also be consistent with the costly adjustment model if market wages vary more for volatile ¯rms or ¯rms in the software industry. Also, the di±culty in hiring enough talented employees in the software industry in recent years was well-documented in the business press, so the software coe±cients are consistent with Oyer's (2001) prediction that options will be more common when labor markets are tight.[14]

4 SEC Disclosure Analysis

Our second dataset was gathered from the SEC's EDGAR internet-based database. We chose 1,000 companies at random that were subject to the SEC's disclosure requirements for public companies in 1999.[15] We then gathered data from these ¯rms' proxy and 10-K statements regarding the number of employee stock options issued. We also gathered the number of options issued to each of

[14] We also looked at what factors were associated with the middle manager's share (b) and the Black-Scholes value of middle manager option grants. We found, unsurprisingly, that agent share decreases in ¯rm size and Black-Scholes value increases in stock volatility. Aside from these mechanical relationships, we found no correlations.

[15] For most companies in our sample, the ¯nancial statements we use refer to the ¯scal year coinciding with calendar 1998. We therefore refer to our analysis as relating to 1998, though the period of analysis for many of the ¯rms in our sample includes at least part of 1999.

the five highest paid executives at the company. We matched this compensation data to accounting data from Compustat and stock data from CRSP, as we did with the NCEO sample. Compared to the NCEO dataset, this data has the important advantage of comprising a random sample of firms in a representative set of industries.

The data have the considerable disadvantage, however, of providing basically no detail of the options holdings of the vast majority of workers at any given firm. We must therefore construct estimates of both whether the firm has a stock option plan for most employees and, if so, how many options (and of what value) a typical employee holds. The tools at our disposal for making these determinations include how options are distributed among the top executives and the considerable overlap between our EDGAR and NCEO datasets.

We begin by constructing an estimate of the number of options granted to non-executives. Core and Guay (2001) define non-executive stock option grants as all grants to employees that are not among the five highest paid workers at the firm. While this measure is easy to construct consistently across firms, it undoubtedly overestimates the number of options granted to non-executives. Consider, for example, Belden Incorporated, a wire and cable manufacturer. The firm granted approximately 1.3 million options to employees in 1998. Of these, the top five executives received 120,000, 30,000, 30,000, 20,000, and 16,000 shares. The firm's proxy statement estimates the value of these options at $1 million to $7.56 million per executive. In all likelihood, the sixth through tenth highest paid executives also received options grants worth nearly $1 million each. To study stock options granted to middle managers and others who are not highly ranked, we do not want to include the executives who just barely miss the top five cutoff.

Improving on a simple top five executive cutoff comes at the cost of imposing some assumptions, however. CEOs often receive a significantly greater option grant than anyone else at the firm. So we focus on the executives with the second through fifth largest grants. We assume that the highest 10% of executives at the firm receive an average grant one tenth as large as the average executive in the second through fifth compensation rank. We subtract these shares, as well as all shares granted to the top five executives, from the total grants to employees and we assume this remainder is the total shares granted to non-executives. If our calculated shares for the top 10% are greater than the total grants made to non-top-five executives, we assume there were no grants to non-executives.[16]

We then generate three indicator variables of likelihood of having a broad-based stock option

[16]We experimented with different assumptions regarding how many other non-top-five executives should be excluded from the definition of a "broad" plan and regarding the proportion of grants to executives 2-5 relative to other senior executives. These assumptions had no effect on our qualitative results. The assumptions we chose maximize the number of firms in our NCEO sample for which we accurately predict their option plan status.

plan. The ¯rst indicator (plan1) equals one if the number of shares granted to non-executives represents at least 2% of the shares outstanding in 1998. The second indicator (plan2) equals one if the average value of non-executive grants per non-executive employee has at least $5,000 of Black-Scholes value. Finally, to construct plan3, we assume that the non-executive grants are given to new employees. We estimate new employees as any increase in employment plus 10% of the previous year's employees. We then set plan3 equal to one if the average \new employee" grant has at least $10,000 of Black-Scholes value.

We run logits of these plan variables on explanatory variables similar to those used in Table 5 with the NCEO data. These include log of the number of employees, growth in number of employees from 1997 to 1998, monthly stock volatility, SIC indicators at various aggregation levels, and an indicator for the software industry. We also include two variables meant to capture the importance of \common shocks" that are important determinants of the adoption of stock option plans in Oyer (2001). First, we calculate \industry volatility" as follows. We calculate ¯rm i's average industry (4-digit SIC code) return each month using all ¯rms in CRSP. We calculate industry return separately for each ¯rm, leaving ¯rm i out of the calculation, and we only use the industry return observation if it is based on at least eight ¯rms. We then de¯ne \industry" volatility as the standard deviation of the monthly industry return. Second, we calculate ¯rm i's \industry volatility share" as the R-square from a regression of ¯rm i's monthly return on its industry return (including those ¯rms for which such a regression has at least twelve observations.) Oyer's (2001) model suggests that ¯rms will be more likely to issue stock options to non-executives if the common shocks (industry volatility) are greater. However, plan2 and plan3 are, by de¯nition of these variables, related to ¯rm and/or industry volatility. So, when we study plan2 and plan3, we use \industry volatility share" as a measure of the importance of common shocks.

Table 6 displays summary statistics for the ¯rms in the dataset we collected from EDGAR. All ¯rms are included in the ¯rst column, while column 2 (3) shows the subset of ¯rms with plan1 = 1 (plan1 = 0). We estimate that 30.5% of the ¯rms in our sample have broad-based stock option plans, with employees at those ¯rms receiving average annual grants in excess of $100,000 (though the average option value at the median ¯rm with plan1 = 1 is only $9,112.) In general the di®erences between the ¯rms in the EDGAR dataset with and without plans mirror those in the NCEO dataset. Plan ¯rms are strikingly smaller, faster growing, and their stock is more volatile. The software industry is highly over-represented among ¯rms with broad plans. Also, note that fewer than half of the ¯rms with broad plans are generating positive pro¯ts (that is, net income), while over three quarters of the non-plan ¯rms earn pro¯ts.

Table 7 explores the correlations of various factors with having a broad plan by using plan status as the dependent variable in a logit. We use all three plan indicators, but we focus on plan1 because we can study how volatility a®ects this measure. The results in columns 1 and 2 con¯rm the results of our NCEO logits. In particular, a ¯rm with 10% more employees (or volatility that is 10% points higher) than another ¯rm is 0.6% (8%) more likely to have a broad-based plan. Software ¯rms have a 21% higher probability of using a broad-based plan, holding the other factors in column 1 constant. These results are largely una®ected by including two-digit SIC dummies, though the volatility coe±cient goes down as industry volatility is largely factored out of the analysis.

One result in column 1 (and throughout Table 7) that we did not include in the NCEO sample is that having negative accounting pro¯ts is associated with an 8% lower probability of implementing a broad-based stock option plan. One possible justi¯cation for this would be that, if a ¯rm has stable pro¯ts and wants to tie worker pay to ¯rm performance, it may prefer to use pro¯t sharing because it passes less risk along to employees. This points out the potential value of expanding our analysis of stock options to look at the incidence of all ¯rm-performance based compensation.

Columns 3-6 introduce the two variables meant to explore Oyer's (2001) prediction that stock option adoption will increase in industry volatility and as common industry shocks grow relative to idiosyncratic ¯rm shocks. The results in column 3 are consistent with both of these predictions because, holding individual ¯rm volatility constant, we ¯nd that industry volatility and the share of volatility explained by industry e®ects are both positively and signi¯cantly associated with plan adoption. Columns 4-6 show that these results, as well as most of the results previously found in the NCEO data, hold when we control for industry e®ects and when we use the alternative indicators for broad-based plan adoption.

The ¯ndings that industry volatility is highly correlated with plan adoption and that, controlling for industry volatility, ¯rm volatility is not strongly or signi¯cantly correlated with plan adoption, are consistent with Oyer's (2001) model. However, one could also interpret this ¯nding as consistent with the sorting model sketched in 2.2 if industry volatility indicates a greater diversity of expectations about industry prospects and workers are selecting jobs largely on industry rather than choosing individual ¯rms. This ¯nding is not consistent with a moral hazard model. Though we cannot control for employee risk preferences in a cross-sectional regression, and therefore would not rule out a moral hazard model if there were no correlation between the various volatility measures and plan adoption, we are unaware of any credible model of stock options as an incentive mechanism that leads to a strong positive association between plan adoption and volatility.[17] In general, we believe Table 7 con¯rms our prior ¯ndings that the data we have collected appear

[17]Prendergast (2000) develops a model that justi¯es the positive risk/incentive relationship in many settings, though the model is unlikely to apply to ¯rm-performance-based pay for workers at low levels of large organizations.

potentially consistent with both sorting and retention/costly adjustment justifications for the use of stock options but inconsistent with options being used to provide incentives to employees below the senior executive level.

5 Conclusion

Using firm-level data on stock option grants and financial information, we have tried to reconcile the fact that some firms issue stock options to lower-level employees with economic theory. We considered three classes of model – moral hazard, sorting on worker beliefs about the firm's prospects, and stock options as a relatively inexpensive way to adjust worker compensation to market conditions. Using details on the stock option plans for middle managers at a sample of over 200 firms, we showed that the incentive effects of stock options for these workers are trivial. For example, we estimate that the median firm in our sample has to compensate a middle manager \$12,100 for the risk he incurs in order to induce him to exert effort he would have been willing to expend if paid \$15. We also show a strong cross-sectional positive correlation between the adoption of stock option plans and stock volatility, which runs counter to the predictions of a moral hazard model.

Though we cannot conclusively determine how important either model is, we interpret our analysis as consistent with both the sorting and retention/costly adjustment models. We show that, if workers are sufficiently optimistic about their employers' prospects, stock options may be an efficient means of compensation. That is, despite demanding compensation for risk, optimistic employees may be willing to willing to accept a large enough reduction in cash compensation to warrant using options as compensation. We also show that, if spot labor market rates are fairly variable and reducing worker wages is costly (that is, \$10,000-\$40,000), then the correlation between the value of a worker's stock option holdings and his reservation utility may induce the firm to issue stock options.

Distinguishing which, if either, of these models is more important requires further analysis. We hope to refine our analysis in a future draft, using data from a recent proprietary Bureau of Labor Statistics survey of the incidence of stock option plans. Because that survey is at the establishment level, it will allow us to explore how geographic variation in wages, turnover costs, and tax rates are related to the use of stock options.

Finally, we think it is also worth considering the use of stock options when agents care about their relative wealth or income (as in Frank (1984).) That is, if workers value moving up the income distribution, then they may prefer to invest part of their income in a "lottery ticket" through stock options. This presents some of the same issues as the sorting model in that there are ways for individuals to take such risks without making it part of an employment relationship. We believe justifying options in this manner requires a model where individuals care about relative status both within and across firms. However, we have not yet derived or seen a tractable model of this form that we can analyze.

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Table 1: Moral Hazard Model

	Small Firm (1)	Large Firm (2)	Sample Mean (3)	Sample Median (4)
Data from NCEO Sample				
Employees	78	30,000	4,183	180
Middle Manager Salary	$100	$90	$83	$90
Agent Share (b)	0.05217%	0.000107%	0.164%	0.0404%
Firm Value (4/00 { $MM)	$184	$485,000	$5,840	$240
Stock Volatility (¾)	148%	30%	67%	72%
Black Scholes Val. ($BS(bv_0)$)	$94.5	$271.8	$149.6	$114.3
Numerically Estimated (Annualized) { Base Scenario				
Reservation Utility ($\overline{H}$)	$109.5	$149.4	$103.8	$100.0
Cost of E®ort (c)	$0.013	$0.000065	$0.052	$0.015
Risk Premium	$16.5	$17.43	$20.2	$12.1
Numerically Estimated (Annualized) { Sensitivity Analysis				
Reservation Utility ($\overline{H}$)	$116.9	$170.9	$117.3	$109.5
Cost of E®ort (c)	$0.064	$0.0002	$0.225	$0.062
Risk Premium	$11.5	$7.14	$10.9	$6.0

Risk-free rate is assumed to be 5%. Options assumed to expire in ten years and fully vest in four years. Assumptions in base scenario include expected annual stock return of 10%, CRRA coe±cient of 3, and the e®ort generated by the stock options generates twice the agent's annual salary in ¯rm value. Assumptions in sensitivity analysis include expected annual stock return of 20%, CRRA coe±cient of 1 (log utility), and the e®ort generated by the stock options generates ¯ve times the agent's annual salary in ¯rm value. All dollar values are in thousands except ¯rm value.

Table 2: Sorting/Tax Model

	Small Firm	Large Firm	Sample Mean	Sample Median
	(1)	(2)	(3)	(4)
Cost to Firm (Salary and Black Scholes Val. (4s + BS(bv_0))				
After Tax Equivalent	\$376.7	\$451.1	\$353.9	\$332.4
Numerically Estimated { r¤ = 10%; ½ = 3				
Agent Certainty Equiv.	\$327.1	\$364.9	\$284.7	\$293.9
Risk Premium	\$38.7	\$102.2	\$79.8	\$53.2
Numerically Estimated { r¤ = 10%; ½ = 1				
Agent Certainty Equiv.	\$334.5	\$418.1	\$307.5	\$308.1
Risk Premium	\$31.3	\$48.9	\$57.0	\$32.5
Numerically Estimated { r¤ = 25%; ½ = 1				
Agent Certainty Equiv.	\$343.0	\$631.5	\$346.1	\$335.0
Risk Premium	\$48.4	\$113.5	\$111.9	\$68.9
Numerically Estimated { r¤ = 40%; ½ = 1				
Agent Certainty Equiv.	\$353.3	\$979.9	\$402.7	\$374.6
Risk Premium	\$70.4	\$194.3	\$194.2	\$127.9

Risk-free rate is assumed to be 5%. Options assumed to expire in ten years and fully vest in four years. Tax rate is assumed to be 20% on salary income and 40% on options income. All dollar values in thousands and represent total for four years.

Table 3: Costly Adjustment Model

	Small Firm (1)	Large Firm (2)	Sample Mean (3)	Sample Median (4)
Annual Cash Compensation (from NCEO survey)				
	$100	$90	$82.6	$90.0
Numerically Estimated { r¤ = 10%; ½ = 3				
High Spot Wage	$133.8	$176.3	$127.0	$117.0
Low Spot Wage	$103.4	$127.8	$92.7	$93.2
Retention Value { High	$150.2	$280.5	$175.4	$131.2
Retention Value { Low	$11.0	$122.5	$34.8	$25.9
Turnover Cost (k)	$40.5	$47.5	$80.6	$43.9
Numerically Estimated { r¤ = 10%; ½ = 1				
High Spot Wage	$142.5	$181.0	$135.4	$120.2
Low Spot Wage	$103.6	$129.8	$93.6	$93.6
Retention Value { High	$150.2	$280.5	$175.4	$131.2
Retention Value { Low	$11.0	$122.5	$34.8	$25.9
Turnover Cost (k)	$4.7	$20.6	$43.8	$27.2
Numerically Estimated { r¤ = 25%; ½ = 1				
High Spot Wage	$145.3	$335.8	$141.1	$126.1
Low Spot Wage	$103.6	$145.4	$98.5	$96.3
Retention Value { High	$160.7	$199.0	$194.9	$147.9
Retention Value { Low	$11.0	$170.9	$50.7	$36.9
Turnover Cost (k)	-$6.2	-$114.1	$1.2	-$2.1

Risk-free rate is assumed to be 5%. Options assumed to expire in ten years and fully vest in four years. \High spot wage" (\Low spot wage") is the implied maximum market wage for a middle manager after a positive (negative) common shock. \Turnover cost" is the minimum costs the ¯rm would incur if it changed the agent's compensation package (or had to replace the agent) in order to justify the amount of stock options it grants to a middle manager. \Retention value" indicates expected Black-Scholes value forfeited if the agent takes the outside o®er, given the value of the common shock.

Table 4: NCEO Sample Summary Statistics

	All Firms (1)	Option Plan (2)	No Option Plan (3)
Employees	9,045	3,455	15,865
	(30,113)	(13,254)	(41,462)
Sales ($MM)	$2,797	$631	$5,467
	(13,523)	(2,440)	(19,731)
Market Value	$6,116	$6,049	$6,167
12/99 { ($MM)	(24,831)	(36,177)	(24,904)
Year Founded	1970	1983	1953
	(34.8)	(21.3)	(41.3)
Stock Return:			
1998	9.6%	19.7%	2.9%
	(78.3%)	(114.0%)	(38.4%)
1999	65.6%	140.8%	13.9%
	(228.0%)	(326.2%)	(91.6%)
2000	3.1%	-8.8%	12.8%
	(66.7%)	(69.0%)	(63.4%)
Monthly Volatility	17.2%	22.5%	13.0%
	(9.6%)	(10.7%)	(6.0%)
Publicly Traded	66.9%	57.9%	77.2%
Software Industry	27.1%	45.7%	5.6%
Sample Size	462	247	215

Data are from the 2000 Survey on Current Practices in Broad-Based Stock Option Plan Design conducted by the National Center for Employee Ownership (NCEO) Column 2 includes ¯rms that reported the majority of their employees receive stock options. Column 3 includes those who said that most employees do not receive options and will not in the next two years. Stock return and volatility data only include publicly traded companies. \Software Industry" indicates primary SIC code is 7370-7379.

Table 5: Option Plan Logits (NCEO Data)

	(1)	(2)	(3)	(4)	(5)	(6)
Log Employees	-0.1345	-0.1412	-0.1263	-0.1863	-0.1096	-0.1085
	(0.0134)	(0.0408)	(0.0472)	(0.0613)	(0.0357)	(0.0357)
Log Sales		0.0132	-0.0070	0.0433	-0.0229	-0.0092
		(0.0356)	(0.0401)	(0.0493)	(0.0316)	(0.0320)
Volatility			1.7633	1.1813		
			(0.6232)	(0.7736)		
Software Industry					0.3769	0.3470
					(0.0786)	(0.0793)
Founded 1990 or later						0.3142
						(0.0889)
2-digit SIC dummies	No	Yes	No	Yes	No	No
Pseudo-R^2	0.2329	0.3385	0.3017	0.3123	0.3030	0.3279
Sample Size	444	376	267	267	376	376

Dependent variable equals one if the firm issues stock options to more than 50% of its employees. Data are from the 2000 Survey on Current Practices in Broad-Based Stock Option Plan Design conducted by the National Center for Employee Ownership (NCEO). "Software Industry" indicates a company's primary SIC code is 7370-7379. Standard errors in parentheses. Coefficients are marginal effects on the probability that the firm has a plan.

Table 6: EDGAR Sample Summary Statistics

	All Firms (1)	Option Plan (2)	No Option Plan (3)
B-S value of non-exec grants	$30,651	$103,387	$1,677
per employee	(435,747)	(813,295)	(6,537)
Grants to non-execs/Total Shares	2.3%	6.7%	0.4%
	(5.1%)	(7.5%)	(0.6%)
Employees	6,635	903	8,902
	(23,275)	(2,844)	(27,112)
Employee Growth	32.7%	62.3%	21.3%
	(184%)	(332%)	(65%)
Market Value	$1,847	$453.6	$2,466
12/98 – ($MM)	(13,078)	(1,520)	(15,648)
Profit > 0	68.9%	48.3%	77.7%
1997 Stock Return	25.2%	17.1%	28.4%
	(59.4%)	(71.6%)	(53.6%)
1998 Stock Return	3.2%	16.3%	-2.3%
	(88.9%)	(131.6%)	(62.0%)
1999 Stock Return	45.7%	109.2%	18.2%
	(175.6%)	(267.1%)	(104.5%)
Monthly Volatility	17.6%	22.8%	15.3%
	(9.8%)	(10.9%)	(8.3%)
Industry Volatility	8.9%	10.4%	8.1%
	(3.9%)	(3.9%)	(3.6%)
Industry Volatility Share	18.3%	20.9%	16.9%
	(15.2%)	(16.0%)	(14.6%)
Software Industry	6.9%	14.5%	3.5%
Sample Size	816	249	567

Data are from a random sample of 1,000 firms that filed 10-K's and proxy statements with the SEC in 1999. The final sample of 816 firms includes those for whom we were able to gather stock return or other financial information. Column 2 includes firms that, during the year we analyze (usually coinciding with calendar 1998), we estimate issued options on at least 2% of its outstanding shares to employees who were not in the top 10% of its management ranks. Details of our estimate and the variable (plan1) that we created are in the text. Column 3 includes firms that did not meet this criterion. "Software Industry" indicates primary SIC code is 7370-7379.

Table 7: Option Plan Logits (EDGAR data)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	plan1	plan1	plan1	plan1	plan2	plan3
Log Employees	-0.0610	-0.0823	-0.0662	-0.1018	-0.1021	-0.1174
	(0.0106)	(0.0152)	(0.0139)	(0.0198)	(0.0124)	(0.0141)
Employee Growth	0.0266	0.0238	0.0254	0.0243	0.0084	0.0035
	(0.0179)	(0.0184)	(0.0158)	(0.0187)	(0.0077)	(0.0108)
Volatility	0.8086	0.5187	0.4267	0.2082		
	(0.2222)	(0.2930)	(0.2883)	(0.3731)		
Software Industry	0.2102		0.1425		0.1486	0.2140
	(0.0622)		(0.0755)		(0.0615)	(0.0720)
Profit > 0	-0.0837	-0.1191	-0.0893	-0.1313	-0.0592	-0.0159
	(0.0405)	(0.0498)	(0.0515)	(0.0611)	(0.4323)	(0.0496)
Industry Volatility			2.4589			
			(0.7483)			
Industry Volatility Share			0.2032	0.4501	0.5551	0.4864
			(0.1539)	(0.1971)	(0.1260)	(0.1423)
2-digit SIC dummies	No	Yes	No	Yes	No	No
Pseudo-R^2	0.2013	0.2279	0.1872	0.2142	0.2355	0.2028
Sample Size	664	664	489	489	489	489

Dependent variables, described in the text, are various indicator variables for whether a firm has a broad-based stock option plan. Data are from a random sample of 1,000 firms that filed 10-K's and proxy statements with the SEC in 1999. Sample size in each logit is based on the number of firms for which financial information, as well as industry stock return, was available. "Software Industry" indicates a company's primary SIC code is 7370-7379. Standard errors in parentheses. Coefficients are marginal effects on the probability that the firm has a plan.