# 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 on firms' stock option grants to middle managers from three distinct sources, 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 appear consistent with the data.

# 1  Introduction

The use of stock option grants in compensation plans for middle- and lower-level employees has attracted ample attention in recent years. The increasing prevalence of this practice presents a challenge to economists interested in firms' relations with their employees.[1] Because the eventual value of a stock option is tied to the value of a single 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, options may be a useful mechanism for retaining employees because options can index employees' deferred compensation to their outside opportunities.

We gather data from three distinct sources and seek to determine which explanation 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

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[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 two distinct empirical methods to distinguish between the theories proposed above. First, we devise economic models of each theory, and 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 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.

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. This finding confirms the intuition that observed option grants are too small to provide strong incentives for middle-level managers. We conclude that middle-manager options are sensible for incentive purposes only under a very limited set of circumstances — namely, if employees can take actions that have very large value implications for the firm, the costs to the employee of taking these actions is very small, and it is extremely difficult for firms to observe whether employees are taking these actions.

Our results are far more 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 twenty thousand dollars within a few years, firms may find it more cost effective to issue stock options to middle managers than to try to adjust wages as market wages fluctuate. Finally, we interpret our cross-sectional results as further evidence consistent with options creating

attraction and retention benefits. Specifically, 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.

Two recent papers, Core and Guay (2001) and Kedia and Mozumdar (2002), study factors that affect option grants to non-executives. These papers use a cross-sectional approach that is methodologically similar to our logit analysis. Both these papers, however, define "non-executives" as any employee other than the five highest-paid executive officers. At the cost of imposing some assumptions on the distribution of grants within firms, we attempt to improve on this definition so as to better capture grants to employees who are not senior managers. This difference in approach, as well as the insights we gain from our calibrations, lead to different conclusions. For example, Core and Guay (2001) and Kedia and Mozumdar (2002) conclude that firms' option-granting decisions are driven, at least in part, by concern for the provision of incentives.

Other authors, including Sesil, Kroumova, Blasi and Kruse (2002) and Ittner, Lambert and Larcker (2003), 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 takes adoption as given. Sesil et al. (2002) study differences in financial outcomes for firms with and without stock options. Ittner et al. (2003) 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 first examine the incidence of broad-based stock option plans, using two distinct sources of data. 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 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, this 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 this source to 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] Just 2.7% of U.S. establishments granted stock options to non-owners in 1999. 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 employees at a firm are eligible for stock option grants. We cannot compute a directly comparable measure using the BLS data, because 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

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[2]The BLS data is available only 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." Technically, anyone holding a share of stock is an owner. It appears, however, that respondents interpreted "owner" as owner/operators, rather than as anyone holding shares.

[4]In computing these Black-Scholes values, we assume all options expire in ten years. Also, because we do not observe the identity of the individual firm, we cannot use historical stock volatilities or implied volatilities from actual

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.

terms of the number of highly paid workers, than establishments in the sample as a whole. Not surprisingly, so-called "new economy" firms are 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. 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.[6] 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 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.[7]

We begin by constructing an estimate of the number of options granted to non-executives. Core and Guay (2001) and Kedia and Mozumdar (2002) define non-executive stock option grants as

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option markets to value these options. Instead, we use 2-digit SIC-level averages of stock volatilities.

[5]Largely following Ittner et al. (2003), 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 (2003) list with codes 3575, 7375, and 7379 because the EDGAR and NCEO firms in these industries are internet-related.

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

[7]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 attempts to maximize the number of NCEO sample firms for which we accurately predict option plan status.

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.[8] 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.

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.[9] 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.[10] New economy firms make up a substantial portion of the firms with

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[8]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, Staples was not among Belden's five highest paid executives, even though, according to the firm's annual report, she was still employed in the same position. Belden was not obligated to disclose any information about options granted to her during 1999. The method of Core and Guay (2001) and Kedia and Mozumdar (2002) would attribute any options granted to her in 1999 as a "non-executive" grant.

[9]In Section 5 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.

[10]Our adjustment to Core and Guay's (2001) method of measuring grants to non-executives appears to be im-

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.

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 Empirical Implications

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 implications of each model to motivate the empirical analysis that follows.

## 3.1  Incentives

We first describe an incentives-based justification for use of equity in compensation. Suppose the value of the firm, $V$, depends on an employee's effort, $e$, as follows:[11]

$$V = ve + \epsilon_v,$$

where $\epsilon_v$ is a normal random variable with mean zero and variance $\sigma_v^2$. Let the employee be risk averse with coefficient of absolute risk aversion $\varphi$.[12] Suppose further that the employee has

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portant. Had we defined our SEC Plan variable similarly but without adjusting for possible grants to non-top-five executives, then we would have concluded that broad option plans are more common at larger firms. This suggests that Core and Guay's (2001) finding that option-based incentives for non-executives are stronger at larger firms may be an artifact of their data collection methodology. It may simply reflect that larger firms grant more options to non-top-five executives.

[11]Here, we follow the linear contracting agency model studied by Holmstrom and Milgrom (1987, 1991). 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. In our calibration below, we develop an agency model that is more closely tailored to the stock-option context.

[12]We denote by $\varphi$ a coefficient of absolute risk aversion, and by $\rho$ a coefficient of relative risk aversion.

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 features

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

This analysis yields the standard comparative statics of agency theory. The employee's share is higher when the variance of firm value, conditional on the employee's effort, is smaller; the marginal return to effort, $v$, is higher; the second derivative of the employee's cost of effort function, $c$, is smaller; and the employee is less risk averse.

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. Firms use many measures that reflect actions of individual employees. Agency theory suggests that if an individual employee's performance is measured less precisely, then the firm will substitute toward other measures, such as overall firm performance. Note the econometrician typically cannot observe the efficacy of individual 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 the absence of good measures of individual employee performance) 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 is typically higher for larger firms. Because of the difficulty in measuring theoretically important constructs such as the marginal return to effort and the variance of measures of individual 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 be an efficient means for providing 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. Traditional models of sorting (see, for example, Lazear (2001)) suggest firms may want to tie some employees' pay to firm performance as a means of attracting able employees to work at the firm. However, non-executives generally have sufficiently little effect on firm value that even a small amount of risk aversion would make the risk costs of options dwarf the benefits of this sorting. We therefore consider a model where employees are heterogeneous 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 three 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, if optimistic employees are relatively willing to invest in firm-specific human capital, to work hard, or are otherwise more productive, the firm needs to make options a condition of employment to insure more productive workers self-select into the firm. Second, there is a tax advantage. The employment relationship allows the employee to avoid paying taxes on the options until he exercises them.[13] This allows the options to compound tax-free (though the tax advantage is not large.) Finally, it may be that the firm can somehow reduce overall transaction costs by making these grants centrally.[14]

This explanation for firms' option granting behavior has several empirical implications. First, option grants will increase with employees' tax rates because the tax benefits of being paid in

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[13]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 has minimal effect on our analysis because the IRS restricts issuance of 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 (2003) for details on employer tax considerations in issuing options. We proceed under the assumption that the options we analyze are NQSOs.

[14]Employees may also gather inside information that enhances the value of the options they are granted (see Huddart and Lang (2003)). 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.

options will be greater. Given progressive income taxation, this suggests option grants should be greater to higher-paid workers. Second, option grants will increase in the variance of employees' beliefs about the value of options. If the variance of beliefs is greater, the firm will be able to extract a larger compensation discount from the most optimistic workers. Finally, firms will be more likely to grant options as the relative productivity of optimistic workers increases relative to other workers.

## 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.

The model in Oyer (2002) suggests an answer. 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. In Oyer's (2002) model, the adoption of broad-based stock option plans increases with the firm's costs of replacing workers, the variance of common shocks to firms participating in a given labor market, employee risk tolerance, and variance in local market wages.

## 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.[15] 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)) 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 much of this information is gathered. Second, even if a firm's employees are advantaged relative 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 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.[16]

### 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

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

[16]The uncertain prospects of many start-up firms are likely to make it difficult for them to reward employees through self-enforcing implicit contracts based on subjective measures of performance (see Bull (1987).) These firms may therefore substitute toward explicit contracts based on share prices. While we believe this explanation may be of some value in explaining the use of options in small startup firms, it cannot explain why a large, established firm would grant options to all employees.

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. This reasoning suggests that a corporate governance problem underlies firms' decisions to issue options, as the separation of ownership and control permits managers take to actions that owners would undo if they could.

We argue that this rationale for option usage is not solely responsible for the decision by firms to adopt broad-based option plans. We base this on several facts that together do not suggest a connection between lax corporate governance and broad option grants: (1) ownership of equity by Chief Executives rose dramatically during the 1990s (Murphy (2000)), which is the same time period as option grants to non-executives grew (Hall and Murphy (2003)), (2) many firms that do have broad plans (such as Microsoft and Oracle) are managed by founders with very large equity stakes, (3) corporate governance is no weaker (and perhaps somewhat stronger) among the types of firms (for example, small firms and technology-based firms) that we show below to be relatively likely to issue options broadly (Gompers, Ishii and Metrick (2003)), and (4) some privately held firms elect to issue stock options to employees.

Managers may not internalize the full cost of option grants to shareholders, and may, therefore, grant more than the optimal level of options. Given, however, that shareholders must directly approve broad-based stock option plans (but not the individual grants made under such plans), we proceed by studying potential economic justification for this practice.

## 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. For each of these firms, 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. This survey was not designed to cover a random sample of firms that might issue options, so we use the survey only to analyze characteristics of observed plans.

## 4.1 Incentives

We begin by considering an incentives-based explanation for stock option use. As 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 intuition underlying our incentives calibration is the following: If observed option grants are optimal, then the marginal benefit to the firm of making additional grants must equal 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 calculate 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 $(v_1)$.[17] 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 increases the mean of $v_1$ by \$1. Let $b$ be the fraction of any appreciation

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[17]While we model this as though the agent works in isolation, $e$ can be interpreted as the sum of all effort that is distasteful (on the margin) to the employee and can include monitoring of co-workers. Also, the mapping of $e$ to firm value can include complementarities across workers so that the marginal contributions of individual workers can be greater than the total firm value.

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 $\varphi$. 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 $\mathrm{E}(\tilde{x}) - (1/2)\varphi\mathrm{Var}(\tilde{x})$. 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 employee's first-order condition for effort is given by

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

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.

Assuming an interior optimum, the optimal option grant satisfies

$$\hat{e}'(b)\left( \int_0^{v_0} v_1 f_2\Big(v_1; \hat{e}(b)\Big) \, dv_1 + (1-b) \int_{v_0}^\infty v_1 f_2\Big(v_1; \hat{e}(b)\Big) \, dv_1 \right) = \varphi b \xi\Big(\hat{e}(b)\Big). \tag{2}$$

This equation has an intuitive interpretation. The left-hand side is the amount by which the value captured by the firm increases when $b$ increases 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 (1) and (2) 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

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of the employee ($\varphi$). 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 $c$, we then 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.[18] The assumption implies that the value (to the risk-neutral firm) of 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 $\sigma$ is the expected annual standard deviation of the firm's return.

For public companies in our NCEO sample, we estimate a historical value of $\sigma$ 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 $\sigma$ using the predicted level from a regression of $\sigma$ 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

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[18]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. 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.

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 employee cost-of-effort functions. 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 ($\rho$). 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 (that is, $\rho = 2.5$). 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, one from each employment size quartile, 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. Because one period in our model corresponds to four calendar years, we annualize all figures in our table by dividing by four. We also display the sample medians for all values in the table.

We focus first on the smallest firm, listed in Column (1). This firm has a small number of employees, and makes modest 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 $10,200, annually. The risk premium the employee attaches to his annual compensation on account of the option grant is $4,600. The annual cost to the employee of exerting this additional effort is $2.60.

The second calibration for this firm yields larger figures for effort and effort costs. To see the intuition for this, recall that our model solves for effort using the firm's first-order condition, which 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. For the small firm, the model indicates that the option grant causes a middle-level employee to produce an additional $50,600 annually, at annual risk and effort costs of $11,500 and $11, respectively. The third calibration also yields higher effort figures than did

| | Small Firm | Med-Small Firm | Med-Large Firm | Large Firm | Medians |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Employees | $< 50$ | $< 100$ | $\sim 300$ | 10,000+ | 180 |
| Middle Manager Salary | $38 | $100 | $90 | $90 | 90 |
| Employee Share ($b$) | 0.015% | 0.052% | 0.009% | 0.00011% | 0.0404% |
| Firm Value (April 2000 – $millions) | $< \$100$ | $\sim\$200$ | $\sim\$300$ | $>\$50,000$ | $230 |
| Stock Volatility ($\sigma$) | $> 75\%$ | $> 75\%$ | $< 75\%$ | $>50\%$ | 72% |
| Black-Scholes Value | $52 | $95 | $11 | $272 | $92 |
| | | | | | |
| Case One: $\rho = 1, c(e) = \frac{1}{2}ce^2$ | | | | | |
| Effort ($e$) | $10.2 | $9.3 | $0.18 | $63.5 | $8.71 |
| Cost of Effort ($c(e)$) | $0.0026 | $0.0014 | $0.000005 | $0.000023 | $0.0010 |
| Risk Premium | $4.6 | $4.3 | $0.088 | $22.6 | $2.76 |
| | | | | | |
| Case Two: $\rho = 2.5, c(e) = \frac{1}{2}ce^2$ | | | | | |
| Effort ($e$) | $50.6 | $35.9 | $0.457 | $1,511.5 | $148.5 |
| Cost of Effort ($c(e)$) | $0.011 | $0.0054 | $0.000012 | $0.0005 | $0.011 |
| Risk Premium | $11.5 | $10.9 | $0.22 | $56.5 | $6.92 |
| | | | | | |
| Case Three: $\rho = 1, c(e) = \frac{1}{4}ce^4$ | | | | | |
| Effort ($e$) | $31.7 | $29.1 | $0.683 | $223.5 | $28.5 |
| Cost of Effort ($c(e)$) | $0.0040 | $0.0023 | $0.000010 | $0.0004 | $0.0019 |
| Risk Premium | $4.6 | $4.3 | $0.088 | $22.6 | $2.76 |

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.

the first. The cost-of-effort function here is flatter, meaning employees are more responsive to low-powered incentives. For the small firm, the model indicates that the option grant causes a middle-level employee to produce an additional $31,700 annually, at annual risk and effort costs of $4,600 and $4, respectively.

Calibrations for the three other firms yield widely differing magnitudes. Our medium-large firm is notable in that it 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. Our largest firm makes grants with a large Black-Scholes value, but because the firm has a very large number of shares outstanding, the employee's resulting share ($b$) is very small. The model therefore infers that weak incentives must motivate employees to create a large amount of value. For this firm, the employee creates an additional $63,500 annually, at risk and effort costs of $22,600 and 2.3 cents.

We conclude from this exercise that the provision of incentives does not appear very plausible as an explanation for option-based pay. We reach this conclusion by comparing the risk premia and effort costs computed by our model. For example, in case one with our small firm, the option grant imposes risk costs on an employee of $4,600 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 if effort were contractible, the employee would be willing to exert this additional effort in exchange for a payment of $2.60. The largest firm in our table could avoid annual risk costs of $22,600 by paying the employee an additional two cents. 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 is the following: Couldn't the firm, at a cost of less than $22,600, devise *some other* means of identifying whether an employee has taken actions that increase the value of the firm at trivial cost to the employee, 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. The most favorable case that can be made for options-as-incentives is this: options are sensible for incentive purposes under a very limited set of circumstances — namely, if employees take actions that have large value implications for the firm, the costs to the employee of taking these actions is very small, and it is extremely difficult for firms to observe whether employees are taking these actions.

## 4.2 Sorting

We now consider the sorting model discussed in Section 3.2, where potential employees vary in their beliefs about the firm's prospects. The intuition underlying our sorting calibration is the following: If sorting drives observed option grants, then the employee must prefer receiving the observed option package to an all-cash compensation package that costs 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 assume the firm would be willing to offer the employee an all-cash package costing the same amount, and then compute the set of values for employee risk tolerance and beliefs as to the firm's expected return under which the employee prefers the observed option package to the all-cash package.

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 the employee exercises 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 $\sigma$ 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.[19] 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 $\tau_b = 40\%$.

Results are displayed graphically in Figures 1 through 4. To produce these graphs, 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 preference toward the option package. The four firms shown in the figures are the same four that we highlighted in Table 3.

We first consider an employee with coefficient of relative risk aversion 2.5 who expects his firm's share price to increase by 10% per year. At our small, medium-small, and large firms

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[19]While constant absolute risk aversion allowed us to simplify our analysis in the previous section, constant relative risk aversion is likely more realistic.
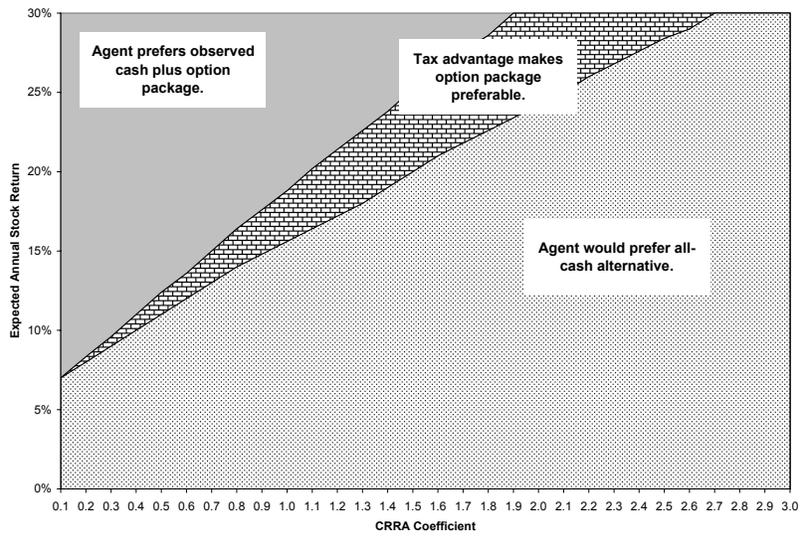
Figure 1: Small firm employee's preferences over compensation plans for different values of $r^*$ and $\rho$.
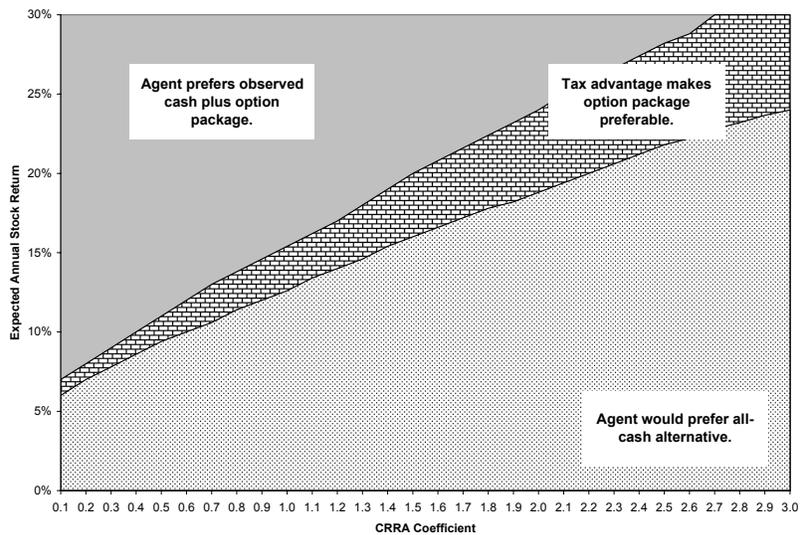


Figure 2: Med-Small firm employee's preferences over compensation plans for different values of $r^*$ and $\rho$.
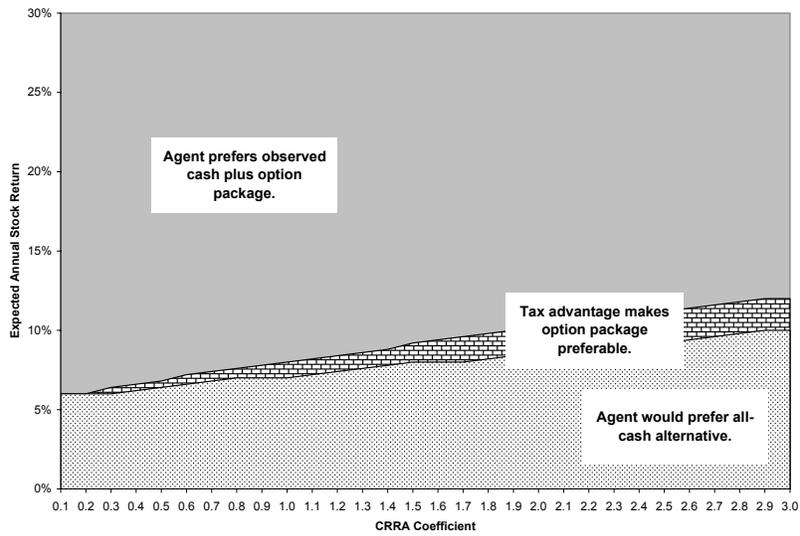
Figure 3: Med-Large firm employee's preferences over compensation plans for different values of $r^*$ and $\rho$.
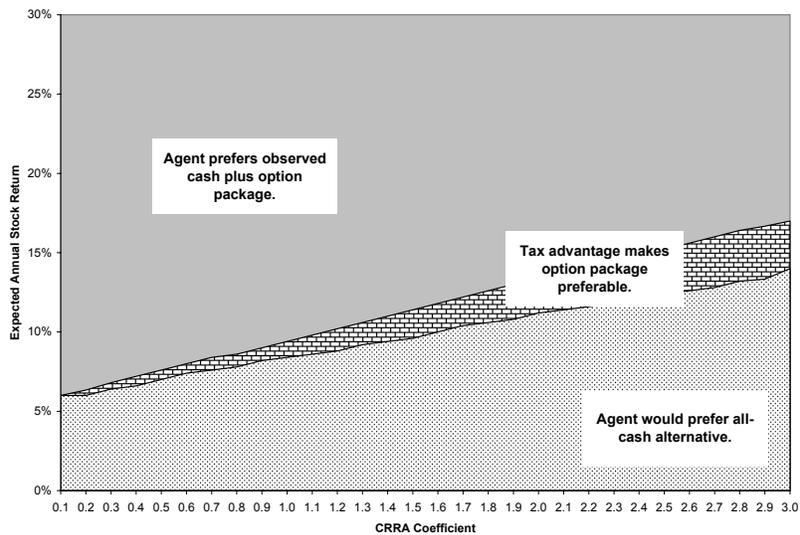


Figure 4: Large firm employee's preferences over compensation plans for different values of $r^*$ and $\rho$.

(Figures 1, 2, and 4), such an employee prefers an all-cash package costing the firm the same amount. The medium-large firm makes small option grants, and such an employee would prefer the observed salary plus option package because of the tax advantages. These conclusions do not change markedly when the employee is less risk averse. Lowering the employee's $\rho$ to 1 does not justify the use of options at the small, medium-small, or large firm, but the gap between the cost to the firm and the employee's valuation becomes smaller.

Next, 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 Figures 1 through 4 now prefer the option package, as do the employees at 205 of the 216 firms in our sample. While 25% 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.

As discussed in Section 3.2, one reason why firms may attach options to the employment relationship (as opposed to simply letting employees trade on their own accounts) is if optimistic employees are more productive. If this is the case, then our assertion above that firms are indifferent between offering observed option packages and an all-cash package costing the firm the same amount is inaccurate. Firms would strictly prefer the option package if granting it also attracts a more productive employee. In this case, we can use our estimates from Table 3 to provide an estimate of what level of productivity differences would justify the options grants in the NCEO data. The expected return in these estimates is 10%, suggesting the employee is only mildly optimistic. Depending on which firm we consider and what level of risk aversion we assume, optimistic employees would have to be anywhere from less than $100 to over $50,000 more productive annually. The required productivity differences at some extreme firms (especially the "large firm" in column (4)) seem implausible. However, the differences at the other firms and at the median firm appear consistent with the possibility that firms are willing to compensate optimistic workers for part of the risk premium of options compensation in order to attract more productive workers.

In general, we believe these results 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 (net of productivity differences) 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

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firms use options is consistent with sorting only if these firms hire a selection of very risk tolerant employees, if the firm can locate extremely optimistic employees, or if optimistic employees are significantly more productive.

## 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. The intuition underlying our retention calibration is the following: 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 $q_g$ ($q_b$), industry conditions are revealed to be "good" ("bad"). 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 $q_h(v_g - v_u) = q_b(v_u - v_b)$. We also assume $\mathrm{Var}[v_1 \,|\, s] = (3/5)\sigma^2$ for each state $s \in \{g, u, b\}$. 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.[20] To compute the $v$ values, we first assume

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[20]We experimented with other allocations of risk between firms and industries, but found that it made surprisingly little difference. The choice of 60% idiosyncratic risk is based on several regressions we ran of individual firm returns on the NASDAQ composite index or the Dow Jones Internet Commerce and Internet Service Indexes. In practice, the amount of idiosyncratic risk is often reduced by firms' lowering the strike price of options.

an expected rate of return, $r$, on the firm's shares. This determines $v_u$, as $E[v_1] = v_u = (1+r)v_0$. We then solve for magnitudes $v_g$ and $v_b$ so that the unconditional variance of the firm's return is equal to $\sigma^2$.

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.[21] 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 $BS(v_0)$. 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.[22] The firm designs its option package with the aim of preventing the employee from seeking an outside offer in any state of the world.[23] If the good state is realized, 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

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

where $f(\cdot \,|\, s)$ is the probability density function of the log-normal with mean $v_s$ and variance $\frac{3}{5}\sigma^2 v$, and $g(\cdot \,|\, \cdot)$ is probability density function of the log-normal with mean $(1 + r)^3 v_1$ and variance

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[21]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.

[22]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.

[23]This assumption — that turnover is never efficient — is a simplification. A more complex version of this model would trade off costs of adjusting wages with benefits of efficient matching.

$3\sigma^2 v$.[24] The firm prefers offering the option-based job to the spot wage job if

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

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 large at many firms in our sample in order for a retention argument to explain option grants made by firms in columns (1) and (3). In the event that spot wages increase, costs associated with re-contracting or replacing a manager for the firm in column (1) would have to be \$45,000 in order to justify the observed option grants.[25] While human resource professionals say that replacement costs can be 25 to 50% of annual wages for some jobs, our estimates for the small firm and the median firm are at the high end 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 or renegotiation costs necessary to justify the use of options. In all four firms in the table, for the median firm, and for a total of 134 of the 216 firms in our sample, our estimates suggest that firms benefit from using options even if they do not lower the cost of raising an employee's wage. That is, the firms in the table can justify the use of options at *any* positive turnover cost.[26] However, for this conclusion to be credible, the model suggests that options can be used for retention purposes if spot wages fluctuate up or down anywhere from \$2,000 to \$20,000 over a short period. In this second set of estimates, the turnover or renegotiation costs are negligible and the amount of unvested option value would have a significant effect on employee retention. Therefore, the results suggest 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 4 suggests*.

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

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[24]Note also that we assume the employee's outside wealth to be equal to $S_{opt}$.

[25]As noted above, we assume that, if spot wages decrease, the firm cannot lower the employee's cash compensation. As a result, our estimates of renegotiation costs only relate to the case of retaining the worker if his spot market wage increases.

[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.

| | Small Firm | Med-Small Firm | Med-Large Firm | Large Firm | Median |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Annual Cash Compensation (from NCEO survey) | | | | | |
| | $38 | $100 | $90 | $90 | $90 |
| | | | | | |
| Case One: $r^* = 10\%, \rho = 2.5$ | | | | | |
| Initial Spot Wage ($S_u$) | $41.3 | $109.1 | $92.3 | $126.4 | $92.6 |
| High Spot Wage ($S_g$) | $ 42.7 | $112.6 | $93.5 | $139.5 | $93.7 |
| Low Spot Wage ($S_b$) | $39.1 | $104.1 | $90.9 | $113.3 | $90.5 |
| Retention Value – High | $ 44.8 | $71.6 | $ 9.7 | $190.8 | $71.0 |
| Retention Value – Low | $ 6.7 | $10.7 | $ 1.5 | $60.1 | $15.6 |
| Transaction Cost ($k$) | $ 45.3 | $10.9 | $0 | $14.0 | $33.3 |
| | | | | | |
| Case Two: $r^* = 10\%, \rho = 1$ | | | | | |
| Initial Spot Wage ($S_u$) | $44.6 | $113.9 | $92.6 | $144.6 | $99.4 |
| High Spot Wage ($S_g$) | $48.3 | $121.2 | $94.1 | $166.5 | $104.6 |
| Low Spot Wage ($S_b$) | $40.1 | $105.6 | $91.0 | $123.6 | $91.6 |
| Retention Value – High | $44.8 | $71.6 | $9.7 | $190.8 | $71.0 |
| Retention Value – Low | $6.7 | $10.7 | $1.5 | $60.1 | $15.6 |
| Transaction Cost ($k$) | $0 | $0 | $0 | $0 | $0 |
| | | | | | |
| Case Three: $r^* = 25\%, \rho = 1$ | | | | | |
| Initial Spot Wage ($S_u$) | $51.5 | $126 7 | $95.2 | $241.7 | $113.1 |
| High Spot Wage ($S_g$) | $57.8 | $138.7 | $97.7 | $284.7 | $125.3 |
| Low Spot Wage ($S_b$) | $44.4 | $113.4 | $92.5 | $199.1 | $100.6 |
| Retention Value – High | $50.4 | $80.7 | $11.0 | $240.9 | $81.8 |
| Retention Value – Low | $10.6 | $16.9 | $2.4 | $97.1 | $24.7 |
| Transaction Cost ($k$) | $0 | $0 | $0 | $0 | $0 |

Risk-free rate is assumed to be 5%. "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.

value their holdings more highly, and the critical values of turnover costs fall even further 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 4 provide evidence that some combination of sorting and retention could be contributing to decisions to issue stock options firm-wide.

## 5 Cross-Firm Variation in Option Plans

In this section, we analyze cross-sectional variation in option plan adoption using our BLS and SEC 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.

### 5.1 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.[27] We then generate three indices of industry wages. The first index is simply the average hourly wage in the industry.

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 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.

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

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[27]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.

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.[28] 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.[29] 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 5 presents results of logits using the option grant indicators "Any Options" and "Broad Plan" as dependent variables.[30] 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. 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. 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. 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 sample, suggesting that, though options may increase in risk among those firms in a pool of possible options grantors, they

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

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

[30]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 5.

Table 5: BLS Option Plan Logits

| Dependent Variable | All For-Profit Establishments | | Publicly Traded Subsample | |
| --- | --- | --- | --- | --- |
| | 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.

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 EDGAR sample) and ownership is not shared with employees. However, it does appear that, as predicted by the retention model, options are more common in industries where the risk across firms is relatively common.[31]

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. We view these results to be generally consistent with both the sorting and retention models, though the findings are not strong enough nor are the predictions of the models we consider distinct enough for us to make sharp distinctions between competing explanations.

## 5.2   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

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[31]Carter and Lynch (2003) provide related cross-sectional support for the importance of retention. They show that option repricing is correlated with reductions in employee turnover.

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. Because 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 6. 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.[32] 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 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 marginally 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.

We believe that Tables 5 and 6 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

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[32]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.

Table 6: 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.

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.

# 6    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 focused on 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 (often much 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 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, 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 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 neither explanation 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 received 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.

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