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

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Abstract

Many firms issue stock options to all employees. We consider three potential economic justifications for this practice: providing incentives to employees, inducing employees to sort, and helping firms retain employees. We gather data from three distinct sources on firms' stock option grants to middle managers, and use two methods to assess which theories appear to explain observed granting behavior. First, we directly calibrate models of incentives, sorting and retention, and ask whether observed magnitudes of option grants are consistent with each potential explanation. Second, we conduct a cross-sectional regression analysis of firms option-granting choices. We reject an incentives-based explanation for broad-based stock option plans, and conclude that sorting and retention explanations do appear consistent with the data.

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1 Introduction

The use of stock option grants in compensation plans for middle- and lower-level employees has attracted ample attention in recent years.[1] The prevalence of this practice presents a challenge to economists interested in firms' relations with their employees. Because the eventual value of a stock option is tied to the value of the firm, this form of compensation subjects employees to a considerable amount of risk. In order for broad option grants to be optimal, there must therefore be offsetting benefits. In this paper, we propose and empirically examine a number of potential sources of benefits stemming from stock-option-based compensation.

We focus our analysis on three possible benefits to firms from stock-option usage. First, option grants may provide incentives to employees. Linking an employee's wealth to the value of the firm may overcome agency problems and motivate the employee to take actions that are in the firm's interest. Second, option grants may induce sorting. As with any form of non-cash compensation, potential employees may have heterogeneous assessments of the value of a firm's option grant. We consider the case where employees differ in their beliefs regarding the firm's prospects, providing an opportunity for firms to reduce compensation costs by using options to attract optimistic employees. Third, options may help firms retain employees. While any form of deferred compensation will make it costly for employees to leave, Oyer (2002) presents conditions under which options are especially useful for this purpose. He shows that if stock prices and labor market conditions are positively correlated, then unvested options serve to index employees' deferred compensation to their outside opportunities.

We gather data from three distinct sources and seek to determine which of these potential explanations is most consistent with the option grants we observe. Our data sources offer offsetting strengths and weaknesses. Our first source, a survey conducted in 2000 by the National Center for Employee Ownership (NCEO) provides detailed information regarding salary and option packages offered to middle-level executives. However, because the NCEO surveyed only those firms believed to have broad-based stock option plans, this sample is not useful for exploring across-firm variation in option-granting behavior.

Our second data source is the Bureau of Labor Statistics' (BLS) Pilot Survey of option grants made in 1999. This survey offers fairly detailed information regarding option grants, and is also selected to be representative of the U.S. economy as a whole. The main limitation of this data source is confidentiality — to insure high response rates, the BLS restricts researchers from learning the

[1] Mehran and Tracy (2001) document the recent increase in employee stock option grants at large, publicly traded companies.

identities of the individual firms that responded. Thus, we are unable to link option-granting behavior to firm characteristics.

Third, we randomly choose 1,000 publicly traded firms that filed both annual reports and proxy statements with the Securities and Exchange Commission (SEC) in calendar 1999. From these disclosures, we gather information on the number of options granted to employees in the preceding fiscal year. While this data source is representative and allows us to use detailed firm-level information, the financial disclosures do not offer detailed information regarding grants made to middle-level employees.

We apply a variety of empirical methods to distinguish between the three theories proposed above. First, we devise economic models of each theory, and attempt to calibrate these models using our NCEO data. To do this, we assume the option packages observed in our NCEO data are the product of firms' optimization over possible grant sizes. Given this, we can ask what the underlying parameters of each model must be in order to give rise to the observed option grants. We ask, for example, what an employee's production function must look like if observed option packages are optimal incentive instruments. How optimistic must employees be regarding the firm's prospects if option grants are driven by sorting? How large must short-run wage variation be if option grants are designed for retention?

Second, we observe that if employee option grants are optimal, then stock option grants must offer higher benefits to firms than equivalently valued stock grants. We therefore compute the benefits to firms from granting options under each theory, and compare this to the potential benefits firms could garner if they elected to grant shares of stock inteasd.

Third, we use our BLS and SEC samples to estimate a series of logit models that relate firms' decisions to adopt a broad-based stock option plan to firm and industry characteristics. Of our three empirical approaches, this is the only one that has been attempted by other authors interested in determinants of broad-based stock option grants. Core and Guay (2001), for example, combine the ExecuComp data on option grants to top executives with information about aggregate option grants from firms' annual reports. The difference yields a measure of option grants to employees other than the five highest-paid executive officers. Kedia and Mozumdar (2002) gather a similar sample from NASDAQ firms. In contrast to ours, both these studies conclude that firms' option-granting decisions are driven, at least in part, by concern for the provision of incentives. However, as suggested by Prendergast (2002), tests of the principal-agent model on cross-sectional data suffer from a number of econometric problems. In particular, the agency model suggests that efficacy of equity-based incentives depends on factors such as the marginal return to effort and the quality of alternative measures of employee performance. Since neither is observed by the econometrician,

it is not clear what pattern in cross-sectional data could reject an incentives-based explanation. These difficulties with cross-sectional tests suggest to us that the returns to attempting alternative empirical strategies is high. We rely on our logit estimates primarily to assess sorting and retention explanations.

Our results are most consistent with the assertions that sorting and retention concerns drive firms' choices to offer broad-based stock option grants. Our calibrations, for example, indicate that a somewhat risk averse employee who expects his firm's stock to increase by about 25% annually would prefer observed option-plus-salary packages to a cash-only compensation plan that costs the employer the same amount. We also find that, if spot salaries for middle managers fluctuate by five to ten thousand dollars within a few years and if the costs of lowering a middle manager's wage (or replacing him) are $10,000 to $20,000, firms may find it more cost effective to issue stock options to middle managers than to try to adjust wages as market wages fluctuate. However, our calibration of the agency model indicates that the risk premiums associated with many firms' option grants are several orders of magnitude larger than the cost to employees of the resulting increases in effort. Given this finding, it seems, stock options could be considered a useful incentive device only if other mechanisms (such as direct monitoring of employees and subjective bonuses based on individual performance) are extremely inefficient at providing incentives. Further, we find that option grants are somewhat advantaged relative to stock grants if retention drives a firm's objectives, but not if the firm's aim is to provide incentives. Finally, we show that broad-based stock option plans are more common at smaller firms, firms with more volatile stock returns (and especially firms in more volatile industries), and firms that are generating negative profits. We conclude that there is very little evidence to support the assertion that firms make broad option grants to provide incentives to employees.

A few other papers, including Sesil, Kroumova, Blasi and Kruse (2002) and Ittner, Lambert and Larcker (2001), have studied performance effects of stock option plans. This work generally treats the adoption of stock option plans as an exogenous event, or at least take adoption as given. Sesil et al. (2002) study differences in financial outcomes for firms with and without stock options. Ittner et al. (2001) study determinants of grants in a sample of firms that have stock option plans and measure the success of these plans against the firms' stated objectives. Our work complements this by identifying sources of performance improvements. Also related is the literature on 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 profit sharing 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.

2 Incidence of Broad-Based Stock Option Plans

We start by examining the incidence of broad-based stock option plans. We use two distinct sources of data for this exercise. First, we obtain a representative random sample of U.S. for-profit establishments from the Bureau of Labor Statistics. Second, we select a random sample of 1,000 publicly traded U.S. firms, and collect information about option-granting behavior from their 1999 financial disclosures.

In 2000, the Bureau of Labor Statistics (BLS), an agency within the U.S. Department of Labor, conducted a survey of employee stock option grants during 1999. A total of 1,437 for-profit establishments, employing 680,000 people, provided complete answers to the survey. The data generated by the BLS survey have several desirable properties. First, the BLS gets a very high response rate (over 75%) because respondents know there is no ulterior motive in the survey and that the confidentiality of their responses will be strictly guarded.[2] Second, the BLS provides establishment-level weights that account for the types of establishment throughout the United States, and for non-response. We use these weights so that all of our analysis, subject to standard sampling error issues, is representative of the U.S. economy in 1999. The fact that the BLS sampling unit is an establishment, rather than an entire company, allows us to analyze the effects of local labor markets on option grants. However, the sampling unit means we observe only the number of employees at the establishment, rather than at the company as a whole. Another disadvantage of the BLS sample is that we do not know the identity of individual firms and, therefore, we cannot match the data to CRSP, Compustat, or other public data.

To analyze the BLS data, we generate two indicator variables intended to capture the breadth of establishment-level stock option grants. First, we set "Any Options" equal to one for any establishment that granted any stock options to any "non-owners" in 1999.[3] Any Options equals one for 10.4% of respondents, but this drops to 2.7% after applying sampling weights.

A second indicator variable is intended to mimic the NCEO measure of broad-based stock option grants that we introduce below. The NCEO survey defines a program as broad if at least half the

[2] The BLS data is only available to researchers who are granted Intergovernmental Personnel Act assignments. All our work with this data was done on-site at the BLS in Washington, DC.

[3] There is some ambiguity in the term "owner" here. Technically, anyone holding a share of stock is an owner. It appears, however, that respondents generally interpreted "owner" as owner/operators, rather than as anyone holding shares in the firm.

Table 1: BLS Sample Summary Statistics

	Public and Private Firms		Public Firms	
	All	Firms with any grant	All	Firms with any grant
	(1)	(2)	(3)	(4)
B-S value of grants per	\$50	\$3,331	\$414	\$3,508
employee	(1,975)	(15,826)	(5,882)	(16,833)
Average Salary per employee	\$31,107	\$36,081	\$35,438	\$38,444
	(54,843)	(63,330)	(55,629)	(67,028)
Number of Employees	25	161	82	159
(at Establishment)	(251)	(664)	(720)	(672)
Number with Salary < \$35K	17	106	53	105
	(156)	(484)	(447)	(492)
Number with Salary > \$75K	1.5	10.8	5.5	11.1
	(19)	(81)	(52)	(85)
Publicly Traded	11.2%	91.0%	100%	100%
New Economy	1.9%	31.3%	7.7%	34.%
"Broad Plan"	1.4%	52.0%	11.8%	53.5%
Sample Size	1437	150	373	137

Establishment data are from the Bureau of Labor Statistics' 1999 Pilot Survey of Stock Option Grants. Non-profit firms and firms that did not provide complete information are not included. BLS sample weights have been applied to all numbers. Industry average wage and growth rates are from the BLS's 1998 and 1999 Occupational Employment Statistics surveys. Industry volatility and volatility share (see text for description) are from CRSP. All industry-level estimates represent 2-digit SIC code industries. "Broad Plan" indicates at least 20% of employees at the establishment were granted stock options in 1999. "New Economy" indicates primary SIC code is 3570-3579, 3661, 3674, 5045, 5961, or 7370-7379. Standard deviations in parentheses.

employees at a firm are eligible for stock option grants. We cannot compute a directly comparable measure using the BLS data, since the survey asks only about actual grants made within calendar 1999. Even in firms where all employees are eligible for grants, it may be the case that only a small fraction actually receive them within a given year. We therefore approximate the NCEO measure with the indicator variable "Broad Plan," which we set equal to one at any establishment that granted options to at least 20% of employees in 1999. Only 1.4% of establishments in the U.S. economy meet this broad plan criteria.

Table 1 shows summary statistics for the BLS data. We provide averages for all public and private establishments, all establishments with option grants, all public establishments, and all

public establishments with option grants. From Column (1) we note that the value of options granted at a typical firm is not very high. The average establishment issues $50 in Black-Scholes value per employee, though the value is $414 at public companies and over $3,000 among firms that issued any options.[4] Establishments that make option grants are noticeably bigger, particularly in terms of the number of highly paid workers, than establishments in the sample as a whole. Not surprisingly, so-called "new economy" firms are highly over-represented among firms that grant options.[5]

The total Black-Scholes value of options granted equals approximately 3.55% of wages for all firms and 25% of wages at firms that issue some options.[6] Of the total options granted, executives received 31.2% of the Black-Scholes value though they comprise only 2.4% of sample employment and 1% of employment at option-granting public and private establishments. Non-executives with annual salaries over $75,000, who comprise 3.7% of sample employment and 5.7% of employment at public and private establishments that grant options, received 61.1% of the value of options granted. Employees earning under $35,000 annually comprise 67.1% of sample employment and received just 1.6% of the value of all options granted.

Our second source of data is the SEC's EDGAR internet-based database of financial disclosures. From the approximately 7,000 firms that filed both a proxy statement (DEF 14A) and an annual report (10-K) with EDGAR during calendar 1999, we randomly select a sample of 1,000.[7] We gather data from these disclosures regarding the number of employee stock options issued. We match this to data on accounting and stock returns from Compustat and CRSP.

The major drawback of the EDGAR data is its high level of aggregation; firms report how many options were granted in total, but there is no detailed information regarding the options holdings

[4] In computing these Black-Scholes values, we assume all options expire in ten years. Also, since we do not observe the identity of the individual firm, we cannot use historical stock volatilities or implied volatilities from actual option markets to value these options. Instead, we use 2-digit SIC-level averages of stock volatilities.

[5] Largely following Ittner et al. (2001), we define firms as being part of the new economy if they manufacture computers, semiconductors, or telephone equipment, if they wholesale computer-related products, or if they create software. We augment Ittner et al.'s (2001) list with codes 3575, 7375, and 7379 because our sample's firms in these industries are internet-related.

[6] Note that these relative values of wages and options differ from the levels implied by Table 1 because the table shows establishment averages rather than per-employee averages.

[7] For most companies in our sample, the financial statements we use refer to the fiscal year coinciding with calendar 1998. We therefore refer to our analysis as relating to 1998, though the period of analysis may include part of 1997 or 1999 for some firms.

of employees other than top executives. Our aim is to construct measures of 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. To construct these measures, we make use of two additional sources of information: (1) how option holdings are distributed among the firm's five most highly paid executives, and (2) data from the NCEO survey on option grants.[8]

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. Given this, we think it likely that the sixth through tenth highest paid executives also received very large option grants.[9] Since our aim is to study option grants to middle-level employees, it does not seem appropriate to include grants to these top executives in our measure.

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 start by focusing on the executives with the second through fifth largest grants. We assume that the highest 10% of employees 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 and shares granted to the top five executives from the total grants to employees, and assume the difference is the total shares granted to non-executives. If the difference is negative, then we assume there were no grants to non-executives.

[8] We know with certainty whether or not the firms in the NCEO sample have a broad-based option plan. We compare the survey data from the NCEO with the information in NCEO firms' EDGAR disclosures. Loosely, our approach here attempts to maximize the number of NCEO sample firms for which we accurately predict option plan status.

[9] As evidence of this, we note that Cathy O. Staples, Belden's Vice President for Human Resources, was granted options to buy 16,000 shares in 1998. In 1999, however, Staples was not among Belden's five highest paid executives, even though, according to the firm's annual report, she was still employed by the firm in the same position. Given her non-top-five status, Belden was not obligated to disclose any information about options granted to her during 1999. Core and Guay's method would attribute any options granted to her during 1999 as a "non-executive" grant.

Table 2: SEC Sample Summary Statistics

	All Firms	Option Plan	No Option Plan
	(1)	(2)	(3)
Black-Scholes value of non-exec	$30,651	$75,320	$947
grants per employee	(435,747)	(687,794)	(5,580)
Grants to non-execs/Total Shares	2.3%	5.2%	0.2%
	(5.1%)	(6.7%)	(0.3%)
Employees	6,635	1,027	10,347
	(23,275)	(2,723)	(29,352)
Employee Growth	32.7%	54.0%	18.8%
	(184%)	(285%)	(53%)
Market Value	$1,847	$448.3	$2,912
12/98 – ($MM)	(13,078)	(1,395)	(17,244)
Fraction with Positive Net Income	68.9%	50.6%	81.8%
1997 Stock Return	25.2%	18.8%	29.7%
	(59.4%)	(67.0%)	(53.2%)
1998 Stock Return	3.2%	8.0%	-0.2%
	(88.9%)	(114.1%)	(65.0%)
1999 Stock Return	45.7%	91.0%	12.0%
	(175.6%)	(246.1%)	(78.3%)
Monthly Volatility	17.6%	21.9%	14.4%
	(9.8%)	(11.1%)	(7.2%)
New Economy	16.5%	28.6%	7.50%
Sample Size	816	350	466

Data are from a random sample of 1,000 firms that filed 10-Ks and proxy statements with the SEC in calendar 1999. The final sample of 816 firms includes those for whom we were able to gather stock return and other financial information. Column (2) includes firms that, during the covered fiscal year, we estimate issued options on at least 1% of its outstanding shares to employees who were not in the top 10% of its management ranks. Column (3) includes firms that did not meet this criterion. "New Economy" indicates primary SIC code is 3570-3579, 3661, 3674, 5045, 5961, or 7370-7379. Standard deviations in parentheses.

We set an indicator variable (SEC Plan) equal to one if the number of shares granted to non-executives represents at least 1% of the shares outstanding in 1998.[10] Table 2 displays summary statistics for the firms in the SEC dataset. All firms are included in the first column, while columns (2) and (3) partition the firms into groups with SEC Plan = 1 and SEC Plan = 0, respectively. We find 42.9% of the firms in our sample had broad-based stock option plans in 1998, though, because these plans are more common at small firms, only 6.2% of employees in the sample worked at firms with SEC Plan = 1. Employees at SEC Plan = 1 firms received average grants worth in excess of $75,000 (though the average option value at the *median* firm with SEC Plan = 1 is only $6,318.) Table 2 makes clear that SEC Plan = 1 firms are strikingly smaller, faster growing, and their stock returns are more volatile.[11] New economy firms make up a substantial portion of the firms with broad plans. Also, note that only half of the firms with broad plans generated positive net income in 1998, while more than 80% of the SEC Plan = 0 firms were profitable.

Tables 1 and 2 illustrate how the BLS and EDGAR samples complement each other. The BLS survey shows the prevalence of stock options in the economy as a whole, while the EDGAR sample helps focus on those firms that more actively grant options. After adjusting for sampling weight, less than 3% of establishments in the BLS sample issued options to anyone, while nearly all the firms in our EDGAR sample issued at least some options. Notably, broad-based option plans are more common at larger establishments in the BLS sample but more common at smaller firms in the EDGAR sample. These differences represent both the higher propensity for the public EDGAR firms to issue options and the fact that, because the BLS sample is at the establishment level, there are many observations where no senior managers are present.

3 Models and Their Empirical Predictions

In this section, we outline several models that may help explain why firms elect to issue options to a broad group of employees. We summarize the empirical predictions of each of these models to motivate the empirical analysis that follows.

[10] In Section 6 below, we construct two alternative indicators for the presence of a broad-based stock option plan using our SEC data. Reproducing Table 2 with these indicators yields similar patterns.

[11] Note here that our adjustment to Core and Guay's (2001) method of measuring grants to non-executives appears to be important. They find non-executive stock option incentives increase with firm size, while we find the reverse. While our adjustment is clearly imperfect, this finding does suggest that Core and Guay's (2001) result may be an artifact of their data collection methodology.

3.1 Incentives

We first describe an incentives-based justification for use of equity in compensation. To develop this reasoning, we follow the linear contracting agency model proposed and studied by Holmstrom and Milgrom (1987, 1991).[12] Suppose the value of the firm, V, depends on an employee's effort, e, as follows:

$$V = ve + \epsilon_v,$$

where ϵ_v is a normal random variable with mean zero and variance σ_v^2. Let the employee be risk averse with coefficient of absolute risk aversion φ.[13] Suppose further that the employee has quadratic effort costs, with second derivative c.

The optimal contract in this case is linear in firm value, and maximizes the total certainty equivalent subject to the employee's incentive constraint. If b is the share of the firm that is owned by the employee, then the optimal contract solves

$$\max_b ve - \frac{1}{2}\varphi b^2 \sigma_v^2 - \frac{c}{2}e^2, \tag{1}$$

subject to

$$e = \arg\max_e bve - \frac{c}{2}e^2.$$

The optimal share is

$$b = \frac{v^2}{v^2 + \varphi c \sigma_v^2}. \tag{2}$$

This analysis yields the standard comparative statics of agency theory. The employee's share is higher when

1. the variance of firm value, conditional on the employee's effort, is smaller;
2. the marginal return to effort, v, is higher;
3. the second derivative of the employee's cost of effort function, c, is smaller;
4. the employee is less risk averse.

[12] While this model's assumptions of linear contracts and normal disturbances are unlikely to be met in the option-based-pay context we study here, it is convenient for its analytic simplicity. We use it to outline our basic approach in linking observed option grants to agency theory. In our calibration below, we develop an agency model that is more closely tailored to the stock-option context.

[13] Throughout the paper, we let φ represent a coefficient of absolute risk aversion, and ρ a coefficient of relative risk aversion.

While the second through fourth comparative statics are difficult to test without detailed information about the production function or employees' preferences, one may think to test this theory using the first. Any such test would be complicated by several factors, however. First is the potential correlation between the marginal return to effort and the variance of the firm's market value. Given that the econometrician cannot observe the marginal return to effort, any cross-sectional analysis of the link between incentives and firm risk suffers an omitted variable bias. If effort is more valuable in high-risk environments (as Prendergast (2002) suggests it may be in some cases), then employees' ownership may appear to be increasing in firm risk due to this correlation.

Second, equity-based instruments are not the only way in which firms can provide incentives to employees. To illustrate this point, consider a multiple-performance-measure agency model where the firm can base pay on firm value V, as defined above, and m, a measure of the employee's individual performance. Let

$$m = e + \epsilon_m,$$

and suppose ϵ_m is a normal random variable with mean zero and variance σ_m^2. Assume further that σ_m^2 and σ_v^2 are independent. As above, the optimal contract is a linear function of V and m. The optimal weights on V and m are

$$\begin{aligned} b_v &= \frac{v^2}{v^2 + \frac{\sigma_v^2}{\sigma_m^2} + \varphi c \sigma_v^2} \\ b_m &= \frac{v}{1 + \frac{v^2 \sigma_m^2}{\sigma_v^2} + \varphi c \sigma_m^2}. \end{aligned}$$

Note here that the optimal share of ownership granted to an employee (b_v) depends positively on the variance of the individual performance measure. If the employee's individual performance is measured less precisely, then the firm substitutes toward the other available measure of performance, firm value.

The econometrician typically cannot observe the efficacy of alternative performance measures, so again cross-sectional tests suffer from an omitted variable bias. Indeed, Core and Guay (2001) take this observation to something of an extreme, arguing that "monitoring costs" (which one can interpret as a high value of σ_m^2) are increasing in firm size, thus predicting that larger firms should make *greater* use of option-based compensation. This prediction is the opposite of what one might expect given that the variance of market value (σ_v^2) is typically higher for larger firms. Given the difficulty in measuring theoretically important constructs such as the marginal return to effort and the variance of alternative measures of performance, it is not clear what pattern in cross-sectional data could *reject* an incentives-based explanation for stock option use. Given these problems with cross-sectional tests, we take a different approach. In Section 4.1 below, we directly calibrate an

agency model, and ask whether the observed option packages offered to middle managers appear to provide economically meaningful incentives.

3.2 Sorting

Next, we consider the possibility that firms may offer option-based compensation to induce workers to sort into the most efficient 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 his notation for consistency within this paper, Lazear (2001) considers contracts where the worker earns a share b of the value of the firm V. If V is a function of the employee's ability, then such contracts are most attractive to employees whose skills are most valuable to this firm. Assuming employees have hidden information regarding where their skills are most valuable, contingent pay arrangements such as this will induce efficient matching. Lazear notes, however, that unless the worker has a large effect on firm value V, then even a small amount of risk aversion would make the risk costs of options dwarf the benefits of this sorting. He concludes that his model "does not explain why some firms give stock options even to very low-level workers."

We therefore consider a variant on this model. We assume employees are heterogeneous not in their ability, but rather in their beliefs regarding the firm's prospects. Given this assumption, the firm may benefit by using stock options to attract the optimistic employees. If employees value the firm's stock options at more than their market price, then the firm can reduce its overall compensation expenses by offering option-based pay packages.

There are two reasons why it may be advantageous to include such compensation as part of an employment relationship, as opposed to simply letting optimistic employees purchase the firm's shares in their own account. First is a tax advantage. The employment relationship allows the employee to avoid paying taxes on the options until he exercises them.[14] This allows the options to compound tax-free. While this tax advantage is not large, it may be enough to swing the optimal

[14] 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 important IRS restrictions on issuing ISOs and, therefore, a significant majority of stock options issued to individuals below the top executive level are NQSOs. Our BLS data show that 77% of the people who received options grants in 1999 received only NQSOs, 15% received only ISOs, and 8% received both. The ISOs are skewed towards senior executives. Some non-executives do receive ISOs and, therefore, our analysis slightly understates the average (but not the median) tax advantages of stock options. See McDonald (2001) for details on employer tax considerations in issuing options. We proceed under the assumption that the options we analyze are NQSOs.

compensation from all cash to cash plus options at some firms. Second, it may be that the firm can somehow reduce overall transaction costs by making these grants centrally.[15]

Formalizing this idea, suppose the time $t = 0$ market price of an option to buy one share of a firm's stock is z_0. Let the value of the option at time $t = 1$ be represented by z_1, and suppose individuals have heterogeneous beliefs over z_1. Suppose individual i draws a signal z_{1i} from a distribution with cumulative distribution function F. Conditional on the value of his signal z_{1i}, let an individual's belief as to z_1 be given by the density $g(z_1 \mid z_{1i})$, with $\mathrm{E}[z_1 \mid z_{1i}] = z_{1i}$.[16] Note that even if an individual expects the option value to rise (that is, $z_{1i} > z_0$), he still holds some uncertainty regarding the $t = 1$ valuation. A risk-averse individual will therefore not elect to place all his or her wealth into this risky asset. Let the firm's expectation as to the time $t = 1$ value of a stock option be the same as that of the market, given by $\bar{z}_1$.

Suppose the firm offers an employment contract to an individual with signal z_{1i}, tax rate τ, concave utility function u, and reservation utility $\bar{u}$. If $z_{1i} > z_0$, then the employee prefers to receive some options as compensation due to the tax advantage.

Assuming, for simplicity, that the firm is able to capture any rents associated with the tax advantage, then the firm selects a salary s and a number of options n to minimize its expected compensation expense for this employee:[17]

$$\min_{s,n} \; s + n\bar{z}_1 \tag{3}$$

[15] Employees may also gather inside information that enhances the value of the options they are granted. See Huddart and Lang (2002) for evidence that even relatively low-level employees appear to exercise their stock options based on non-public information. However, employees can make full use this information (and optimize given their individual risk preferences) by trading on their own accounts. Thus, the presence of such inside information cannot by itself explain why firms elect to issue options to employees.

[16] Note that this framework supports imperfectly informed or irrational individuals. For example, heterogeneity in valuations could arise if some employees overestimate the importance of "momentum" in the firm's stock price (see Benartzi (2001)). Alternatively, our description can 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 feature prices that are not fully revealing of traders' information; hence, it is rational for traders to make use of their private signals in making trades.

[17] We allow a slight inconsistency of notation here. In discussing options as incentives, we allowed the firm's contract to consist of (s, b), where b is the fraction of the firm owned by the employee. Here, the firm's contract is (s, n), where n is the number of options granted. Note the fraction ownership determines incentives but the number of options held determines the profit an employee can earn from his grant.

subject to

$$\int_{z_1} u\Big((1-\tau)(s+nz_1)\Big) g(z_1 \mid z_{1i})\, dz_1 \geq \bar{u}. \tag{4}$$

The number of stock options granted increases as

1. the employee's tax rate increases,
2. the variance in employees' beliefs about value of the options (that is, the variance of the distribution represented by F) increases, and
3. the variance of an employee's belief about z_1 conditional on z_{1i} (that is, the variance of the distribution represented by $g(\cdot \mid z_{1i})$) increases.

The two variances here are likely to be difficult to disentangle empirically.

3.3 Retention

Because options granted to employees typically have a vesting period attached, they have the effect of increasing the costs to employees of departing the firm. Options may therefore help firms retain employees. What is unclear, though, is why firms would use stock options for this purpose — any form of compensation that is forfeited if employees leave will help with retention. Given that using options for this purpose loads risk onto employees, one may wonder why firms would not simply defer cash payments if retention is their aim.

Oyer (2002) suggests an answer. He points out that if labor market conditions in a given industry are positively correlated with firms' share prices, then options serve to index deferred compensation to employees' outside options. Consider a firm that is contemplating offering $100,000 in deferred cash compensation vs. $100,000 in Black-Scholes value of stock options. If it turns out that labor markets are exceptionally tight, then the $100,000 in deferred cash may not be sufficient to induce the employee to stay with the firm. However, if the employee holds options, then it is likely that the value of the option package will be substantially higher than $100,000 in the event that the employee receives an attractive outside offer. The states of the world in which the firm incurs costs from replacing the employee (if he leaves) or negotiating over a new wage (if he can be convinced to stay) is smaller given the option package.

If, on the other hand, labor markets are slack, then the firm must still pay the employee the $100,000 in deferred cash. For the option package, though, the realized value may be considerably less than the initial Black-Scholes value. Given the widely held view that it is difficult for firms to cut nominal salaries, the option package may be an effective way to link total compensation to labor market conditions without resorting to nominal wage cuts.

Oyer (2002) derives a number of comparative statics:

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

2. Adoption of broad plans and the number of options granted increases as the variance of common shocks to firms participating in a given labor market increases, the variance of idiosyncratic shocks to firm value decrease, and employees become less risk averse.

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

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

3.4 Other Explanations

We focus on the preceding three explanations in our analysis, but briefly recount some others here.

3.4.1 Financing Constraints

Some have suggested that cash-constrained firms offer stock options to their employees as a substitute for salary.[18] This explanation may hold some intuitive appeal, especially given the prevalence of option-based pay in new ventures. There is a substantial literature (see Stein (2001) for a summary) examining information asymmetries in financial markets; frictions in markets may lead to a preference for internal finance.

However, one would expect firms to seek the lowest-cost forms of financing, and hence this "options-as-finance" explanation is sensible only if asking employees to take a discount in salary is the lowest-cost way to finance a new venture. We argue there are a number of reasons why middle-level employees would not be the cheapest form of finance. First, the informational asymmetries afflicting financial markets would presumably affect attempts to finance through the labor market as well. While employees may have the opportunity to gather ample information regarding the firm's operations after they take the job, the decision by an employee to accept a lower salary in exchange for equity is made before such information is gathered. Second, even if a firm's employees are at a comparative advantage compared to outside financiers in observing management's actions, the weak control rights associated with small option grants means there is little employees can do to protect their investments. Third, specialist financial intermediaries would presumably have more

[18] See, for example, Core and Guay (2001) and Kedia and Mozumdar (2002).

expertise in assessing new ventures and greater risk tolerances than would middle-level employees. We therefore argue that this explanation for broad-based option use is sensible only if employees are optimistic regarding the firm's prospects, a possibility we discussed in Section 3.2.

3.4.2 Favorable Accounting Treatment

Stock-option-based compensation receives a favorable accounting treatment. If a firm pays an employee an additional $100 in wages, then this payment is counted as an expense for the firm, and the firm's reported net income in the current period is lower by $100. If, on the other hand, a firm gives an employee a stock option grant worth $100, then the firm may elect not to recognize this as a compensation expense. Under this accounting regime, a firm interested in boosting its share price in the short run may try to reduce compensation expense by using options rather than cash. Magnitudes of option grants, however, must be disclosed. (Such disclosures are the source of our EDGAR data set.) Unless equity prices fail to reflect this publicly available information, attempts to fool the market by shifting to option-based pay will fail. Aboody, Barth and Kasznik (2001) show that stock valuations do appear to incorporate this information.

Even if the market is not systematically fooled by firms' attempts to hide compensation expense using stock options, top managers may still issue options to lower level employees if they naively believe the market can be fooled, or if their own compensation depends more on accounting earnings than share prices (see Murphy and Oyer (2002)). This reasoning suggests that a corporate governance problem underlies firms' decisions to issue options, as the separation of ownership and control permits managers take actions that owners would undo if they could. We argue that this rationale for option usage is inconsistent with the facts that (1) ownership of equity by Chief Executives rose dramatically during the 1990s (Murphy (2000)), and (2) many firms that do have broad plans (such as Microsoft and Oracle) are managed by founders with very large equity stakes.

3.4.3 Options as Explicit Contract

Finally, one potential difference between stock options and other incentive mechanisms is that options are an explicit contract. While many firms provide strong incentives using implicit contracts based on subjective measures of performance, this practice has two important drawbacks. First, implicit contracts cannot rely on external enforcement, and hence must be self-enforcing. Bull (1987), among others, has studied how reputation can provide an enforcement mechanism in such cases. Second, supervisors instructed to make subjective assessments may find it costly to make sharp distinctions between employees, thus weakening the power of such incentives.

This reasoning suggests that option-based compensation may be more prevalent as an incentive

mechanism when these costs associated with implicit contracts are high. That is, one might expect option-based pay at new firms that have not yet developed a reputation, and for jobs in which it is difficult to derive verifiable measures of performance. While we believe this explanation may be of some value in explaining the use of options in small startup firms, it probably cannot explain why a large, established firm would grant options to all employees.

4 Calibrations

In this section, we fit data on stock option grants to the incentive, sorting, and retention models discussed above. Here, we rely on 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-profit 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 list of surveyed companies was compiled from several sources and all were thought likely to have a stock option plan that covered at least half the company's employees. The NCEO received 247 detailed responses from firms that had stock option plans covering the majority of employees and 222 responses from firms 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. For each firm returning a survey, we search the 2000 *Ward's Business Directory* for basic firm-level data, such as primary SIC code, number of employees, year founded, and annual revenue. Both by design and due to the fairly low response rate (approximately 20-25%), this survey does not cover a random sample of firms with or without stock options plans. We therefore use the survey primarily as a tool for analyzing observed plans, rather than assessing the determinants of the decision to adopt such a plan.

4.1 Incentives

We begin our series of calibration exercises by considering an incentives-based explanation for stock option use. As we noted above, agency theory suggests that the marginal return to effort and the efficacy of alternative performance measures should be key determinants of the use of equity-based compensation. The fact that these constructs are not observed by the econometrician makes assessing an agency-theoretic explanation for option use very difficult in cross-sectional data. As such, we take a different approach.

The insight leading to our analysis is the following: If observed option grants are optimal, then

it must be that the marginal benefit to the firm of making additional grants is equal to the marginal cost. The marginal benefit comes from additional effort leading to additional productivity, while the marginal cost comes from the fact that an employee must be compensated for bearing additional risk. We calibrate the firm's first-order condition, using observed option packages, observed variances of firms' market values, and information about individuals' typical levels of risk aversion. This allows us to estimate the value, gross of risk and effort costs, associated with observed stock option grants. We can also compute the employee's effort cost and risk premium. Given these figures, we can ask whether observed option grants appear to be consistent with an incentives-based justification for stock option use.

Formally, we let v_0 be the value of the firm as of the date of an option grant. Suppose the employee makes an effort choice e that affects the terminal value of the firm (v_1). Let the cumulative distribution function of v_1 conditional on e be represented by $F(v_1; e)$. We normalize effort such that one unit of effort increases the mean of v_1 by \$1. Let b be the fraction of any appreciation in the firm's value that is given to the employee as part of the option grant. If the firm grants options on n shares to an employee and has N shares outstanding, then $b = \frac{n}{n+N}$. The final payoff to the employee from his grant of stock options is therefore given by $\max[b(v_1 - v_0), 0]$.

Suppose the employee has constant absolute risk aversion with coefficient φ. We use a Taylor series approximation of the employee's utility function to write the employee's certainty equivalent when holding random payoff $\tilde{x}$ as

$$\mathrm{E}(\tilde{x}) - \frac{1}{2}\varphi \mathrm{Var}(\tilde{x}).$$

Let the employee's utility in his next best job be given by $\bar{u}$.

The firm's problem is to select a salary s and an option grant b to maximize its profits. The assumption of no-wealth-effects allows us to simplify the firm's problem by substituting the employee's participation constraint into the firm's objective. The firm selects b to maximize the total certainty equivalent of the two parties less effort costs, subject to the employee's incentive constraint:

$$\max_b \int_0^\infty v_1 \, dF(v_1; e) - c(e) - \frac{1}{2}\varphi b^2 \xi(e)$$

subject to

$$e \in \arg\max_e \; b \int_{v_0}^\infty v_1 \, dF(v_1; e) - c(e) - \frac{1}{2}\varphi b^2 \xi(e).$$

Here, we have defined $\xi(e)$ to be the variance of $\max[v_1 - v_0, 0]$ conditional on the employee's effort level. The salary s is selected to keep the employee on his participation constraint.

The employee's first-order condition for effort is given by

$$b \int_{v_0}^\infty v_1 f_2(v_1; e) \, dv_1 - c'(e) - \frac{1}{2}\varphi b^2 \xi'(e) = 0, \tag{5}$$

where f_2 is the derivative of the density of the firm's terminal value with respect to the employee's effort choice. We define $\hat{e}(b)$ as the solution to this equation — it is the employee's optimal effort choice conditional on the firm's option grant. Substituting this into the firm's objective, we have the firm's problem as

$$\max_b \int_0^\infty v_1 \, dF\Big(v_1; \hat{e}(b)\Big) - c\Big(\hat{e}(b)\Big) - \frac{1}{2}\varphi b^2 \xi\Big(\hat{e}(b)\Big).$$

Assuming an interior optimum, the optimal option grant satisfies

$$\int_0^\infty v_1 f_2\Big(v_1; \hat{e}(b)\Big)\hat{e}'(b)\, dv_1 - c'\Big(\hat{e}(b)\Big)\hat{e}'(b) - \varphi b \xi\Big(\hat{e}(b)\Big) - \frac{1}{2}\varphi b^2 \xi'\Big(\hat{e}(b)\Big)\hat{e}'(b) = 0.$$

We rearrange, and then substitute the employee's first-order condition from (5):

$$\hat{e}'(b)\Big(\int_0^{v_0} v_1 f_2\Big(v_1; \hat{e}(b)\Big)\, dv_1 + (1-b)\int_{v_0}^\infty v_1 f_2\Big(v_1; \hat{e}(b)\Big)\, dv_1\Big) = \varphi b \xi\Big(\hat{e}(b)\Big). \tag{6}$$

This equation has an intuitive interpretation. The left-hand side is the amount by which the value captured by the firm increases when the firm increases b by a small amount. It is the product of the derivative of effort with respect to b and the derivative of value captured by the firm with respect to effort. The right-hand side is the amount the employee's risk premium increases when the firm increases b. The optimal option grant equates this marginal benefit to this marginal cost.

We rely on the first-order conditions in Equations (5) and (6) in conducting our calibration exercise. We take characteristics of the firm and its option grants from our NCEO data and make assumptions regarding the distribution of the terminal value of the firm (f) and the risk aversion of the employee (φ). Given this, the only unknowns in this pair of first-order conditions are the employee's effort level e, and his marginal cost of effort $c'(e)$. Assuming effort costs are quadratic with second derivative c, then we have two equations with two unknowns, which we can solve numerically. Our normalization of effort means that a calculation of e gives the dollar value of the employee's increased production coming about as a result of the option grant. Given c, we can compute the cost to the employee of exerting this effort. We can also compute the risk premium the employee applies to the option grant.

To tailor our analysis to the stock-based pay context, we make a number of assumptions. First, we let one period in our model correspond to four calendar years. The employee receives an option grant at the beginning of the first year and either exercises his options or leaves the firm (forfeiting the option value) at the end of the fourth year. This assumption is motivated by the fact that most option packages granted by firms in our NCEO data are fully vested after four years, and that research on option granting behavior by lower-level employees suggests that a large fraction of these options are exercised very shortly after vesting.[19] At the public companies in our 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. The assumption that options are fully executed after four years implies that the cost to the firm of issuing the option is equivalent to the Black-Scholes value of an option that expires after four years. We use this as the cost to the firm of issuing the options to the employee.

Second, we assume that the distribution of the terminal value of the firm follows a log-normal distribution. The mean of this distribution is given by $v_0(1+r)^4 + e$, where v_0 is the value of the firm at time zero, r is the annual expected return on the firm's shares, and e is the effort level chosen by the employee. We set $r = 10\%$ in our analysis. The standard deviation of this distribution is given by $2\sigma v_0$, where σ is the expected annual standard deviation of the firm's return.

For public companies in our NCEO sample, we estimate a historical value of σ using stock return data from the Center for Research in Securities Prices (CRSP) from 1995 through 2000. For the 86 companies that are private or for which historical stock returns are insufficient, we compute a historical σ using the predicted level from a regression of σ on the firm's number of employees using the 130 companies for which we can compute historical volatilities. For our calculation of option values, we would like to apply expectation of future stock volatility, rather than the historical volatility we compute. Implied volatilities from options markets show that future and historical levels are similar in short forward-looking horizons (a year or two), but markets going out four years do not exist. We therefore assume that future volatilities will be the minimum of 0.75 and 75% as high as the computed historical volatilities.

We consider two possible values for the employee's level of risk aversion, and two possible cost-of-effort functions for the employee. Friend and Blume (1975) and Hall and Murphy (2002) argue that 2.5 is a rough lower bound on the average person's coefficient of relative risk aversion (ρ). To allow for the possibility that option-based pay attracts a selection of risk-tolerant employees, however, we use a relative risk aversion value of one in our basic specification. We convert this to an Arrow-Pratt measure of absolute risk aversion (as required by our agency model), by dividing by the employee's wealth level, which we assume to be five times the annual salary paid by the firm to middle managers. We also consider the case where middle managers are of "average" risk tolerance, by setting the Arrow-Pratt risk aversion measure to be 2.5 divided by five times the

[19] For example, Aboody (1996) shows 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 options were exercised in the first four years after the grant date. Huddart and Lang (1996) study a sample of eight firms, and report that about half of all options were exercised in the first half of the options' term.

annual salary. In our basic specification, we assume quadratic effort costs with second derivative c. We also apply $c(e) = \frac{1}{4}ce^4$.

In Table 3, we present a summary of the results from this exercise. We select four firms, corresponding approximately to the 20th, 40th, 60th and 80th market capitalization percentiles from our NCEO data. We present results from three calibrations for each. The first calibration assumes quadratic effort costs and absolute risk aversion of one divided by five times salary. The second assumes quadratic effort costs and absolute risk aversion of 2.5 divided by salary. The third assumes effort costs of $\frac{1}{4}ce^4$ and absolute risk aversion of one divided by five times salary. Since one period in our model corresponds to four calendar years, we annualize all figures in our table by dividing by four.

We focus first on the smallest firm, listed in Column (1). This firm has a small number of employees, and makes fairly large option grants to middle-level managers. Assuming quadratic effort costs and a coefficient of absolute risk aversion of one, our model computes that the employee's additional productivity coming about as a result of the option grant is \$54,900, annually. The risk premium the employee attaches to his annual compensation on account of the option grant is \$25,500. The annual cost to the employee of exerting this additional effort is \$52.

The second calibration yields larger estimates of effort and effort costs. To see the intuition for this, recall that our model solves for effort using the firm's first-order condition. This condition states that the marginal benefit and marginal cost associated with additional option grants must be equal. If employees are more risk averse, then the marginal cost to the firm of using option-based pay is higher. Hence, firms are willing to make the observed grants only if the responsiveness of effort to incentives is higher. The second calibration therefore estimates a smaller value of c, and a higher value of e. For the 20th-size percentile firm, the model indicates that the option grant causes a middle-level employee to produce an additional \$293,300 annually, at annual risk and effort costs of \$63,800 and \$225, respectively. The third calibration also yields higher effort figures than did the first. The cost-of-effort function here is flatter, meaning employees are more responsive to low-powered incentives. For the 20th-size-percentile firm, the model indicates that the option grant causes a middle-level employee to produce an additional \$179,900 annually, at annual risk and effort costs of \$25,500 and \$85, respectively.

Calibrations for the three other firms yield widely differing magnitudes. Our 40th-size-percentile firm makes small option grants to middle managers. These grants impose small risk costs on employees, so the model infers that the value created and effort costs incurred by employees must be small as well. For case one, the model indicates that the grants induce an employee to create an additional \$178 annually, at risk and effort costs of \$88 and half a cent. Our 60th-size percentile

Table 3: Calibration — Incentives

	Small Firm (20th size pctile)	Med-Small Firm (40th size pctile)	Med-Large Firm (60th size pctile)	Large Firm (80th size pctile)
	(1)	(2)	(3)	(4)
Employees	< 50	> 200	<100	$\sim$2000
Middle Manager Salary	\$90	\$90	\$70	\$100
Employee Share (b)	0.33%	0.009%	0.066%	0.006%
Firm Value (4/00 – \$MM)	$<$ \$100	$\sim$\$300	$\sim$\$400	$\sim$\$1500
Stock Volatility (σ)	$> 75\%$	$< 75\%$	$> 75\%$	$\sim$25%
Black-Scholes Value	\$190	\$11	\$224	\$47
Case One: $\rho = 1, c(e) = \frac{1}{2}ce^2$				
Effort (e)	\$54.9	\$0.178	\$107.0	\$1.36
Cost of Effort ($c(e)$)	\$0.052	\$0.000005	\$0.018	\$0.00003
Risk Premium	\$25.5	\$0.088	\$40.6	\$0.64
Case Two: $\rho = 2.5, c(e) = \frac{1}{2}ce^2$				
Effort (e)	\$293.3	\$0.457	\$1,711.8	\$3.76
Cost of Effort ($c(e)$)	\$0.225	\$0.000012	\$0.837	\$0.00009
Risk Premium	\$63.8	\$0.22	\$101.5	\$1.53
Case Three: $\rho = 1, c(e) = \frac{1}{4}ce^4$				
Effort (e)	\$179.9	\$0.683	\$331.2	\$5.67
Cost of Effort ($c(e)$)	\$0.085	\$0.000010	\$0.029	\$0.00006
Risk Premium	\$25.5	\$0.088	\$40.6	\$0.64

Risk-free rate is assumed to be 5%. Options assumed to expire in ten years and fully vest in four years. All dollar values are in thousands except firm value.

firm makes larger grants, and hence our model computes larger effort effects. In case one, the employee is calculated to produce an additional $107,000 annually on account of the equity-based pay. Our 80th-size-percentile firm again offers small option grants. In case one, a middle-level employee is computed to produce an additional $1,360 annually, at risk and effort costs of $640 and 3 cents.

We conclude from this exercise that the provision of incentives does not appear to be a plausible justification for the use of equity grants to middle-level employees at reasonably large firms. We reach this conclusion by comparing the risk premia and effort costs computed by our model. For example, in case one with our 20th-size-percentile firm, the option grant imposes risk costs on an employee of $25,500 annually. Under an incentives-based explanation for stock-option use, the offsetting benefit to the firm is greater effort leading to greater productivity. Our calculations, however, indicate that the cost to the employee of exerting this additional effort is only $52. That is, if effort were contractible, the employee would be willing to exert this additional effort in exchange for a payment of $52. In every case we have calculated, the risk premium stemming from option-based pay simply dwarfs the cost to the employee of the associated increase in effort.

The question we are left with, therefore, is the following: Couldn't the firm, at a cost of less than $25,500, devise *some other* means of identifying whether an employee has taken actions that increase the value of the firm, and then reward the employee directly for these actions? Even if "effort" cannot be objectively measured, it appears to us relatively straightforward for firms to use various forms of subjective performance evaluation to reward employees for value they create. Given our calculations here, we find it very difficult to believe that stock options could be the most efficient incentive mechanism available to firms. This leads us to reject an incentives-based explanation for stock-option use.

4.2 Sorting

We now consider the variant on Lazear's (2001) model discussed in Section 3.2, where employees vary in their beliefs about the expected return of the firm. While employees can trade in their employers' shares on their own accounts, firms link option grants to the employment relationship to allow employees to realize tax benefits. Firms may capture some or all of the resulting rents.

The insight underlying our analysis here is the following: If this form of sorting explains firms' decisions to issue stock options, then it must be the case that employees strictly prefer the observed salary plus option packages to an all-cash package costing the firm the same amount. Hence, we proceed by first computing the cost to the firm (salary plus Black-Scholes value of options) of observed compensation packages. We calculate, using various assumptions regarding optimism and

risk preferences, how much employees value observed packages. We then ask how optimistic and risk tolerant employees must be in order to prefer option-based compensation to cash.

We vary our analysis somewhat from the prior section while retaining most of the same basic assumptions. Let one period of our model correspond to four calendar years. Suppose again that options vest after four years, and that employees exercise all options immediately upon vesting. Let v_1 be the terminal value of the firm, and suppose the employee believes it to be log-normally distributed with mean $v_0(1+r^*)^4$ and standard deviation $2\sigma v_0$, where σ is the annual standard deviation of returns. We determine the options' value when issued (which we use as the cost to the firm) using Black-Scholes assuming expiration in four years. Let the employee have constant relative risk aversion with initial wealth equal to his annual salary.[20] We make assumptions regarding tax rates applied to three types of income: current salary, options profits, and additional cash salary the employee would receive if he got no stock options. Current salary is inframarginal in this analysis, so we apply $\tau_s = 20\%$ to capture an estimate of average tax rates in calculating utility. The other two types of earnings are marginal, so we apply $\tau_b = 40\%$.

The top row of Table 4 shows the after-tax 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. In subsequent rows, we list our assumptions regarding the employee's risk preferences and degree of optimism. The first set of estimates assumes $r^* = 10\%$ and coefficient of relative risk aversion (ρ) 2.5. At the two firms that grant large amounts of options (columns (1) and (3)) and the median firm, the employee values this package at less than it costs the firm and, therefore, would prefer an all cash package costing the firm the same amount. However, at the firms that grant options sparingly (columns (2) and (4)), as well as 61 of the 216 firms in the sample, the employee values the options-based package more highly. 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.

The next set of estimates shows that the conclusions change somewhat when the employee is less risk averse. Lowering the employee's ρ to 1 does not justify the use of options at the median firm or the firms in columns (1) and (3), but the gap between the cost to the firm and the employee's valuation becomes smaller. Of the 216 firms in the sample, the employees at 94 prefer the options package to the all cash package. From these first two exercises, we conclude that the sorting model

[20] While constant absolute risk aversion allowed us to simplify our analysis in the previous section, constant relative risk aversion is likely more realistic.

Table 4: Calibration — Sorting

	Small Firm (20th pctile) (1)	Med-Small Firm (40th pctile) (2)	Med-Large Firm (60th pctile) (3)	Large Firm (80th pctile) (4)	Sample Median (5)
Cost to Firm of Observed Option Package					
(After Tax Equivalent)	\$366.1	\$292.6	\$310.9	\$337.2	\$306.9
Case One: $r^* = 10\%, \rho = 2.5$					
Employee After Tax Value (CE)	\$322.4	\$292.9	\$255.9	\$342.0	\$294.0
Risk Premium	\$65.8	\$1.1	\$79.7	\$3.5	\$22.5
Case Two: $r^* = 10\%, \rho = 1$					
Employee After Tax Value (CE)	\$344.7	\$293.5	\$280.9	\$344.0	\$303.3
Risk Premium	\$43.5	\$0.5	\$54.6	\$1.5	\$13.9
Case Three: $r^* = 25\%, \rho = 1$					
Employee After Tax Value (CE)	\$390.2	\$298.4	\$326.5	\$379.9	\$326.8
Risk Premium	\$91.3	\$1.3	\$113.0	\$4.5	\$30.2
Case Four: $r^* = 40\%, \rho = 1$					
Employee After Tax Value (CE)	\$454.2	\$305.5	\$391.0	\$434.6	\$437.7
Risk Premium	\$168.4	\$2.8	\$205.5	\$9.8	\$57.2

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.

cannot be the primary reason most firms in our sample give middle managers stock options if those managers believe the firm's stock will rise by 10% per year. With these expectations of future stock returns, employees at most firms would prefer an all-cash package. However, given that the stock of many of the firms in this sample had been rising at much higher rates, this figure may underestimate the optimism of many of the employees.

In our next exercise, we keep the employee's risk aversion relatively low, but assume he expects 25% annual stock appreciation (four-year appreciation of 144%.) The employees at all of the four firms in Table 4 now prefer the option package, as do the employees at 205 of the 216 firms in our sample. As columns (1) and (3) show, given these parameter estimates, the employee's valuation of the options package is well above that of the cash package even at the firms that impose $100,000 or more of risk costs on their employees. Finally, we raise the expected stock return to 40% (284% for four years). While this may seem like an excessively optimistic expectation, it is well below the average return at these firms in 1999. If employees naively believe there is momentum in share prices, then perhaps this figure is not far from accurate. At this expected return, the employees at nearly all the firms in our sample value their options packages significantly more than they would value comparable all-cash packages.

Finally, we consider the magnitude of the tax advantages of attaching options to the employment relationship, as opposed to simply letting optimistic employees trade on their own accounts.[21] To do this, we comput the critical expected annual stock gain — that is, the expected annual return above which the employee prefers the option and cash package to an equivalent cost all cash package — first assuming the actual favorable tax treatment, then assuming no tax advantages. The tax advantage causes the critical expected annual stock gain to decrease by about 1% at firms that make small grants. For example, assuming a ρ of 1 and $\tau_b = 40\%$, an employee at the firm in column (2) prefers the option package to all cash for any $r^* > 6.8\%$. When there are no tax effects (that is, $\tau_b = 0\%$), the critical r^* increases to 7.6%. The ax advantage is much greater at firms such as the one in column (1). At that firm, assuming $\rho = 1$ and $\tau_b = 40\%$, the critical expected return for an employee to prefer the option package is 17.8%. Without tax effects, the critical r^* jumps to 21.8%. By having options linked to the employment relationship rather than trading on their own accounts, employees give up the flexibility to liquidate the position whenever they choose. In return for this, it appears employees can increase their expected returns by about four percent per year.

[21] As discussed in the introduction, the tax advantages are larger for the minority of employees who receive Incentive Stock Options.

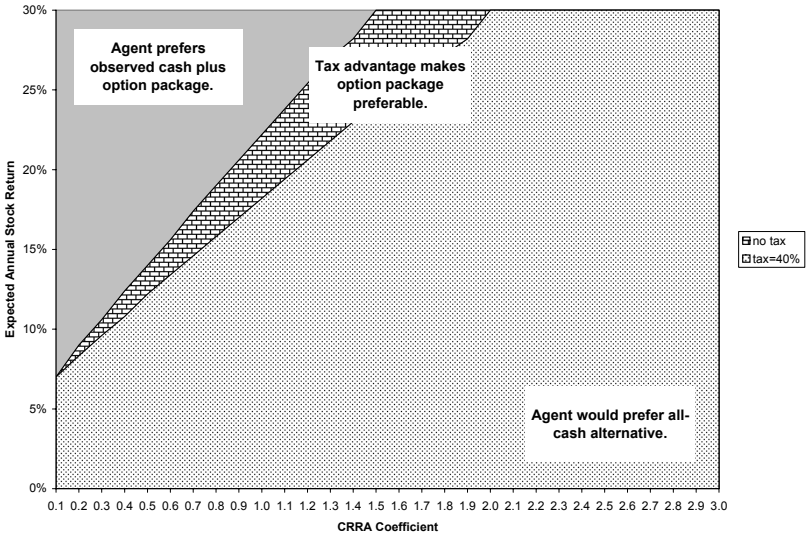

Figure 1: Small firm employee's preferences over compensation plans for different values of r^* and ρ.

We display these results graphically in Figures 1 through 4. To do this, we place the employee's coefficient of relative risk aversion on the x-axis and his expectation as to the firm's annual stock return on the y-axis. For each point on this plane, we can compute whether an employee with these preferences and beliefs prefers the observed option package or an all cash package that costs the firm the same amount. We also identify a region in which the tax advantages tips the employee's prefence toward the option package.

In general, we believe the results in Table 4 suggest that the sorting model could be at least a contributing factor in explaining why some firms offer stock options to lower level employees. If potential employees are somewhat risk tolerant and have optimistic views about the future of the firm, then employees will value cash-plus-options packages at more than their cost to the firm. Full confirmation of this model will require an examination of across-firm variation in who uses stock options. Our calculations here indicate that, holding the employee's risk aversion constant, firms with lower stock volatility can more efficiently use stock options. Firms in the NCEO sample tend, however, to have very high volatilities. The fact that high-volatility firms use options is consistent with sorting only if these firms hire a selection of very risk tolerant employees, or if the firm can locate extremely optimistic employees.

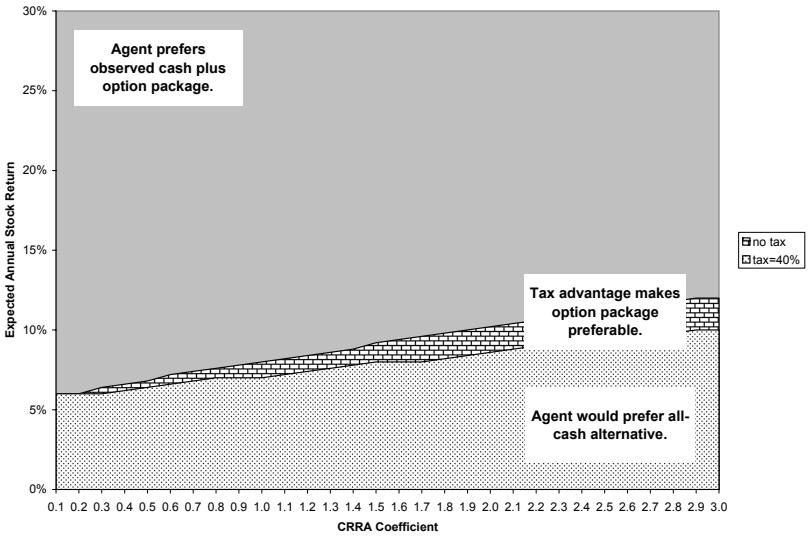

Figure 2: Med-Small firm employee's preferences over compensation plans for different values of r^* and ρ.

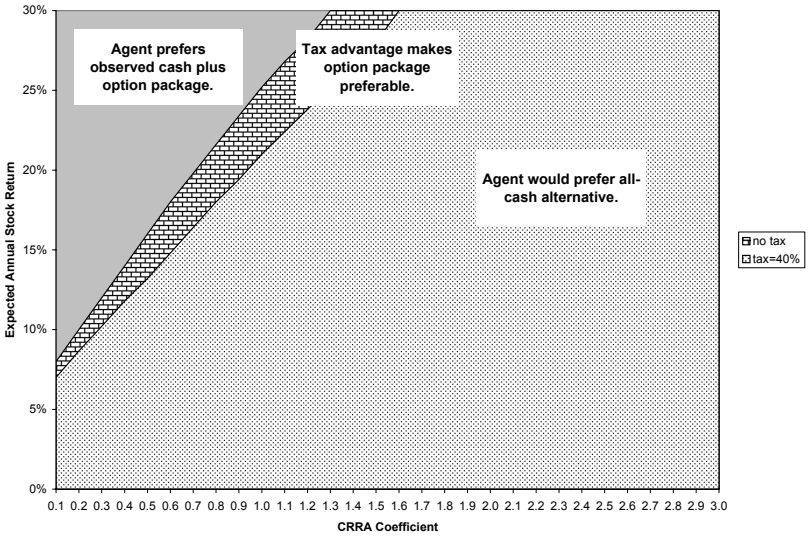

Figure 3: Med-Large firm employee's preferences over compensation plans for different values of r^* and ρ.

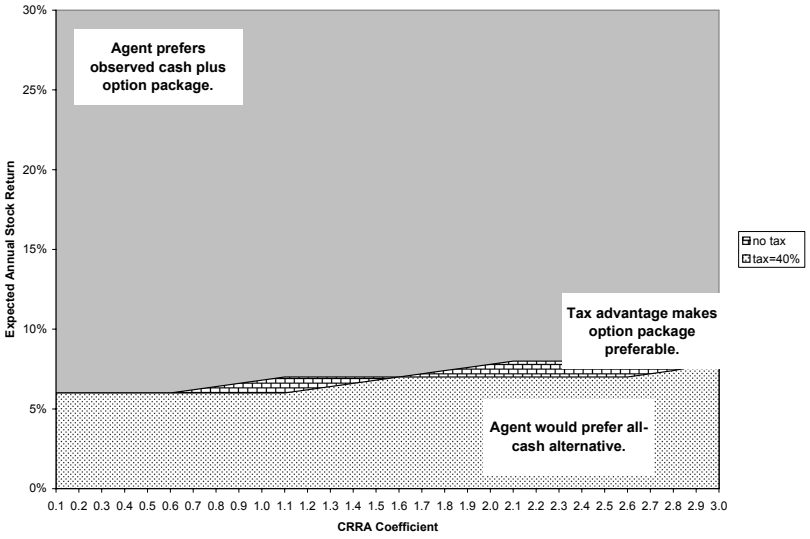

Figure 4: Large firm employee's preferences over compensation plans for different values of r^* and ρ.

We highlight two additional implications of the sorting explanation. This model suggests that if employees' expectations about firms' equity returns change, firms option-granting behavior should change as well. If, for example, employees suddenly expect negative returns to their employers' equity, then no firm will offer option-based pay, since employees would demand a premium over the market value of the cash and securities. Second, the distributional implications of this sorting explanation may be markedly different from those of the incentive and retention stories. Under the incentive and retention explanations, employees earn (*ex ante*, at least) their reservation utilities. If, on the other hand, employees accept options as part of compensation because they are naively optimistic regarding employers' stock returns, then firms benefit at employees' expense.

4.3 Retention

We now consider Oyer's (2002) explanation of option-based pay as a means for indexing the value of employees' deferred compensation to their outside options. Our approach here is motivated by the following observation: If options are intended to help firms index wages to market conditions, then short-run variation in the value of option packages must be of the same order of magnitude as short-run variation in spot wages. Given our detailed NCEO data on option grants, we can compute

the short run variation in the value of option packages, and use this to infer firms' expectations regarding wage variation.

We adjust the timing of our discussion somewhat to reflect the additional complexity of this model. Whereas previously we allowed one period in our model to represent four calendar years, we now assume that one period represents one calendar year. We assume a firm hires an employee at time $t = 0$. Between $t = 0$ and $t = 1$, one of three states of the world is realized. With probability q_g (equal to $\frac{1}{3}$ in most of our calculations), industry conditions are revealed to be "good," while conditions are "bad" with probability q_b (again, equal to $\frac{1}{3}$). Conditions are "unchanged" with probability $1 - q_g - q_b$. The firm operates until time $t = 4$, and then the model ends.

Industry conditions affect both labor and financial markets. If industry conditions are good, then the employee could, at time $t = 1$ obtain a job offer from another employer that pays wage S_g. If conditions are unchanged or bad, then the best offer the employee can get is S_u or S_b, respectively, with $S_g > S_u > S_b$. Share prices are affected as follows:

$$\begin{aligned} \mathrm{E}[v_1 \,|\, \text{Good state}] &= v_g \\ \mathrm{E}[v_1 \,|\, \text{Unchanged state}] &= v_u \\ \mathrm{E}[v_1 \,|\, \text{Bad state}] &= v_b. \end{aligned}$$

We let the unconditional expectation of v_1 equal v_u, which implies $q_h(v_g - v_u) = q_b(v_u - v_b)$. Unlike above, here there is no difference in opinion between firm and employee as to the firm's expected return. We also assume

$$\mathrm{Var}[v_1 \,|\, \mathcal{S}] = \frac{3}{5}\sigma^2$$

for each state $s \in \{g, u, m\}$. In words, the variance of firm value conditional on industry prospects is equal to 60% of the unconditional variance, which means 40% of the total variance is determined by industry conditions.[22] To compute the v values, we first assume an expected rate of return, r, on the firm's shares. This determines v_u, as $\mathrm{E}[v_1] = v_u = (1 + r)v_0$. We then solve for magnitudes v_g and v_b so that the unconditional variance of the firm's return is equal to σ^2.

[22] This figure 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^2 of these regressions varied from quite low up to 70% or more. Because a stock market index likely does not capture the precise set of firms competing in a given labor market, we take these R^2 figures to be a lower bound on the common variation in returns of firms within a labor market. In any case, we experimented with other values and found that it made surprisingly little difference. The convexity of the option value/stock value relationship roughly offsets the concavity in the employee's utility function when the employee's ρ is equal to 3. In most cases when ρ is one, an increase in idiosyncratic risk actually makes options more cost effective.

When making hiring decisions, the firm must decide between offering spot wages and offering an option-based package. If the firm chooses spot wages, then it pays the employee S_u in the first year. If industry conditions then turn good, the employee seeks an outside offer prior to $t = 1$. The firm matches the offer and incurs transaction cost k in doing so.[23] If conditions turn bad, then the firm cannot adjust the employee's wage downward. After the first-period uncertainty is revealed, no further changes in industry conditions occur, and the employee works for three additional periods at the set wage. Hence, the expected cost to the firm of offering the spot wage job is

$$S_u + 3\Big(q_g S_g + (1 - q_g)S_u\Big) + q_g k.$$

An option-based compensation package consists of a salary S_{opt} and an option grant consisting of n options with initial Black-Scholes value $\mathrm{BS}(v_0)$. We assume that the employee decides whether to seek an outside offer after observing the realization of industry conditions, but before observing the realization of the idiosyncratic shock to his firm's value.[24] The firm designs its option package with the aim of preventing the employee from seeking an outside offer in any state of the world. If the good state obtains, then the employee will choose not to seek an outside offer if, in expectation, he values his compensation from his current job at more than that at the next best job. If the employee does not seek another offer, then he remains with the firm and does not exercise any options until $t = 4$. If the employee seeks an offer and takes it, then he exercises one-quarter of his options immediately. Thus, he will not seek an outside offer in state s if

$$\int_0^\infty \int_0^\infty U\Big(W + 5S_{opt} + n \max\Big[(v_4 - v_0), 0\Big]\Big) g(v_4 \mid v_1) f(v_1 \mid s)\, dv_4 dv_1 \geq \int_0^\infty U\Big(2S_{opt} + 3S_g + \frac{n}{4}\max[v_1 - v_0, 0]\Big) f(v_1 \mid s)\, dv_1, \tag{7}$$

where $f(\cdot \mid s)$ is the probability density function of the log-normal with mean v_s and variance $\frac{3}{5}\sigma^2 v$, and $g(\cdot \mid \cdot)$ is probability density function of the log-normal with mean $(1 + r)^3 v_1$ and variance $3\sigma^2 v$?[25] The firm prefers offering the option-based job to the spot wage job if

$$S_u + 3\Big(q_g S_g + (1 - q_g)S_u\Big) + q_g k > 4S_{opt} + \mathrm{BS}(v_0). \tag{8}$$

[23] Alternatively, the parameter k can be interpreted as a turnover cost — if the employee leaves, then the firm hires a new employee at the prevailing spot wage. Such a cost can arise from training or search.

[24] It may be more realistic to assume that the employee observes the value of the firm before determining whether to seek an outside offer. Under this assumption, the employee would seek an outside offer whenever the idiosyncratic shock to firm value is sufficiently negative. In designing its option package, the firm would need to choose under what realizations of idiosyncratic shocks it wants the option package to be large enough to retain the employee.

[25] Note also that we assume the employee's outside wealth to be equal to S_{opt}. Also, is this variance right?

These inequalities allow us to compute upper bounds on S_g, S_u, and S_b, and a lower bound on k. We also compute the "retention value" — that is, the Black-Scholes dollar value of options forfeited in the event the employee leaves —- under the good and bad industry states.

The first case we consider, with $r^* = 10\%$ and $\rho = 2.5$, suggest that contracting costs would have to be very large in order for a retention argument to explain option grants made by firms in columns (1) and (3). Costs associated with re-contracting or replacing a manager for the firm in column (1) would have to be $210,000 in order to justify the observed option grants. While human resource professionals say that replacement costs can be 25 to 50% of annual wages for some jobs, this $210,000 figure is clearly outside of this range.

The second case, 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 high (but not unreasonably so) at the firms in columns (1) and (3), the median is about $10,500. In addition, the model suggests that options can be used for retention purposes even if spot wages fluctuate just up or down 10% or so over a short period. Note that the firms in columns (2) and (4), due to relatively low volatility, can justify the use of options when spot wages vary by about $3,000 to $10,000 over a period of a few years at *any* positive turnover cost.[26] This second set of estimates suggests to us that the retention model can justify the use of stock options *if market wages for managers in this sample really vary by as much as Table 5 suggests.* That is, the turnover cost estimates seem quite plausible for many firms, as do the amount of retention value,

The third case combines the sorting and retention models, by assuming the employee is optimistic regarding the firm's share price. Here, the retention argument can explain option grants even if spot wages vary $5,000 to $40,000 over a short horizon. The retention values grow as employees value their holdings more highly, and the critical values of turnover costs fall below zero. Note that the assumptions underlying the retention model reinforce the sorting model because, by assuming stock options only expose the employee to idiosyncratic risk on the margin, they lower the risk premium the employee would otherwise need to be paid. We therefore believe that the last two subsections and the bottom part of Table 5 provide evidence that some combination of sorting and retention could be contributing to decisions to issue stock options firm-wide.

[26] All else equal, options are relatively more attractive to employees in this section's analysis than in section 4.2 because employees are exposed to some risk regardless of what form their compensation takes. If the firm offers the spot wage job, the employee's compensation will fluctuate due to changes in spot wages.

Table 5: Calibration — Retention

	Small Firm (20th pctile) (1)	Med-Small Firm (40th pctile) (2)	Med-Large Firm (60th pctile) (3)	Large Firm (80th pctile) (4)	Sample Median (5)
Annual Cash Compensation (from NCEO survey)					
	\$90	\$90	\$70	\$100	\$90.0
Case One: $r^* = 10\%, \rho = 2.5$					
Initial Spot Wage (S_u)	\$102.3	\$92.3	\$80.5	\$110.5	\$92.6
High Spot Wage (S_g)	\$105.1	\$93.5	\$81.9	\$114.6	\$93.7
Low Spot Wage (S_b)	\$96.3	\$90.9	\$75.7	\$106.5	\$90.5
Retention Value – High	\$164.1	\$9.7	\$182.8	\$33.4	\$71.0
Retention Value – Low	\$24.6	\$1.5	\$27.4	\$10.3	\$15.6
Transaction Cost (k)	\$210.5	-\$7.9	\$254.4	-\$52.8	\$33.3
Case Two: $r^* = 10\%, \rho = 1$					
Initial Spot Wage (S_u)	\$114.3	\$92.6	\$93.8	\$111.8	\$99.4
High Spot Wage (S_g)	\$125.9	\$94.2	\$104.7	\$116.6	\$104.6
Low Spot Wage (S_b)	\$100.3	\$91.0	\$80.3	\$107.1	\$91.6
Retention Value – High	\$164.1	\$9.7	\$182.8	\$33.4	\$71.0
Retention Value – Low	\$24.6	\$1.5	\$27.4	\$10.3	\$15.6
Transaction Cost (k)	\$39.7	-\$12.8	\$66.6	-\$69.9	\$10.5
Case Three: $r^* = 25\%, \rho = 1$					
Initial Spot Wage (S_u)	\$136.9	\$95.2	\$116.2	\$130.8	\$113.1
High Spot Wage (S_g)	\$157.1	\$97.7	\$136.0	\$139.3	\$125.3
Low Spot Wage (S_b)	\$114.2	\$92.5	\$94.0	\$122.2	\$100.6
Retention Value – High	\$185.0	\$11.0	\$206.0	\$41.9	\$81.8
Retention Value – Low	\$38.8	\$2.4	\$43.2	\$16.5	\$24.7
Transaction Cost (k)	-\$256.7	-\$46.6	-\$229.1	-\$309.2	-\$187.3

Risk-free rate is assumed to be 5%. Options assumed to expire in ten years and fully vest in four years. "Initial spot wage" is the implied market wage when middle manager receives the options grant and, if there is no common shock, one year later. "High spot wage" ("Low spot wage") is the implied maximum market wage for a middle manager one year after the options are granted and after a positive (negative) common shock. "Transaction cost" is the minimum expected costs the firm would incur over a four year period due to changes in the agent's compensation package and/or replacing the agent in order to justify the amount of stock options it grants to a middle manager. "Retention value" indicates expected Black-Scholes value (assuming he expects to exercise options four years after they are issued) forfeited if the employee takes the outside offer, given the value of the common shock.

5 An Alternative to Stock Options

To this point, we have compared stock options to providing more cash compensation. But firms can offer employees other rewards based on firm performance, including profit sharing and stock. Profit sharing is unlikely to be an effective compensation device at many of the firms in the NCEO sample, because many of them are unprofitable. However, firms could grant employees actual shares (which, in order to make them vest over a period of time, would actually come in the form of restricted stock.) We now compare the use of stock to stock options in each of the three models we previously considered, to see if the fact that these firms chose stock options helps distinguish between the theories.

We compare the effects of options packages we observe firms offering to the modeled effects of a firm issuing equally costly shares, where the options costs are based on Black-Scholes value (but, as before, the options are treated as expiring after four years) at the time options are granted and the shares are based on market value at time of issue. Shares and options may have advantages relative to one another that we do not capture. Most importantly, restricted stock grants reduce accounting earnings while stock option grants do not. If markets cannot perfectly account for these differences (or, even if markets can account for this, but manager remain fixated on accounting results), options and stock of equal cost may not have the same effect on stock price.

Figures 5 and 6 show some of the critical differences between stock and options for a single firm in the NCEO sample. We show the value of a middle manager's options if executed four years after they are granted. The graph also shows the value of the employee's stock holdings four years after the grant date, if the original grant had been in stock and if it had cost the firm the same as the option grant cost. That is, the "stock value" line in the graph assumes that, instead of giving the employee an option grant, it gave him a stock grant which had the same initial value as our estimate of the value of the option grant we observe. The third line in the graph is the probability density function of the stock price four years after the share or option is granted. Figure 5 shows the value and price distribution for a firm in the NCEO sample that has stock volatility of 0.3. Figure 6 shows what the values would be if that firm had volatility of 0.75.

As the graphs make clear, for a substantial portion of the probability distribution, the value of the stock is higher than the value of the options. The stock value is higher than the option value at $t = 4$ with 46% probability when volatility is 0.3 and with 78% probability when volatility is 0.75. The potential advantage of options is that at extremely high stock returns, they yield a far higher value than stock. The fact that, over much of the probability distribution, options are valued lower than stock (in fact, there is a substantial probability that the options will be worthless) and the fact that options are worth more at wealth levels where risk averse employees have lower marginal

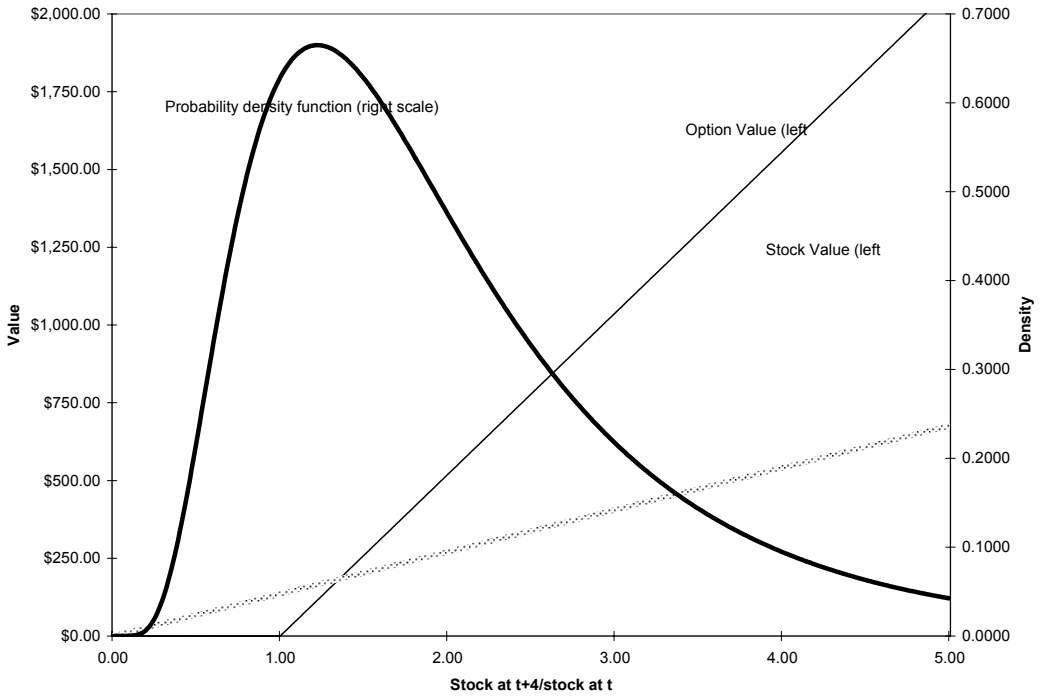

Figure 5: Comparison of Stock and Option Values when Stock Volatility is 0.3

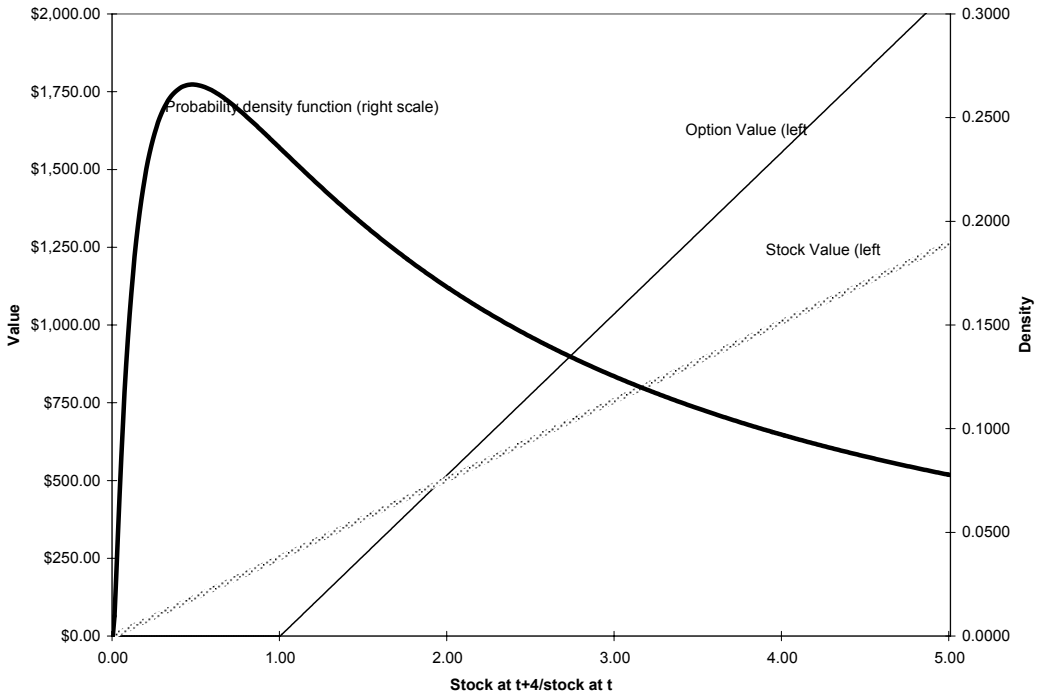

Figure 6: Comparison of Stock and Option Values when Stock Volatility is 0.75

utility of wealth indicate that firms are paying a higher risk premium for using options than they would pay if they issued stock.[27]

The graphs also show one way the moral hazard model could potentially overcome the increased risk costs associated with options relative to stock – through a steeper performance/wealth relationship. Firms get more incentive bang for the buck using options because the marginal increase in wealth per unit increase in performance is greater for options. The trade-offs between incentives and risk make it unclear whether options or stock would be preferable if moral hazard were causing firms to offer equity incentives to their middle managers. But we do not believe this comparison of stock and options provides any significant evidence to contradict our earlier conclusions that firms do not offer stock options to their middle managers as an incentive mechanism.

The comparison between stock and options is more informative when considering the sorting model, however. Switching from options to stock grants has the benefit of lowering the risk premium in the sorting model, while lowering the expected rewards if the firm's stock ends up performing very well. When considering the case where the employee expects an annual stock return of 10% and has a risk aversion coefficient of 1, the median worker's after-tax four year compensation if paid through cash and stock would have a certainty equivalent of $3,000 higher (that is, $306,000, rather than the $303,300 in column (5) of Table 4) than if the employee received stock options. This difference is similar when the employee expects a stock return of 25%, but it is reversed in the most optimistic scenario (expected annual stock return of 40%.) It appears that that, if sorting is a contributing factor to firms' decision to grant stock options to middle managers, the fact that firms issue options instead of shares suggests that employees have fairly substantially inflated expectations of their employers' stock return.

As with the other models, switching from options to stock would have the benefit of reducing the employee's risk premium under the retention model. However, this may be offset by the fact that options are more effective than stock at making the retention value of unvested securities more responsive to market conditions. That is, the difference between the value of options if the market gets a positive shock (and the employees get more attractive outside offers) and the value of options if the market gets a negative shock is greater than the difference in the values of stock. We quantified these offsetting effects by redoing the analysis in Table 5 assuming each middle manager received stock rather than options. We consider the middle scenario from Table 5 where the expected stock return is 10% and $\rho = 1$. Because the risk premium is significantly lower with

[27] See Jenter (2002) for a fuller elaboration of the implications of the inverse correlation between the marginal utility of wealth and the pay-for-performance sensitivity of stock options.

stock grants, any positive turnover costs would justify issuing stock at the median and average firm. That is, the lower bound on k is negative. However, the retention value in the low state is now \$35,000 at the median firm, an increase of \$10,000 from the option estimates. The median retention value in the high state increases by \$9,000 to \$89,000. The firm may less effectively tie the value of an employee's equity holdings to market wages if it switches from options to stock, especially in states of the world when the workers are not receiving attractive offers.

It is hard to draw very firm conclusions when comparing observed option contracts to hypothetical stock grants because the "equal cost" grants we model are unlikely to be the actual choices made by the firm if they switched to options. Also, we do not have enough information to accurately assess the effect of such a switch on firm profits in the moral hazard and retention models. Nonetheless, we think this section makes it clear that, if the sorting model is important, firms are counting on very high levels of employee optimism. We think it neither strongly supports nor negates the other two models. In particular, it does not provide evidence to contradict our previous dismissal of the idea that options provide important incentives to middle managers.

6 Cross-Firm Variation in Option Plans

In this section, we analyze cross-sectional variation in option plan adoption using each of our three data sets. Our general approach is to estimate a series of logit models using our indicators for option plan adoption (as defined in Section 2 above) as dependent variables.

6.1 BLS Sample

We begin with our BLS sample. One important explanatory variable for this analysis, establishment employment, is available in the BLS dataset. However, because of the confidentiality restrictions surrounding the BLS data, many of our other explanatory variables are based on characteristics of the firm's industry rather than the firm itself.

Using the BLS Occupational Employment Survey (OES), we compute a number of measures of wages and employment in the firm's industry. First, we calculate the 1998-1999 employment growth rate for each industry.[28] We then generate three indices of industry wages. The first index is simply the average hourly wage in the industry.

[28] Throughout this section, we define industry at the 2-digit SIC level, except in calculating industry volatility. We reran the analysis using 3-digit industries and using MSA, rather than state, variables. The results were not materially different from those presented.

We refer to the second as the "occupation-adjusted wage index." To construct this measure, we compute, for each occupation employed by a given industry, the ratio of the average wage paid to people in that occupation in that industry to the average average wage paid to people in that occupation across all industries. The index is the average ratio within an industry, weighted by employment. An occupation-adjusted wage index greater than one suggests the industry, conditional on occupation, tends to pay well. [29]

We refer to our third index as the "occupation wage index." We construct this measure by computing the average (weighted by industry employment) of the economy-wide average hourly wage for each occupation. This index does not capture anything specific about the pay practices of the industry, but instead reflects whether an industry tends to employ highly skilled people with high outside options.

Oyer's (2002) model suggests that firms will be more likely to issue stock options to non-executives if the common shocks (industry volatility) are greater and if the stock return of a firm is more closely tied to that of its competitors. To assess this, we compute two measures of the importance of industry effects in firms' share prices. First, we calculate "industry volatility" as follows: we calculate average industry (2-digit SIC code) return each month using all firms in CRSP.[30] We then define industry volatility as the standard deviation of the monthly industry return. To construct "industry volatility share," we first run regressions of each CRSP firm's monthly returns on industry returns.[31] We average the R^2 from these regressions and define this as the industry volatility share. Finally, we use the 1997 Economic Census to compute a number of geographic variables, including the average pay in each state and average pay in each state/industry combination.

Table 6 presents results of logits using the option grant indicators "Any Options" and "Broad Plan" as dependent variables.[32] Displayed coefficients are the marginal effect of an increase in the independent variable on the probability of a plan. Columns (1) and (2) include the full sample, while columns (3) and (4) focus on the 349 establishments that are part of publicly traded companies.

[29] The industries with the three highest occupation-adjusted wage indices are Securities Brokers, Commodity Brokers, and Air Transportation. The three lowest are Video Tape Rental, Variety Stores, and Child Day Care Services.

[30] Here, we use the industry return observation only if it is based on at least eight firms.

[31] For inclusion here, we require firms to have twelve observations of monthly returns.

[32] We also experimented with a third dependent variable, "Any Non-Executive," that indicated at least one employee who the firm did not consider an executive (that is, a key decision maker) was granted stock options in 1999. Results were comparable to those presented in Table 6.

While larger establishments are more likely to grant options to some employee, they are no more likely to have broad plans. This may indicate that large establishments are likely to have executives present, and that executives are disproportionately likely to receive options.

In the sample that includes all establishments, both the occupation-adjusted and the occupation wage indexes are positively related to all three measures of stock option plans. However, the raw average wage is negatively related to option grants. This suggests that options are granted in skill-based industries — that is, industries that employ high-wage occupations, and that pay well conditional on the occupation mix. The fact that lower wages, when not occupation adjusted, are associated with a greater tendency to grant options may reflect options substituting for salary. Because these relationships do not consistently hold up in the public subsample, they could just indicate which industries are more likely to have firms that go public.

The BLS sample exhibits a negative relationship between industry-level variance and stock option grants. As shown below, this result is reversed in the EDGAR and NCEO samples, suggesting that, though options may increase in risk among those firms in a pool of possible options grantors, they are decreasing in risk in the broader economy. It appears that many low risk industries tend to have small local establishments (and so are not in the NCEO or EDGAR samples) and ownership is not shared with employees. However, it does appear that, as predicted by Oyer's (2002) model, options are more common in industries where the risk across firms is relatively common.

The most striking result concerns the explanatory power of the "New Economy" indicator. In all specifications, new economy firms are significantly (both statistically and economically) more likely to grant options than other firms. In the sample of all establishments, for example, the coefficient of 0.0385 indicates that new economy firms are about two and a half times as likely as other firms to make a grant. Controlling for new economy masks other potentially interesting effects. When we do not include the new economy indicator, we find a positive and significant relationship between local wages, local industry wages, and options grants. Similarly, without the New Economy indicator, we find firms in high wage states and especially in high wage industries in high wage states are more likely to issue stock options.

The results in this section suggest that the use of stock options differs systematically with local wages, with the skill levels of workers, and with the amount of risk that is common across firms in an industry. While these results are generally consistent with Oyer's (2002) model, they are not strong enough nor are the predictions of the models we consider distinct enough for us to positively distinguish among competing explanations.

Table 6: BLS Option Plan Logits

	All For-Profit Establishments		Publicly Traded Subsample	
Dependent Variable	Any Option	Broad Plan	Any Option	Broad Plan
	(1)	(2)	(3)	(4)
Log Employees	0.0041	-0.0007	0.0380	-0.0093
	(0.0020)	(0.0015)	(0.0159)	(0.0072)
Occup-Adj Index	0.0731	0.0276	-0.4621	-0.2056
	(0.0358)	(0.0274)	(0.6337)	(0.3415)
Occup Wage Index	0.0874	0.0389	0.0433	0.1930
	(0.0364)	(0.0302)	(0.8325)	(0.5405)
Log Industry Wage	-0.0750	-0.0240	0.0303	0.0652
	(0.0331)	(0.0240)	(0.7120)	(0.4096)
Industry Growth	-0.0125	-0.0129	1.1092	0.4452
	(0.0392)	(0.0202)	(0.6425)	(0.3589)
Industry Volatility	-0.0405	-0.2402	-2.2658	-2.0602
	(0.1676)	(0.1166)	(1.1829)	(0.8877)
Industry Vol Share	0.1558	0.0787	1.3000	0.4416
	(0.0765)	(0.0356)	(0.4721)	(0.2468)
Log State Pay	0.0194	0.0098	-0.4786	-0.2201
	(0.0167)	(0.0076)	(0.2477)	(0.0949)
Log State/Ind Pay	-0.0008	-0.0051	0.2045	0.0021
	(0.0089)	(0.0061)	(0.1219)	(0.0947)
New Economy	0.0385	0.0175	0.7894	0.2886
	(0.0137)	(0.0089)	(0.2389)	(0.1306)
Pseudo-R^2	0.2988	0.4511	0.4308	0.6191
Sample Size	1325	1325	349	349

See notes to "Any Options" indicates at least one employee at the establishment was granted stock options in 1999."Broad Plan" indicates at least 20% of employees at the establishment were granted options in 1999. Sample include all firms for which 2-digit SIC industry information was available. Coefficients are marginal effects on the probability that the firm has a plan. Standard errors (in parentheses) allow for heteroskedasticity and within-industry correlation.

6.2 EDGAR Sample

We next analyze cross-sectional variation in option plan adoption using our EDGAR data. We estimate a series of logit models using "SEC Plan", as defined in Section 2, as our dependent variable. Explanatory variables include log of the number of employees at the firm as a whole, growth in number of employees from 1997 to 1998, an indicator for positive net income, monthly firm stock volatility, industry fixed effects, an indicator for the new economy, industry volatility, and industry volatility share.

To verify that our findings are not sensitive to the definition of our dependent variable, we define two additional indicators of option plan adoption. A second indicator, SEC Plan2, equals one if the Black-Scholes value of options granted per non-executive employee in 1998 was at least $2,500. Option grants are disproportionately made to new employees, so we construct a third indicator — SEC Plan3 — that adjusts for the possibility that option granting behavior depends on employment growth. We assume that all non-executive grants are given to new employees, and estimate the number of new employees to be the sum of the 1997 to 1998 increase in employment and 10% of the 1997 employment. We then set SEC Plan3 equal to one if the Black-Scholes value of options granted to each new employee is $5000. Since these additional variables are constructed using the market value of options granted, they are, by definition, related to firm and/or industry volatility. In regressions using these variables, we omit firm and industry volatility, and use "industry volatility share" as a measure of the importance of common shocks.

Results are in Table 7. Firms with more employees are significantly less likely to have broad stock option plans. A firm with 10% more employees than another firm is about one percentage point less likely to have a broad-based plan.[33] A firm with volatility that is 10 percentage points higher than another firm is more likely by 12 percentage points (that is, the probability increases by about one third) to have a broad plan. New economy firms have a 32 percentage point higher probability of using a broad-based plan, holding the other factors in column (1) constant. Having positive net income is associated with a 14 percentage points lower probability (that is, it drops by approximately a third) of implementing a broad-based stock option plan. One possible explanation for this would be that, if a firm has stable profits and wants to tie worker pay to firm performance, it may prefer to use profit sharing because it passes less risk along to employees. These results are

[33] Core and Guay (2001) report the opposite result, namely that the value of options grants per employee increases with firm size. Recall from our discussion in Section 2 that they define any option grant to an employee other than the five highest paid executives as a grant to a "non-executive." When we apply their definition, we also find that the likelihood of broad option plans increases with firm size. Thus, it seems their finding may be indicative that non-top five executives receive larger option grants at larger firms.

largely unaffected by including two-digit SIC dummies.

Columns (3) through (6) introduce the two variables meant to explore Oyer's (2002) prediction that plan adoption will increase in industry volatility and as common industry shocks grow relative to idiosyncratic firm shocks. The results in column (3) are consistent with the first of these predictions because, holding individual firm volatility constant, we find that industry volatility is positively and significantly associated with plan adoption. Columns (5) and (6) support the second prediction because options plans are more common at firms in industries where more of a typical firm's volatility can be explained by industry effects, though this finding is not supported when looking at the SEC Plan measure of broad plans.

6.3 NCEO Sample

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. 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.

Table 8 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 higher market values than 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 over half of the plan firms are in the new economy, compared to about 15% of the non-plan firms.

Table 7: EDGAR Option Plan Logits

Dependent Variable	SEC Plan	SEC Plan	SEC Plan	SEC Plan	SEC Plan2	SEC Plan3
	(1)	(2)	(3)	(4)	(5)	(6)
Log Employees	-0.0859	-0.0965	-0.0886	-0.1079	-0.1404	-0.1337
	(0.0124)	(0.0159)	(0.0151)	(0.0192)	(0.0147)	(0.0154)
Employee Growth	0.0381	0.0439	0.0370	0.0407	0.0088	0.0037
	(0.0283)	(0.0343)	(0.0288)	(0.0360)	(0.0099)	(0.0111)
Firm Volatility	1.2172	1.2648	1.0047	1.2835		
	(0.3032)	(0.3776)	(0.3737)	(0.4560)		
New Economy	0.3241		0.2992		0.2846	0.1897
	(0.0575)		(0.0681)		(0.0528)	(0.0538)
Positive Net Income	-0.1538	-0.1721	-0.1370	-0.1622	-0.0970	0.0260
	(0.0483)	(0.0558)	(0.0574)	(0.0646)	(0.0483)	(0.0532)
Industry Volatility			1.4383			
			(0.8367)			
Industry Volatility Share			0.0159	0.1115	0.5932	0.2724
			(0.1683)	(0.2005)	(0.1493)	(0.1545)
2-digit SIC dummies	No	Yes	No	Yes	No	No
Pseudo-R^2	0.2614	0.2723	0.2527	0.2582	0.2792	0.1880
Sample Size	775	775	584	584	578	520

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 annual reports 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. "New Economy" indicates primary SIC code is 3570-3579, 3661, 3674, 5045, 5961, or 7370-7379. Coefficients are marginal effects on the probability that the firm has a plan. Standard errors (in parentheses) allow for heteroskedasticity and within-industry correlation.

Table 8: NCEO Sample Summary Statistics

	All Firms	Option Plan	No Option Plan
	(1)	(2)	(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	$6,625	$7,449	$5,986
12/99 – ($MM)	(29,095)	(34,184)	(24,531)
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%
New Economy	37.4%	56.7%	15.3%
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 firms 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. "New Economy" indicates primary SIC code is 3570-3579, 3661, 3674, 5045, 5961, or 7370-7379.

Table 9 shows the results of logits where the dependent variable is 1 for plan firms and 0 for non-plan firms. As in the EDGAR sample, 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 percentage points 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 new economy and firms founded in the 1990s are significantly more likely to have option plans. The coefficients on each of these are quite large, indicating that either one of these characteristics are associated with a 30 percentage point increase in the likelihood that a firm will adopt an options plan.

We believe that Tables 6-9 are consistent with both the sorting and retention models, but they provide little reason to reverse our belief that incentive effects are not important in broad-based option plans. 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 effects of the number of employees on incentives dissipate quickly as a firm grows and that these firms are generally above the level where we would expect such an association between size and incentives. Also, the dramatically higher volatility of plan firms contradicts every "informativeness" agency model, unless plan firms can somehow select on significantly more risk tolerant employees than non-plan firms.

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 reflect more variation in employees' beliefs about the firm and smaller firms may find it easier to attract enough employees with favorable opinions of the firm's prospects. Also, there may be more variation in employees' beliefs about new firms and, at least in the late 1990s, about internet-related firms. The fact that firms with higher volatility and in the new economy are more likely to have option plans could also be consistent with the retention model if market wages vary more for volatile firms or firms in the new economy. Also, the difficulty in hiring enough talented employees in the new economy in recent years was well-documented in the business press, so the new economy coefficients are consistent with Oyer's (2002) prediction that options will be more common when labor markets are tight.[34]

[34] 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 employee share decreases in firm size and Black-

Table 9: NCEO Sample Logits

	(1)	(2)	(3)	(4)	(5)	(6)
Log Employees	-0.1345	-0.1412	-0.1263	-0.1863	-0.0918	-0.0900
	(0.0134)	(0.0408)	(0.0472)	(0.0613)	(0.0361)	(0.0360)
Log Sales		0.0132	-0.0070	0.0433	-0.0380	-0.0238
		(0.0356)	(0.0401)	(0.0493)	(0.0318)	(0.0322)
Volatility			1.7633	1.1813		
			(0.6232)	(0.7736)		
New Economy					0.3114	0.2897
					(0.0680)	(0.0686)
Founded 1990 or later						0.3309
						(0.0894)
2-digit SIC dummies	No	Yes	No	Yes	No	No
Pseudo-R^2	0.2329	0.3385	0.3017	0.3123	0.2964	0.3240
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). "New Economy" indicates primary SIC code is 3570-3579, 3661, 3674, 5045, 5961, or 7370-7379. Standard errors in parentheses. Coefficients are marginal effects on the probability that the firm has a plan.

7 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 stock options appear to be an incredibly inefficient means of providing incentives to employees. By calibrating an agency model to data on actual grants of stock options to middle-level employees, we computed that risk premia associated with these grants are typically several orders of magnitude larger than the cost to employees of the resulting increases in effort. Our calibrations suggest that, if a typical firm in our sample were granting options to middle managers as a means of inducing them to increase effort, the firm would be paying each employee many thousands of dollars in risk premium in order to generate added effort that the employee values at less than $100. We conclude, based on these calculations, that stock options are an inefficient incentive mechanism for middle managers.

Though we cannot conclusively determine how important either model is, we interpret our analysis as consistent with both the sorting and retention 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.

We believe that neither accounting treatment of option grants, cash constraints, nor any of the three models we examined in this paper can single-handedly explain the use of broad-based stock option plans. The belief that the accounting treatment of options is solely responsible for their widespread use seems inconsistent with the cross-sectional variation in adoption of option plans and with the fact that so many firms with broad plans have been successful for long periods. As we discussed in Section 3.4, employees are too expensive a source of capital to justify the cash constraints explanation. We believe our estimates in Section 4.1 rule out the incentive model as a primary (much less exclusive) justification for broad option plans. We think that the evidence

Scholes value increases in stock volatility. Aside from these mechanical relationships, we found no correlations.

in this paper suggests that sorting or retention may be first-order determinants of a typical firm's decision to adopt a broad-based stock option plan. But we think neither of these explanations can stand completely on its own. The sorting model begs a critical question of why firms and employees would agree to make employees' beliefs part of an inflexible employment contract, given that the tax advantages of using options are not very large relative to cash compensation. We also believe that, while we have demonstrated that stock options can be a useful tool for making compensation vary with an employee's market wage, it is a fairly crude tool for this purpose. If firms got no other benefits from option grants besides savings on the costs of adjusting compensation agreements, it seems likely they would try to find more specialized measures of employee's market value that did not expose the employee to so much idiosyncratic firm risk. It is therefore our belief that the firms that adopt broad option plans are those where the returns to cost effectively attracting and retaining employees is particularly high. But those firms may well choose option plans (as opposed to stock grants, profit sharing, or other pay mechanisms) as a means towards these ends for secondary reasons such as accounting treatment or a need to find a simple metric upon which to base pay.

One factor that we did not analyze is how our analysis would differ if people care about their relative status. That is, we think it is also worth considering the use of stock options when employees care about their relative wealth or income (as in Frank (1984) and Encinosa, Gaynor and Rebitzer (1997) .) 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. [35] 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 do not know of a tractable and sensible model along these lines that we could subject to empirical analysis.

[35] Alternatively, even if employees do not care about relative wealth, they may have convex segments of their utility function. Zabojnik (2002) explores the implications of such a model.

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