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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 employee retention. We gather data from three sources on firms' stock option grants to middle managers. First, we directly calibrate models of incentives, sorting and retention, and ask whether observed magnitudes of option grants are consistent with each potential explanation. We also 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.

JEL classification: G30; J33; J41

Keywords: Employee compensation; Stock options; Incentives; Sorting; Retention

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1. Introduction

The use of stock option grants in compensation plans for middle- and lower-level employees has attracted considerable attention in recent years. The increase in the 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 exposes employees to a large degree 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 some of these potential benefits.

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 might 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.

When employees differ in their beliefs regarding the firm's prospects, firms can reduce compensation costs by using options to attract optimistic employees. Third, options may help firms retain employees. Any form of deferred compensation will make it costly for employees to leave. However, options may be especially useful for this purpose when stock prices and labor market conditions are positively correlated because they 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 have 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 it believed to have broad-based stock option plans, this sample is not useful for exploring across-firm variation in option-granting behavior.

Second, 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.

Our third 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

[1] Mehran and Tracy (2001) document the increase in employee stock option grants at large, publicly traded companies during the 1990s.

response rates, the BLS prevents researchers from learning the identities of the individual firms that responded. Thus, we are unable to link option-granting behavior to firm characteristics. Because of these limitations, we use the BLS data only to describe broad patterns of stock option usage in the U.S.

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 SEC sample to estimate a series of regressions 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, when 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 broad-based stock option granting decisions. Our calibrations, for example, indicate that a somewhat risk-averse employee who expects his or her 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 5,000 to 20,000 dollars over a few years, firms might 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 that options create attraction and retention benefits. Specifically, we show that broad-based stock option plans are more common at smaller firms, at firms with more volatile stock returns (and especially firms in more volatile industries), and at firms with negative cash flow.

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 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, leads 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. These studies also argue that financing constraints play some role in option-granting decisions, as cash-strapped firms substitute equity for salary. We argue that this rationale for option grants lacks a compelling economic justification, *unless* employees are optimistic regarding the firm's prospects, as in the sorting model.

Other authors, including Sesil et al. (2002) and Ittner et al. (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. study differences in financial outcomes for firms with and without stock options. Ittner et al. 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 theirs by identifying sources of performance improvements.[2]

Another body of work studies employee profit sharing (see, e.g., Kruse, 1993; 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. Some of our analysis is similar to the profit sharing literature in that we establish characteristics of firms that issue stock options broadly.

The remainder of the paper proceeds as follows. In Section 2, we discuss the incidence of broad-based stock option plans in the U.S. economy. In Section 3, we outline several models that might help explain why firms elect to issue options to a broad group of employees, and then use these models to frame our calibration exercises in Section 4. Section 5 presents our cross-sectional logit analyses, and Section 6 concludes.

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, 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

[2]While we take as given that firms choose options as the form of equity to grant to employees, a few other papers have studied the choice between stock grants and stock option grants. Barron and Waddell (2003b) and Oyer and Schaefer (2003) study this decision for grants to executives and non-executives, respectively.

properties for providing descriptive background on the incidence of option grants. First, the BLS gets a very high response rate (over 75%) because respondents know the confidentiality of their responses will be strictly protected. (The BLS data is available only to researchers who are granted Intergovernmental Personnel Act assignments; all our work with the data was done on site at the BLS in Washington, DC.) Second, the BLS provides establishment-level weights that account for the distribution of establishment types in the United States, as well as 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.[3]

We generate two indicator variables intended to capture the breadth of establishment-level stock option grants. First, we set the first variable (Any Options) equal to one for any establishment that granted any stock options to any "non-owners" in 1999. (Technically, anyone holding a share of stock is an owner, but it appears that respondents interpreted "owner" as owner/operators, rather than as anyone holding shares.) Just 2.7% of U.S. establishments granted stock options to non-owners in 1999. The 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 might be the case that only a small fraction actually receive them in a given year. To approximate the NCEO measure, we set the second indicator variable (Broad Plan) equal to one at any establishment that granted options to at least 20% of its employees in 1999. Only 1.4% of establishments in the U.S. economy meet this broad plan criteria, though almost 12% of establishments that are part of public companies qualify as having broad plans.

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.[4] 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.[5] Establishments that make option grants have somewhat higher salaries on average, though they do not have a noticeably different fraction of high-salary (over $75K) or low-salary (under $35K) workers than establishments in the sample as a

[3]While the BLS data are useful for descriptive purposes, their usefulness for other analysis is limited by the fact that sampling was done as the establishment (rather than firm) level and that firm anonymity prevents us from matching the option grant information to other financial information.

[4]While columns (2) and (4) include 10% and 37% of their relative samples, respectively, these proportions fall to 2.7% and 22.1% when BLS sampling weights are applied.

[5]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 option markets to value these options. Instead, we use two-digit SIC-level averages of stock volatilities.

Table 1
Bureau of labor statistics sample summary statistics

	Public and private firms		Public firms	
	All (1)	Firms with any grant (2)	All (3)	Firms with any grant (4)
B-S value of grants per employee	$50 (1,975)	$3,331 (15,826)	$414 (5,882)	$3,508 (16,833)
Average salary per employee	$31,107 (54,843)	$36,081 (63,330)	$35,438 (55,629)	$38,444 (67,028)
% of employees with salary <$35K(%)	68.0	65.8	64.6	66.0
% of employees with salary >$75K(%)	6.0	6.7	6.7	7.0
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
Weighted share of sample (%)	100	2.7	11.2	2.5

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. "Broad plan" indicates that 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 are in parentheses.

whole. Not surprisingly, so-called "new economy" firms are over-represented among firms that grant options.[6]

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 receive 31.2% of the Black-Scholes value though they constitute 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 constitute 3.7% of sample employment and 5.7% of employment at public and private establishments that grant options, receive 61.1% of the value of options granted. Employees earning under $35,000 annually constitute 67.1% of sample employment and receive just 1.6% of the value of all options granted.

The BLS statistics make it clear that stock options are an important component of compensation for non-executives at a large group of firms. While most firms do not distribute options widely, non-executive options constitute a significant majority of total grants. At firms that grant options, options compensation is an important part of total labor costs. Therefore, understanding why these firms adopt this practice is an important question in understanding compensation practices.

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

[6]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 SIC codes 3575, 7375, and 7379 because the SEC and NCEO firms in these industries are internet-related.

statement (DEF 14A) and an annual report (10-K) with EDGAR during calendar 1999, we randomly select a sample of 1,000.[7] We gather data from these disclosures regarding the number of employee stock options issued. We match this to data on accounting and stock returns from Compustat and the Center for Research in Securities Prices.

The major drawback of the SEC data is its high level of aggregation; firms report how many options were granted in total, but there is no detailed information regarding the option 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.[8]

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 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 because, at many firms, the sixth, seventh, etc. highest-paid executives also receive very large option grants.[9] Because 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,

[7]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.

[8]We know 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' SEC disclosures. Loosely, our approach attempts to maximize the number of NCEO sample firms for which we accurately predict option plan status.

[9]To show the importance of option grants to executives who miss the top-five cutoff, we use the Execucomp dataset to look at option grants at companies that report compensation details for more than five executives in a given proxy statement. There are 3,236 firm/year observations with more than five listed executives between 1996 and 2002. Of this sample, 57.4% made option grants to the fifth highest-paid executive, while 33.4% made grants to the sixth highest paid. Among those who received grants, Execucomp's valuation of the Black-Scholes value of the grants for the average (median) executive is \$802K (\$266K) for fifth highest executive and \$782K (\$253K) for sixth highest paid. Average and median grant values are similar for seventh and eighth highest-paid executives in the firm/years where details are provided.

Table 2
SEC sample summary statistics

	All firms (1)	Option plan (2)	No option plan (3)
Black-Scholes value of non-exec grants per employee	$17,891 (52,351)	$36,982 (70,829)	$288 (1,285)
Grants to non-execs/total shares (%)	2.2 (4.2%)	4.4 (5.2%)	0.1 (0.1%)
Employees	5,684 (18,742)	970 (2,519)	10,032 (25,112)
Employee growth (%)	26.0 (168%)	38.2 (237%)	14.3 (34%)
Market value 12/98—($MM)	$1,660 (10,451)	$450.6 (1,605)	$2,815 (14,446)
Fraction with positive cash flow (%)	78.0	61.9	92.8
1997 stock return (%)	24.0 (61.8%)	20.0 (67.3%)	27.4 (56.6%)
1998 stock return (%)	5.9 (82.5%)	8.1 (108.1%)	4.2 (49.8%)
1999 stock return (%)	33.1 (161.8%)	62.0 (213.5%)	6.3 (82.2%)
Monthly volatility (%)	17.5 (9.6%)	20.9 (10.2%)	14.2 (7.7%)
New economy (%)	16.2	26.2	6.6
Sample size (%)	798	390	408

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 798 firms includes those for whom we are 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 0.5% of its outstanding shares to employees who were not in the top 10% of its management ranks. Column 3 includes firms that do not meet this criterion. This rate of grant is capped at 30%. "New economy" indicates a primary SIC code of 3570–3579, 3661, 3674, 5045, 5961, or 7370–7379. Standard deviations are in parentheses.

then we assume there were no grants to non-executives. We define an indicator variable (SEC Plan) that equals one if the number of shares granted to non-executives represents at least 0.5% of the shares outstanding in 1998.[10]

Table 2 displays summary statistics for the firms in the SEC dataset. All firms are included in the first column, while Columns 2 and 3 partition the firms into those with broad-based plans (SEC Plan = 1) and those without (SEC Plan = 0), respectively. We find 48.9% 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 8.3% of employees in the sample worked at firms with broad-based plans. Employees at firms with broad-based plans received average grants worth in excess of $36,000 (though the average option value at the *median* firm with a broad-based plan is only $6,551). Table 2 makes clear that firms with broad-based plans are

[10]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.

strikingly smaller, faster growing, and their stock returns are more volatile. New economy firms make up a substantial portion of the firms with broad plans. Also, note that only three-fifths of the firms with broad plans generate positive cash flow in 1998 (defined as earnings before extraordinary items plus depreciation), while more than 90% of the other firms generated cash.

Our adjustment to Core and Guay's (2001) method of measuring grants to non-executives is important. Had we defined our SEC Plan indicator 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 finding that option-based incentives for non-executives are stronger at larger firms is an artifact of their data collection methodology. It appears that larger firms grant more options to non-top-five *executives,* but are less likely to have broad-based plans.

3. Models and empirical implications

In this section, we outline several models that might 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 the use of equity in compensation. 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. Suppose the value of the firm, V, depends on an employee's effort, e, as follows:

$$V = ve + \varepsilon_v, \tag{1}$$

where ε_v is a normal random variable with mean zero and variance σ_v^2. Let the employee be risk averse with a coefficient of absolute risk aversion φ. (We denote by φ a coefficient of absolute risk aversion, and by ρ a coefficient of relative risk aversion.) Suppose further that the employee has quadratic effort costs, with second derivative c.

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

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

This analysis yields the standard comparative statics of agency theory. The employee's share is higher when (1) the variance of firm value, conditional on the

employee's effort, is smaller; (2) the marginal return to effort, v, is higher; (3) the second derivative of the employee's cost of effort function, c , is smaller; and (4) 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 might think to test this theory using the first. In fact, there is a large literature testing this comparative static using the pay-for-performance contracts of top executives. Murphy (1999) surveys many of the relevant papers. Aggarwal and Samwick (1999) and Jin (2002), for example, confirm the negative risk/incentive relation for chief executive officers, while Barron and Waddell (2003a) confirm the relation for the top five executives at a given firm. Many other papers have analyzed this relation using the compensation data provided for five executives in proxy statements or for a slightly larger group of top managers surveyed by consulting firms (see, for example, Bushman et al., 1995; and Keating, 1997). We test this prediction of the incentive model in our cross-firm analysis of option plans in Section 5 below.

Previous cross-sectional tests of the risk/incentive relation, as well as our test below, are 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 a potential omitted variable bias. If effort is more valuable in high-risk environments, as Prendergast (2002) suggests it can be in some cases, then employees' ownership could 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.[11] 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 therefore supplement standard methods with a different approach. In Section 4.1, we directly calibrate an agency model, and ask whether the observed

[11]Some studies of high-level executives have attempted to measure the quality of individual performance measures in order to assess the effect of these measures on the link between pay and firmwide performance. See, for example, Bushman et al. (1996) and Aggarwal and Samwick (2003).

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 might 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 that a firm might want to tie some of its 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 can 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 might be advantageous to include such compensation as part of an employment relation, 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, relatively hard working, or 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 relation allows the employee to avoid paying taxes on the options until exercise.[12] This allows the options to compound tax-free (though the tax advantage is not large.) Finally, the firm might be able to reduce overall transaction costs by making these grants centrally.[13]

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

[12]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 McDonold (2004) for details on employer tax considerations in issuing options. We proceed under the assumption that the options we analyze are NQSOs.

[13]Employees might 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 of 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.

tax benefits of being paid in options will be greater. Given progressive income taxation, this suggests option grants should be larger for 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, they have the effect of increasing the costs to employees of departing the firm. Options could 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 might wonder why firms would not simply defer cash payments if retention is their aim.

The model in Oyer (2004) 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 opportunities. Consider a firm that is contemplating offering $100,000 in deferred cash compensation versus $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 might not be sufficient to induce the employee to stay with the firm. If the employee holds options, however, 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 or she leaves) or negotiating over a new wage (if he or she 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 can 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 might be an effective way to link total compensation to labor market conditions without resorting to nominal wage cuts. In Oyer's (2004) 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.[14]

[14]A related justification for options is analyzed by Inderst and Mueller (2004), who argue that options minimize wage costs in exactly the states of the world where high fixed wages might lead a firm's owners to decide (inefficiently) to shut the firm down. By indexing wages to firm value, this inefficiency is mitigated.

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. This explanation might 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 can lead to a preference for internal finance.

This hypothesis has garnered considerable interest from both practitioners and, as discussed below, prior academic studies. However, we argue that this hypothesis, when considered in isolation, ignores employees' labor supply decisions and thus lacks a clear economic justification. While some previous empirical studies simply look for an empirical relation between firms' financing needs and the grants they make to employees, we believe it is important to consider under what conditions asking employees to accept equity in lieu of cash is an efficient source of capital. Given that risk-averse employees would demand a higher return on these equity investments than other, better-diversified investors, employees who provide capital to their employers must expect higher returns than other investors. This could result, for example, from a potential employee having inside information from a friend working at the company or from the employee simply having relatively optimistic expectations for a firm or its industry. This suggests that employees are an efficient source of capital only when they are more optimistic than alternative investors regarding the firm's prospects, which is precisely the sorting idea we discussed in Section 3.2.[15]

Another concern regarding the "options-as-finance" hypothesis is that the relation between financing constraints and option grants is, at best, mixed. We discuss these prior results below in Section 5 when we do our cross-sectional analysis of broad-based option plan adoption. We argue there that the reason for these inconsistent results is that it is difficult to disentangle the sorting and financing constraints hypotheses empirically.

While we claim that the financing constraints hypothesis is an incomplete form of the sorting model, note that financing constraints are not a necessary condition for the sorting model to hold. Firms that have plenty of cash on hand would still have an incentive to use options as a form of compensation if some potential employees value those options more highly than do the equity markets. In fact, Oyer and Schaefer (2003) argue that sorting can explain Microsoft's long tradition of broad equity grants even though Microsoft has plenty of cash available to fund current

[15]This observation arose from the attempts we made to write (and then calibrate) a sensible economic model of the financing constraints hypothesis.

compensation expenses.[16] If sorting is an important determinant of broad option plans, but only some of the time broad options help firms avoid raising money externally, this could explain the inconsistent empirical correlation between option grants and proxies for financing constraints.

3.4.2. *Favorable accounting treatment*

As Hall and Murphy (2003) emphasize, stock-option-based compensation receives favorable accounting treatment. If a firm pays an employee an additional $100 in wages, then this payment is counted as an expense for the firm, and the firm's reported net income in the current period is lower by $100. If, on the other hand, a firm gives an employee a stock option grant worth $100, then the firm can elect not to recognize a compensation expense. Under this accounting regime, a firm interested in boosting its share price in the short run might 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 SEC dataset.) Unless equity prices fail to reflect this publicly available information, attempts to fool the market by shifting to option-based pay will fail. It is not clear how precisely stock prices incorporate option grant information. Based on several papers, including Aboody (1996), Huson et al. (2001), and Aboody et al. (2004), it is generally accepted that market valuations are affected by this information. Bell et al. (2002) confirm that option grants affect valuations, but suggest that their findings "call into question whether investors assess correctly the effect [of employee stock options] on profitable software firm value." Also, Garvey and Milbourn (2004) propose a trading rule based on the market's failure to perfectly incorporate option grant data.

Even if the market is not systematically fooled by firms' attempts to hide compensation expense using stock options, top managers might 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 on 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 to take actions that owners would undo if they could.

While we acknowledge that accounting might have some effect, we argue that this rationale is not solely responsible for the decision by firms to adopt broad-based option plans. We base this on the implied cost of the corporate governance problem that would generate observed non-executive option grants and on the fact that there is little evidence of any connection between broad option grants and lax corporate governance. Oyer and Schaefer (2003) estimate that, if the only benefit of non-executive grants is favorable accounting treatment, a typical firm with a broad-based stock option plan incurs real costs of about $3,000 per middle manager per year in order to increase reported pre-tax income by about $9,000. In addition, a typical firm

[16]Oyer and Schaefer (2003) also argue that the financing constraints explanation for option grants suggests that firms should issue stock, not options, to employees, because doing so results in smaller employee risk premiums.

with a broad-based plan exhibits a *marginal* willingness to pay \$0.64 of actual costs (in the form of risk premium to employees) in order to increase pre-tax income by one dollar. Given that compensation costs are an important component of these firms' cost structure, it is difficult to imagine that these firms could stay competitive if they wasted resources at such a rate.

There are several well-established facts that, taken together, suggest there is no connection between lax corporate governance and broad option grants. First, ownership of equity by chief executives rose dramatically during the 1990s (Murphy, 1999), which is the same time period during which option grants to non-executives grew (Hall and Murphy, 2003). Second, many firms that used broad plans (such as Microsoft and Oracle) are managed by founders with very large equity stakes. Third, 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 et al., 2003). Finally, some privately held firms elect to issue stock options to employees. Accordingly, we take as our starting point the assertion that broad-based stock option plans are in shareholders' interests, and search for underlying sources of value creation.

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 2000, they sent questionnaires to compensation administrators at approximately 2,000 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. Because firms do not frequently vary the variable

that is of interest to us (namely, the existence of a broad option plan), we are limited to cross-sectional data. As such, we supplement our across-firm analysis with 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 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 a grant of stock options is therefore given by $\max[b(v_1 - v_0), 0]$.

Suppose the employee has constant absolute risk aversion with coefficient φ. We use a Taylor series approximation of the employee's utility function to write the employee's certainty equivalent when holding random payoff $\tilde{x}$ as $\mathrm{E}(\tilde{x}) - (1/2)\varphi \operatorname{Var}(\tilde{x})$. Let the employee's utility in the 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:

$$\max_b \int_0^\infty v_1 \, \mathrm{d}F(v_1; e) - c(e) - \frac{1}{2}\varphi b^2 \xi(e) \tag{3}$$

subject to

$$e \in \arg\max_e \; b \int_{v_0}^\infty v_1 \, \mathrm{d}F(v_1; e) - c(e) - \frac{1}{2}\varphi b^2 \xi(e). \tag{4}$$

[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.

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

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

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

Assuming an interior optimum, the optimal option grant satisfies

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

This equation has an intuitive interpretation. The left-hand side is the amount by which the value captured by the firm increases when 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 by which 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 Eqs. (5) and (6) in conducting our calibration exercise. We take characteristics of the firm and its option grants from our NCEO data and make assumptions regarding the distribution of the terminal value of the firm (f) and the risk aversion of the employee (φ). Given this, the only unknowns in this pair of first-order conditions are the employee's effort level e and the 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 the 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

[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 are 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 are 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 are exercised immediately upon vesting, an additional 31% are exercised within a year after vesting, and 21% are exercised between one and two years after vesting.

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 σ is the expected annual standard deviation of the firm's return.

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

We consider two possible values for the employee's level of risk aversion, and two possible 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 (ρ). To allow for the possibility that option-based pay attracts a selection of risk-tolerant employees, however, we use a relative risk aversion value of one in our basic specification. We convert this to an Arrow-Pratt measure of absolute risk aversion (as required by our agency model) by dividing by the employee's wealth level, which we assume to be five times the annual salary paid by the firm to middle managers. We also consider the case where middle managers are of "average" risk tolerance (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. Note first that the value of option grants to middle managers varies considerably in the sample. The typical firm grants options with a Black-Scholes value equal to approximately one year of salary, though the large firm in Column 4 grants three years of salary to new middle managers (worth a total of over a quarter of a million dollars.) Note, however, that while some of these firms make valuable grants, the middle manager typically owns a very small fraction of the firm (less than one-thousandth of a percent in the case of the large firm). In contrast, "senior managers" of these same firms receive grants of approximately eight times as many shares and the top executives of some of the bigger firms receive grants that are several orders of

Table 3
Calibration—incentives

	Small firm (1)	Med-small firm (2)	Med-large firm (3)	Large firm (4)	Medians (5)
Employees	<50	<100	~ 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 (σ) (%)	> 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 are assumed to expire in ten years and fully vest in four years. All dollar values are in thousands except firm value.

magnitude greater than grants to middle managers.[19] Therefore, though the BLS statistics in Section 2 indicate that high paid non-executives, such as the middle managers we study, receive the majority of total option grants, we expect the incentive effects of these grants to be very different from those for top executive analyzed by, for example, Hall and Murphy (2002).

We present results from three calibrations for each of the four firms in the table. 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.

[19]The difference between non-executives and the top five proxy-listed executives (which is the group typically studied) is very stark in the Execucomp dataset. For the period 1996–2002, we use our methodology to estimate the value of grants to executives and non-executives at firms that meet our "SEC plan1" criteria. The average (median) grants to the CEO are 73 (89) times as great as grants to non-executives. The average (median) grants to a non-CEO top five executive are 17 (22) times as great as grants to non-executives.

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 arising as a result of the option grant is \$10,200, annually. The risk premium the employee attaches to 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 does 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 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 base this conclusion on the following observation: In the case of the small firm and the first set of assumptions, options bring \$10,200 of additional benefits into the employee/firm relationship at a total cost (not including the risk costs) of less than three dollars. If this were the case, it seems clear that the parties' inability to contract on effort is generating a very substantial underprovision of effort. This difference, which strikes us as implausibly large, is implied by our agency model combined with the assumption that observed option grants reflect optimal incentives. This comparison is even more dramatic in the case of the large firm, where the additional benefits and costs of options are \$63,500 and about two cents, respectively.

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? Or, put another way, if additional

effort would bring some amount on the order of $63,500 into the employment relation at a cost of a few cents, wouldn't the firm and employee figure out some way to split the surplus that did not require the employee to bear so much risk that the surplus was largely depleted? 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, when employees can take actions that have large value implications for the firm, the costs to the employee of taking these actions are 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 σ is the annual standard deviation of returns. We determine the options' value when issued (which we use as the cost to the firm) using Black-Scholes assuming expiration in four years. Let the employee have constant relative risk aversion with initial wealth equal to annual salary.[20] We make assumptions regarding tax rates applied to three types of income: current salary, options profits, and additional cash salary the employee would receive if he got no stock options. Current salary is inframarginal in this analysis, so we apply $\tau_s = 20\%$ to capture an estimate of average tax rates in calculating utility. The other two types of earnings are marginal, so we apply $\tau_b = 40\%$.

Results are displayed graphically in Figs. 1–4. To produce these graphs, we place the employee's coefficient of relative risk aversion on the x-axis and the employee's

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

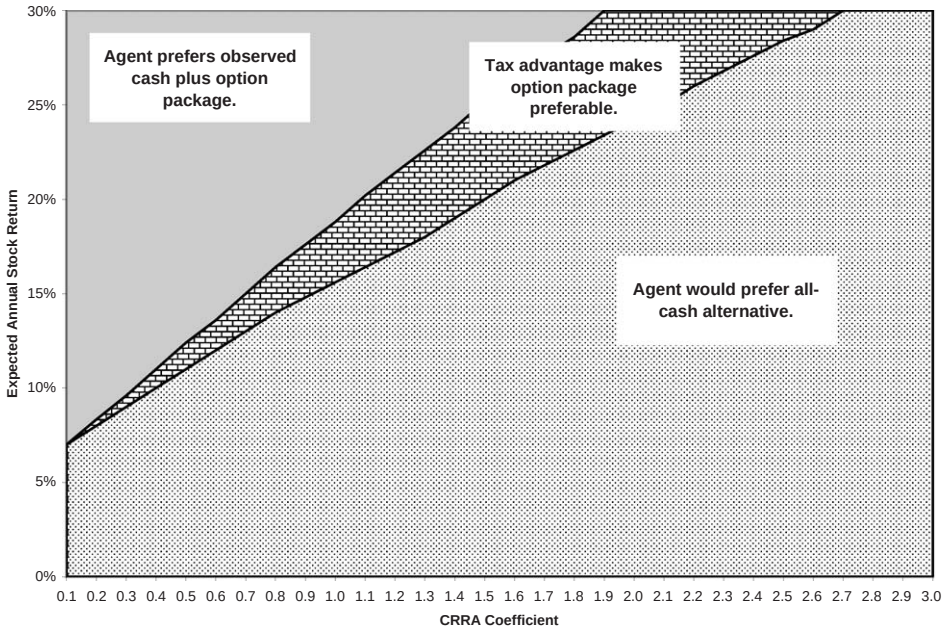

Fig. 1. Small firm employee's preferences over compensation plans for different values of r^* and ρ.

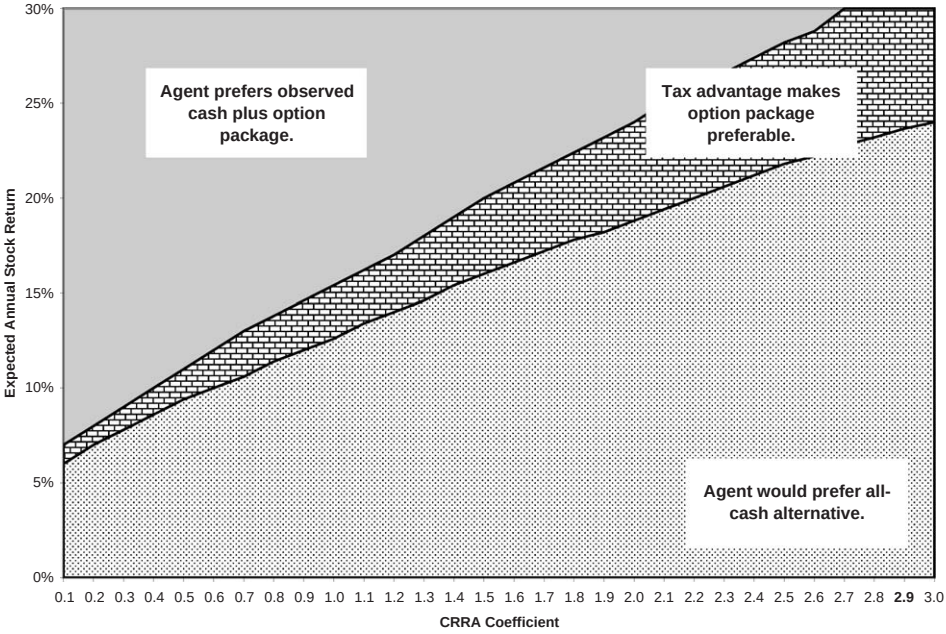

Fig. 2. Med-small firm employee's preferences over compensation plans for different values of r^* and ρ.

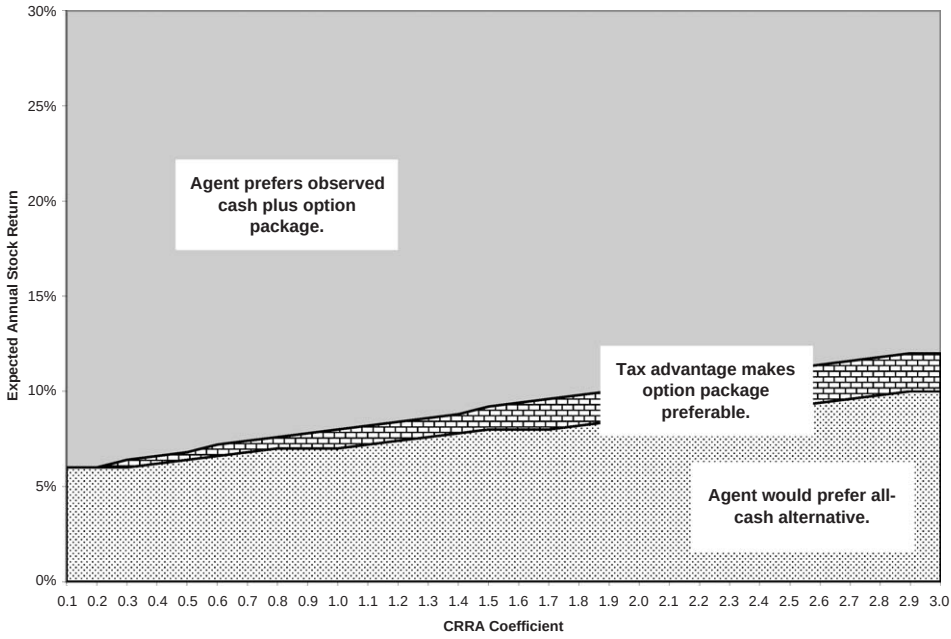

Fig. 3. Med-large firm employee's preferences over compensation plans for different values of r^* and ρ.

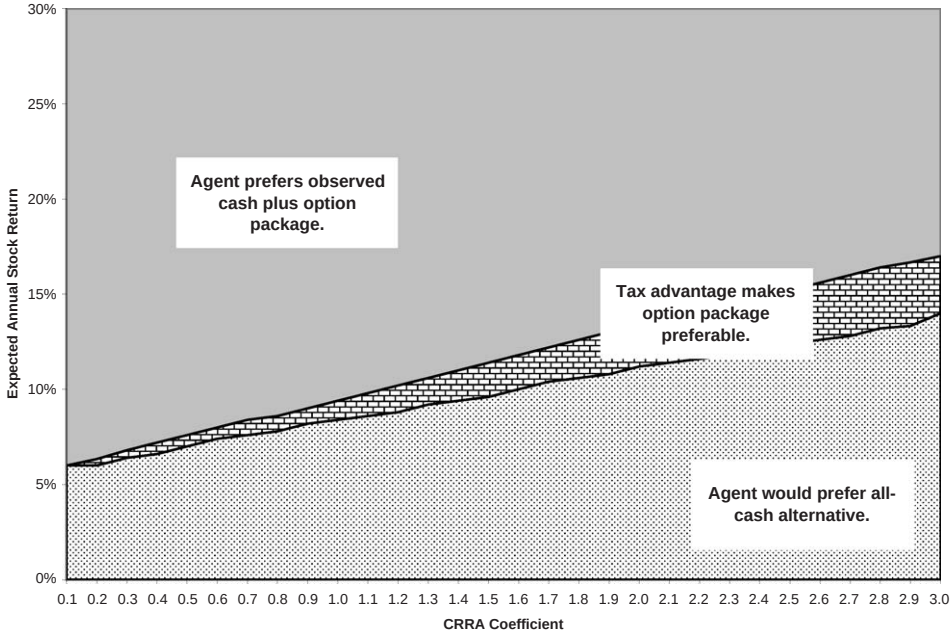

Fig. 4. Large firm employee's preferences over compensation plans for different values of r^* and ρ.

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 advantage 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 the firm's share price to increase by 10% per year. At our small, medium-small, and large firms (Figs. 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 ρ 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 or she expects 25% annual stock appreciation (four-year appreciation of 144%). The employees at all of the four firms in Figs. 1–4 now prefer the option package, as do the employees at 205 of the 216 firms in our sample. While 25% might 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 might attach options to the employment relation (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 earlier assertion 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 the level of the productivity difference that 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 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 (2004) explanation of option-based pay as a means for indexing the value of employees' deferred compensation to their outside opportunities. 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 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:

$$\mathrm{E}[v_1 \mid \text{Good state}] = v_g$$
$$\mathrm{E}[v_1 \mid \text{Unchanged state}] = v_u$$
$$\mathrm{E}[v_1 \mid \text{Bad state}] = v_b.$$

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 $\mathrm{Var}[v_1 \mid s] = (3/5)\sigma^2$ for each state $s \in \{g, u, b\}$. In other 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.[21] To compute the v values, we first assume an expected rate of return, r, on the firm's shares. This determines v_u, as $\mathrm{E}[v_1] = v_u = (1 + r)v_0$. We

[21]Other allocations of risk between firms and industries make 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.

then solve for magnitudes v_g and v_b so that the unconditional variance of the firm's return is equal to σ^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.[22] 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

$$S_u + 3(q_g S_g + (1 - q_g)S_u) + q_g k. \tag{7}$$

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 the firm's value.[23] The firm designs its option package with the aim of preventing the employee from seeking an outside offer in any state of the world. (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.) If the good state is realized, then the employee will choose not to seek an outside offer if, in expectation, the employee values compensation from the current job at more than that at the next-best job. If the employee does not seek another offer, then he or she remains with the firm and does not exercise any options until $t = 4$. If the employee seeks an offer and takes it, then he or she exercises one-quarter of the options immediately. Thus, the employee will not seek an outside offer in state s if

$$\begin{aligned}\int_0^\infty \int_0^\infty & U(W + 5S_{opt} + n\max[(v_4 - v_0), 0])g(v_4 \mid v_1)f(v_1 \mid s)\,dv_4\,dv_1 \\ & \geqslant \int_0^\infty U\left(2S_{opt} + 3S_g + \frac{n}{4}\max[v_1 - v_0, 0]\right)f(v_1 \mid s)\,dv_1,\end{aligned} \tag{8}$$

where $f(\cdot \mid s)$ is the probability density function of the log-normal with mean v_s and variance $\frac{3}{5}\sigma^2 v$, and $g(\cdot \mid \cdot)$ is probability density function of the log-normal with mean $(1 + r)^3 v_1$ and variance $3\sigma^2 v$.[24] The firm prefers offering the option-based job to the

[22]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.

[23]It might 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.

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

spot wage job if

$$S_u + 3(q_g S_g + (1 - q_g)S_u) + q_g k > 4S_{opt} + BS(v_0). \quad (9)$$

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 25–50% 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 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 at the margin, they lower the risk premium the employee would otherwise have 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 firmwide.

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

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

Table 4
Calibration—retention

	Small firm (1)	Med-small firm (2)	Med-large firm (3)	Large firm (4)	Median (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 the 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 the recipient expects to exercise options four years after they are issued) forfeited if the employee takes the outside offer, given the value of the common shock.

5. Cross-firm variation in option plans

5.1. Variables and hypotheses

In this section, we analyze cross-sectional variation in option plan adoption using our SEC data, which is a random sample of public firms.[27] We estimate a series of

[27]We also perform the analysis in this section for each year from 1996 through 2001 using all firms in Standard & Poors Execucomp dataset, and our conclusions are unchanged.

logit models using our indicator for a broad-based plan (SEC Plan, as defined in Section 2) as our dependent variable. To verify that our findings are not sensitive to the definition of our dependent variable, we define two additional indicators of option plans. The first (SEC Plan2) equals one if the Black-Scholes value of options granted per non-executive employee in 1998 was at least $1,000. Option grants are disproportionately made to new employees, so we construct a third indicator (SEC Plan3) that adjusts for the possibility that option-granting behavior depends on employment growth. We assume that all non-executive grants are given to new employees, and estimate the number of new employees to be the sum of the 1997–1998 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 at least $2,500. 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.

The explanatory variables include measures related to the comparative static implications of each model, as well as control variables. All of our analyses include controls for the log of the number of employees at the firm, the growth in number of employees from 1997 to 1998, and an indicator variable for "new economy" status, as defined earlier. Note the predicted effects of these controls on option usage do not vary in a way that would allow us to distinguish between the models. In unreported specifications, we also control for two-digit SIC code. This does not materially affect the results.

Agency theory predicts a negative relation between risk and incentives, so the incentive model implies that option plans should be less common at high-volatility firms. If higher volatility also reflects higher variance in people's beliefs about a firm, then the sorting model predicts that higher-volatility firms (or firms in higher-volatility industries) will be more likely to make broad option grants. The retention model predicts that non-executive option plans will be negatively related to idiosyncratic firm volatility, but positively related to the volatility of the set of firms that compete for a given group of employees. To test these implications, we use two volatility measures as explanatory variables. First, we include monthly firm stock volatility. In addition, we include industry volatility, which we define as the standard deviation of the monthly average return for all CRSP firms in a given four-digit SIC code industry. We exclude observations for which there are not at least eight firms available to construct industry return.

The retention model predicts that option plans will be more common at firms whose returns are more closely related to the returns of other firms that compete for the same set of workers. To test this implication, we generate a variable that we refer to as "industry volatility share". To construct this variable, we first run regressions of each CRSP firm's monthly returns on industry returns. For inclusion here, we require firms to have 12 observations of monthly returns. We average the R^2 from these regressions and define this as the industry volatility share.

Finally, we include variables that proxy for variance in potential employees' beliefs about future returns and financing constraints. These include an indicator

variable for positive cash flow in 1998, 1998 cash flow as a fraction of beginning-of-year capital, and 1998 investment as a fraction of beginning-of-year capital. We also include cash flow and investment as a fraction of beginning-of-year market capitalization.

5.2. Results

Table 5 presents the results of the cross-sectional analysis of broad-based plan adoption. First, note that option plans are more common at smaller firms and new economy firms. New economy firms have a 33 percentage point higher probability of using a broad-based plan, holding the other factors in Column 1 constant. Firms with more employees are significantly less likely to have broad stock option plans. A firm with 10% more employees than another firm is one to one-and-a-half percentage points less likely to have a broad-based plan.

In contrast to the basic agency theory of an inverse risk/incentive relation, we find that a firm with volatility that is ten percentage points higher than another firm is more likely by 13 percentage points (that is, the probability increases by about one third) to have a broad plan. This provides further support for our conclusion in Section 4.1 that incentives are not an important cause of firms' decisions to adopt broad option plans. The dramatically higher volatility of plan firms (and, as discussed below, their industries) contradicts every "informativeness" agency model.

Column 2 shows that the positive relation between risk and option plans is largely driven by industry volatility rather than idiosyncratic firm volatility. Industry volatility is positively (and significantly) related to option plans and, when controlling for industry volatility, firm volatility is not significantly related to option plans. This is consistent with the industry versus firm volatility prediction of the retention model.[28] While the sorting model does not have as explicit a prediction about the relative importance of industry and firm volatility, this model is also consistent with the results in Table 5 if volatility is correlated with the variance in employees' expectations about future returns.

We also add industry volatility share as an explanatory variable in Column 2 and in the logits that use SEC Plan2 and SEC Plan3 as the dependent variable. While this variable does not show a significant relation with option plan status in Columns 2 and 6, it is positively and significantly related to SEC Plan2. This is consistent with the retention model because it suggests that firms are more likely to grant options if their returns are more closely related to other firms that could employ their workers.

In Column 2, we find that positive cash flow is associated with a 22 percentage point lower probability (that is, a drop of approximately two-thirds) of implementing a broad-based stock option plan. While this provides some potential support for the financing constraints hypothesis, Column 4 shows that the other controls for financing constraints are not related to option grants. When we use SEC Plan2 or SEC Plan3 as the dependent variable, we find that firms that are making large

[28]Carter and Lynch (2004) provide related cross-sectional support for the importance of retention. They show that option repricing is correlated with reductions in employee turnover.

Table 5
SEC option plan logits

Dependent variable	SEC plan (1)	SEC plan (2)	SEC plan (3)	SEC plan (4)	SEC plan2 (5)	SEC plan3 (6)
Log employees	−0.1472	−0.1188	−0.1209	−0.1231	−0.1770	−0.1226
	(0.0146)	(0.0172)	(0.0196)	(0.0181)	(0.0228)	(0.0190)
Employee growth	0.0763	0.0817	0.0310	0.0562	0.0702	−0.0449
	(0.0441)	(0.0485)	(0.0383)	(0.0478)	(0.0545)	(0.0163)
Firm volatility	1.3232	0.6306	0.3029	0.5436		
	(0.3279)	(0.4071)	(0.4212)	(0.4183)		
New economy	0.3291	0.2764	0.2512	0.2815	0.3512	0.1912
	(0.0676)	(0.0738)	(0.0757)	(0.0749)	(0.0775)	(0.0666)
Positive cash flow		−0.2215	−0.2256	−0.2225	−0.2371	0.0574
		(0.0745)	(0.0749)	(0.0827)	(0.0779)	(0.0710)
Industry volatility		2.3205	1.9704	2.1861		
		(0.9440)	(0.9881)	(0.9497)		
Industry volatility share		−0.0831			0.5065	0.1888
		(0.1780)			(0.2106)	(0.1878)
Investment/value			−0.1125		−0.6078	−0.3424
			(0.1919)		(0.2741)	(0.2227)
Investment/capital			0.1123		0.1832	0.3473
			(0.0602)		(0.0719)	(0.0776)
Cash flow/value				−0.0504		
				(0.1475)		
Cash flow/capital				0.0016		
				(0.0040)		
Pseudo-R^2	0.2818	0.2763	0.3057	0.2822	0.3962	0.2234
Sample size	765	573	479	549	479	439

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, is available. "New economy" indicates a primary SIC code of 3570–3579, 3661, 3674, 5045, 5961, or 7370–7379. Coefficients are marginal effects on the probability that the firm has a plan. Standard errors are in parentheses.

investments relative to capital are more likely to have option plans. However, firms that are making larger investments relative to the value of their equity are, if anything, *less likely* to have option plans.

5.3. Discussion

One noteworthy difference between our results and the previous literature is the negative relation between firm size and broad option plans. Core and Guay (2001) report the opposite result, namely that the value of option 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 is indicative that non-top-five executives receive larger option grants at larger firms. Also note that this negative size/option plan relation holds in every year of the Execucomp dataset.

Our findings regarding the relation between option grants and proxies for financing constraints are similar to previous studies in that the results are mixed. For example, Kedia and Mozumdar (2002) use interest coverage, dividend payout ratio, and net operating losses carried forward as proxies for financing constraints, and report a significant connection between option grants and losses carried forward. Core and Guay (2001) measure financing constraints with cash flow shortfall and interest burden, and report a positive relation between the two measures and option grants. This association between cash constraints and options is, however, not a universal finding. For example, Ittner et al. (2003) study option grants at new economy firms in 1999 and 2000, and find that cash flow and option grants are *positively* related. Bergman and Jenter (2003) report that non-executive grants are positively related to high cash levels and *not* to leverage, interest burden, or distress. They conclude that option grants are related to cash constraint proxies that are, in turn, related to employee optimism, but that cash-constrained firms do not grant options when employees are not likely to be optimistic (such as when firms are in financial distress). The difference in results across samples could illustrate the difficulty of distinguishing the sorting and cash-constraints hypotheses. Across a fairly broad cross-section of firms, such as in the samples studied here or by Kedia and Mozumdar (2002) and Core and Guay (2001), firms that are making substantial investments are likely to be firms whose future returns are variable and where expectations vary across potential employees.

When taken together with other work, we believe our results support the assertion that the financing constraints hypothesis appears consistent with the data because it cannot be easily distinguished from the sorting model. However, we acknowledge that one could also argue that cash constraints are driving option grants and the sorting model is supported in the cross-section merely because it has similar implications to the cash constraint hypothesis. While we do not find this argument compelling (especially given the difficulty of constructing an economic justification for the financing constraints hypothesis in the absence of sorting), we cannot rule this out with our present data sources.

In general, we view the results in Table 5 as consistent with both the sorting and retention models. They provide little reason to reverse our belief that incentive effects are not important in broad-based option plans. Though the negative association between employees and option plans would lend some support to the moral hazard explanation of option use, our previous numerical analysis suggests that the marginal effects of the number of employees on incentives dissipate quickly as a firm grows and that these firms are generally above the level where we would expect such an association between size and incentives. More importantly, the strong positive relation between risk and option plans contradicts a central prediction of the incentive model.

6. Conclusion

Using firm-level data on stock option grants and financial information, we have tried to provide an economic explanation for the fact that some firms issue stock options to lower-level employees with economic theory. We focus 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 show 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 compute 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 can be an efficient means of compensation. That is, despite demanding compensation for risk, optimistic employees might 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 or her reservation utility can induce the firm to issue stock options.

We believe that neither cash constraints, accounting treatment of option grants, nor any of the three models we examine 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 discuss in Section 3.4, employees are too expensive a source of capital to justify the cash constraints explanation. We believe our calculations 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 could 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 raises 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 an 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 for which the returns to cost effectively attracting and retaining employees is particularly high. But those firms could 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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