

# Employee Stock Options in Compensation Agreements: A Financing Explanation\*

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## Abstract

We develop a model for the use of stock options in compensation agreements based on a financing explanation. Our model is consistent with the extensive use of options for non-executive employees. Simulation results from our model show an optimal use of options of about 9.3% of total compensation for a non-executive employee with a compensation of \$50,000. Finding an optimal level of options as part of compensation in this context requires a balancing of two opposing factors – the benefit of a lower capital issuance cost versus a higher compensation cost as a result of the discount an employee places on options because of an undiversified position.

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## **Abstract**

We develop a model for the use of stock options in compensation agreements based on a financing explanation. Our model is consistent with the extensive use of options for non-executive employees. Simulation results from our model show an optimal use of options of about 9.3% of total compensation for a non-executive employee with a compensation of \$50,000. Finding an optimal level of options as part of compensation in this context requires a balancing of two opposing factors – the benefit of a lower capital issuance cost versus a higher compensation cost as a result of the discount an employee places on options because of an undiversified position.

# **Employee Stock Options in Compensation Agreements: A Financing Explanation**

## **I. Introduction**

Stock options are often used as part of a compensation package offered to the employees of a firm. The use of stock options as part of compensation is usually justified on the basis of providing incentives to employees in terms of increased compensation when shareholder wealth grows (i.e., the stock price increases). In this way, employees are enticed to act in the interests of owners to increase the value of the firm since their own wealth increases at the same time. This motivation for options requires some degree of control on the part of an employee in terms of influencing the stock's price. However, non-executive employees often do not have the ability to influence the stock price to any significant degree. Thus, explaining the issuance of options to non-executives is problematic for the incentive hypothesis.

Many other hypotheses have been offered to explain the extensive use of options in compensation agreements. One hypothesis, a financing (or what Yermack [1995] refers to as a "liquidity") explanation, has received particularly little rigorous investigation. In this paper, we offer a model for the use of options based on a financing explanation that is consistent with the broad use of options in compensation beyond top executives. Our model identifies an optimal use of options in compensation as the point in which the marginal benefit of using options for financing equals the marginal cost

from the discount an employee places on “risky” options. Our model also incorporates the ability of employees to invest a portion of their wealth in a market portfolio in order to provide some diversification.<sup>1</sup> We show that a financing motivation can indeed explain the broad use of options to compensate non-executive employees. For example, our simulation results indicate that the optimal use of options is 9.3% of compensation for an employee with a compensation of \$50,000.

As an anecdotal example of a company using options in the compensation of non-executive employees, on April 12, 2001, the Acxiom Corporation released a press announcement describing a unique program to reduce the cash salary of most of their employees, exchanging 5% of their cash salary for an equivalent number of stock options. Furthermore, on a voluntary basis, employees were allowed to exchange up to an additional 15% of their cash salary in a 2-for-1 match in stock options. Such a program reduces reported expenses as well as preserves internally generated cash. This example demonstrates that firms do indeed issue stock options as part of compensation for reasons other than incentives and control, specifically as a means to reduce cash expenses and thus cash financing needs.

Furthermore, an Economist article (1999b) notes options have “reduced the cash costs of starting a company... A firm with almost no assets can compete for staff head-to-head with an IBM, simply because it can lure clever people by offering options. Silicon Valley, cradle of the information-technology revolution, is built on options-not just for the bosses, but for most staff.” For example, nearly 80% of options at high-tech companies went to non-top-five employees (Economist, 1999a). Core and Guay (2001)

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<sup>1</sup> Others have cited the average discount in the value of options instead of the marginal discount, and have not incorporated a market portfolio as part of employee wealth (e.g., Hall and Murphy, 2002).

report non-executive employees hold 67% of the outstanding options issued to employees. Also, Hall and Murphy (2003) report that over 90% of options were granted in 2002 to other than the top five employees for S&P 500 firms. Furthermore, William M. Mercer (1999) reported that in 1999, 39% of large firms issued options to at least half of their employees (up from 17% in 1993). Core and Guay (2001), using data for 756 firms during 1994-1997, find evidence that options are granted to non-executive employees more intensively when firms have greater financing needs and face financing constraints.

When a firm issues options to employees, the firm receives a benefit as equity is issued at a cost less than the issuance cost in public capital markets. Lee, Lochhead, Ritter, and Zhao (1996) show an average flotation cost of 7.11% for seasoned equity offerings. Smaller issues of less than \$10 million have a larger average issuance cost of 16.96%, while issues greater than \$500 million have an average issuance cost of 3.15%.<sup>2</sup>

However, the firm must provide additional compensation above an all-cash salary to keep the employee at the same level of reservation utility as an all-cash salary. This approach is consistent with Lambert, Larcker, and Verrecchia (1991), Hall and Murphy

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<sup>2</sup> The total cost of issuing external financing consists of direct costs as indicated by Lee, Lochhead, Ritter and Zhao (1996) and indirect costs measured as abnormal returns at the announcement of an offering. Asquith and Mullins (1986) indicate an announcement effect of -43.4% of the offering size. However, we conservatively assume that the indirect cost from an announcement effect is relatively small because it may not be persistent and perhaps reflects only an acceleration of the removal of asymmetric information. If in fact indirect costs are actually large, the conditions applicable for a financing explanation of the use of options will be broader than we show later.

(2002), and Muelbroeck (2001) who examine the implications of risk averse or undiversified employees valuing stock options less than the risk-neutral valuation. As these authors have shown, there is a difference between the risk-neutral valuation and the value the employee assigns to the option. This difference exists because employees often hold a larger portion of their wealth in securities from their own firm, and some employees either are restricted in certain ways from hedging that position (e.g., officers and directors are restricted from selling short their company's stock) or simply choose not to hedge their position due to transaction costs. Therefore, the wealth of an employee is frequently not fully diversified and will have some unsystematic risk. Such an employee, therefore, will consider the option part of his compensation as having less value than the cost of those options to the firm. Thus, if a company uses options as a form of compensation, a higher level of compensation will be required to provide the same level of utility to the employee.<sup>3</sup> To illustrate the extent to which employees discount options, Hall and Murphy (2002) show that employees significantly discount options as part of their compensation package compared to an all cash salary. They show an average discount of 36.5% for their base case of five thousand options; however, there is a significantly higher marginal discount (which we include in our model later). The average discount means that an employee is indifferent between an average of 63.5 cents

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<sup>3</sup> It might at first appear plausible to sell options on the open market to receive the full cash value to compensate the employee with the cash equivalent and thus circumvent the discount an employee places on the stock options because of his undiversified position. However, there is no market for 10-year options for a firm. In addition, creating a synthetic option from a dynamically hedged portfolio also would likely have significant transaction costs and/or information effects. Thus, there would likely be costs parallel to the issuance costs already identified.

in cash and an average of one dollar worth of options (priced at market value). On a marginal basis, an employee in this circumstance is indifferent between an additional fifty cents in cash and one dollar worth of additional options.

This benefit and cost creates a tension between two forces. The firm desires to use more options in compensation because of lower financing costs but must increase compensation to maintain the same level of utility for its employees. The optimal use of options, within this framework, is determined when the marginal discount the employees places on an additional option is equal to the marginal cost of raising additional equity from the market.

Since Lee, Lochhead, Ritter, and Zhao (1996) find the average direct costs of seasonal equity offerings is 7.11% while Hall and Murphy have shown employee discounts of 36.5%, a financing explanation may seem tenuous at best. The problem facing the financing explanation gets even worse. In the Hall-Murphy model, the employee's outside wealth can only be invested in a risk-free asset. In the model presented below, we allow employees to optimally invest outside wealth in both a risk-free asset and a market portfolio. This approach is an improvement to the Hall and Murphy model, although similar to the approach taken by others (see Ingersoll [2002], Hall and Knox [2003], and Cai and Vihj [2003]). This additional investment opportunity of a market portfolio has the effect of *increasing* the discount employees place on options, making it even less obvious that firms would ever use options for a financing reason. One might therefore suspect that any use of options based on financing reasons could be dismissed outright. However, our model suggests that even with these hurdles there is justification for a financing explanation for a moderate use of options when

employees are not too undiversified (i.e., in the sense that none or only a relatively small portion of their outside wealth is held in the form of company stock.). Specifically, for employees who hold very little outside wealth in company stock, the discount employees place on options is significantly reduced (approaching the risk-neutral value) making the financing motivation more plausible. These employees are generally not able to individually influence the value of the firm to the same extent as the top executives. Therefore, this model is consistent with the widespread use of options to non-executive level employees. The implication of the model is that a firm with an external financing need would be encouraged to utilize equity securities to a larger degree in place of cash in compensating their employees (a prediction empirically supported by Core and Guay (2001)).

The organization of this paper is as follows. Section II develops the model while Section III shows the results of the model using numerical simulation. Section IV provides a summary of our research.

## **II. The model**

Suppose a firm with a financing constraint is trying to find an optimal way to compensate an employee. The firm can offer a cash-only salary of  $\bar{C}$  to the employee, or can offer any combination of a certain amount of cash,  $C$ , and number of options,  $n_o$ , that the employee finds equally acceptable. For a traditional option that might be used as part of compensation for the employee, the initial exercise price is set equal to the initial stock price. At the end of the period, the payoff of an option is calculated as  $V(S_T) = \text{Max}[(S_T - X), 0]$ , where  $S_T$  is the terminal stock price and  $X$  is the exercise price.

The company stock price is determined by CAPM with a return volatility of the company stock of  $\sigma_S$ , a market return volatility of  $\sigma_I$ , and a beta of  $\beta$ . The instantaneous correlation of the stock return with the market portfolio return is therefore  $\beta\sigma_I/\sigma_S$ . The risk-free asset has a return of  $r_f$  and the market risk-premium is  $rp_m$ . The options have a ten-year life. The employee has outside wealth of  $\bar{W}$ . His initial total outside wealth can include  $n_s$  shares of company stock initially priced at  $S_0$ . The employee optimally allocates  $\bar{W} - n_s S_0 + C$  between a market portfolio and the risk-free asset to maximize the employee's expected utility.<sup>4</sup> The employee has reservation utility of

$$\int_{I_T} \int_{S_T} p_{S_T} p_{I_T} U \left[ n_s S_T + \frac{\pi(\bar{C})W(\bar{C})}{I_0} I_T + (1 - \pi(\bar{C}))W(\bar{C})e^{rT} \right] dS_T dI_T \quad (3)$$

where

$$W(C) = \bar{W} - n_s S_0 + C \quad (4)$$

is the amount of free wealth available to allocate between the market portfolio and a risk-free asset. When the employee receives  $C$  amount of cash compensation, he allocates  $\pi(C)$  to the market portfolio and the remaining fraction to the risk-free asset.

The terms  $p_{S_T}$  and  $p_{I_T}$  indicate the likelihood the end stock price and index values are  $S_T$  and  $I_T$  respectively. The initial value of the market portfolio is  $I_0$ . The participation constraint for the employee is

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<sup>4</sup> We are assuming the employee gets his full cash salary,  $C$ , at time 0 and is then free to invest that portion between the risk-free asset and the market portfolio. We are abstracting away from the consumption-savings decisions of the employee.

$$\int \int_{I_T S_T} p_{S_T} p_{I_T} U \left[ n_o V(S_T) + n_s S_T + \frac{\pi(C)W(C)}{I_0} I_T + (1 - \pi(C))W(C)e^{rT} \right] dS_T dI_T =$$

(5)

$$\int \int_{I_T S_T} p_{S_T} p_{I_T} U \left[ n_s S_T + \frac{\pi(\bar{C})W(\bar{C})}{I_0} I_T + (1 - \pi(\bar{C}))W(\bar{C})e^{rT} \right] dS_T dI_T$$

where  $n_o$  is the number of options that must be granted to the employee in return for decreasing his cash salary by  $\bar{C}-C$ . Note that the optimal percentage allocated to the market portfolio changes as the cash-salary is reduced in exchange for options. The rate at which options are exchanged for cash reflects the employee's discount of the options because he is not a fully diversified investor. One point to note is that the employee discount within this setup is greater than it is in a Hall and Murphy (2002) world, where there is no market portfolio available for investment – only a risk-free asset. The intuition behind this result is that the employee values an additional dollar of free wealth much more when he has a market portfolio available compared to when he can only allocate an additional dollar of free wealth to a risk-free asset. Within the Hall-Murphy world, an employee is indifferent between an average of one dollar worth of options and an average of 63.5 cents worth of cash (with which he invests in the risk-free asset). When a market portfolio is available to invest free wealth, an employee is indifferent between an average of one dollar worth of options and only approximately 50 cents worth of cash as additional free wealth. This is because he values a diversified position in a market index investment more than an investment position in stock or options. Therefore, he discounts the value of the option to a greater degree, or equivalently, he needs less cash to remain indifferent relative to one dollar worth of options.

From the firm's perspective, the reduction in the cash portion of salary would lower any external equity financing need by  $\bar{C} - C$ . The firm faces flotation costs of  $F$  for raising capital from external capital markets. In order to generate this amount of cash in the public capital market,  $(\bar{C} - C)/(1 - F)$  would need to be issued. Thus, the financing benefit to the firm for using options in compensation to reduce issuance costs would be  $(\bar{C} - C)F/(1 - F)$ . The firm alternatively can preserve cash by compensating employees with options in lieu of cash. There is an added cost to the firm when options are issued to the employee as part of compensation in lieu of strictly a cash salary. This additional cost occurs because the total compensation package needs to be larger to compensate for the additional risk associated with the options. This is another way of interpreting the Hall and Murphy (2002) concept of the discount in the value an employee places on options due to lack of diversification.<sup>5</sup> If the company provides compensation of  $n_o$  options and a cash salary of  $C$ , then the expected value of this compensation package from the firm's view is  $n_o \int_{S_T} [e^{-rT} p_{s_T} V(S_T)] dS_T + C$ . The difference between this cost and the cost of paying a cash salary of  $\bar{C}$  is the net cost to the firm for this compensation package, or  $n_o \int_{S_T} [e^{-rT} p_{s_T} V(S_T)] dS_T + C - \bar{C}$ . The net benefit to the firm would be the

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<sup>5</sup> In this Hall-Murphy model, the employee may actually put a premium on the options (value it above the Black-Scholes value) because of diversification reasons (i.e., the stock offers a higher expected return). With a market portfolio available, the maximum value of an option becomes the risk-neutral value (i.e., Black-Scholes). Thus, an employee will always place a discount on options if he has an undiversified position. Therefore, more value must be given to the employee in terms of options than taken from the employee in terms of cash.

financing savings less the extra cost of compensation. Therefore, the firm's objective is to choose an amount of cash,  $C$ , and a number of options,  $n_o$ , to maximize the net benefit simplified to

$$\frac{(\bar{C} - C)}{1 - F} - n_o \int_{S_T} [e^{-rT} p_{S_T} V(S_T)] dS_T \quad (6)$$

subject to the above participation constraint given in (5).

The optimal option-cash combination is determined where the discount that the employee places on an additional option equals the flotation cost. The intuition of this result is straightforward: the employee's marginal discount is the marginal cost of retaining cash internally by issuing options in lieu of cash to employees (i.e., the additional value over and above the amount of salary for which the options are exchanged) and the flotation cost is the marginal cost of raising capital externally.

The discount the employee places on the options is determined in a similar manner as in Hall and Murphy (2002) with one difference – we are interested in finding the discount on the marginal option instead of the average discount over a bundle of options. To find the “marginal discount”, we first find how many options the employee would be willing to exchange for a certain amount of cash. In Table 1, for example, an employee with our base case assumptions would be willing to substitute \$10,000 of cash salary for 655 options, worth approximately \$10,843. (The discount Hall and Murphy (2002) would assign to this exchange is  $100 * (1 - 10,000 / 10,843) = 7.8\%$ .) We then find the certainty equivalent of the 655<sup>th</sup> option by finding the difference in the amount of cash an employee would need to receive in order to be indifferent between receiving 655 options and 654 options. The marginal discount is the ratio between this cash difference and the risk-neutral option value, which is 14.0% in this case.

### III. Results

We assume the risk-averse employees have a power function utility preference, as follows:

$$U(\cdot) = \frac{(\cdot)^{1-\alpha}}{1-\alpha} \quad (7)$$

where  $\alpha$  is the coefficient of relative risk aversion. We use numerical methods to solve for the optimal percent of cash and options. We first assume an initial set of parameters as a base case and then show the effects of changing the individual parameters. The parameters we use are generally the same as those used by Hall and Murphy (2002) except we focus on non-executives. Therefore, we first describe the results for a general employee with a potential all cash salary of \$50,000<sup>6</sup>, an initial wealth of \$200,000 with no restriction to hold stock as part of wealth ( $n_S = 0$ ), and a risk aversion of  $\alpha = 2$ . Lower level employees generally do not hold a significant portion of their wealth in company equity and have complete access to a market portfolio. Therefore, they do not discount options to the same extent as an executive who may have a significant portion of wealth tied to company performance through stock or options. For the simulation of stock and index prices, we use the probabilities given by the bivariate lognormal distribution with  $\sigma_S = 0.30$ ,  $\sigma_I = 0.20$ ,  $\beta = 1$ ,  $\rho = 0.67$ ,  $r_f = 0.06$ ,  $rp_m = 0.065$ ,  $S_0 = I_0 = 30$ , and the strike price equal to the grant-date stock price of \$30.

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<sup>6</sup> We also ran the model using \$30,000 and \$100,000 cash compensation, but found approximately the same relative results as in the base case using a \$50,000 salary. However, given that the average propensity to consume is a declining function of income, one would expect that higher paid employees would have a higher relative level of wealth, which in turn would result in a higher optimal usage of options. Under this assumption, the use of options in compensation would be a monotonically increasing function of compensation, *ceteris paribus*.

In our simulation, we calculate the number of options that must be granted to the employee as his cash compensation is reduced by various amounts. To calculate this number of compensating options, we first calculate the employee's reservation utility using (3). In calculating the reservation utility, the optimal allocation of wealth,  $W(C)$ , (which includes the employee's cash salary and non-stock wealth) to the market portfolio is determined as the fraction of wealth that maximizes the employee's expected utility. Once the reservation utility is determined, we then calculate the number of options that must be granted to the employee as his cash compensation is reduced in order to satisfy the employee's participation constraint given in (5). The number of compensating options the employee must receive is simultaneously determined with the allocation of wealth the employee would optimally allocate to the market portfolio. For example, using the base case, when cash compensation is reduced by \$5000, the employee must receive 316 options with a value of \$5,226 while his optimal allocation of wealth to the market portfolio is 75.2 percent (not shown in table). When cash compensation is reduced by \$10,000, the employee must receive 655 options worth \$10,843 while his optimal allocation of wealth to the market portfolio 73.5 percent. Finally, once we determine how many options an employee must receive to compensate for a given decrease in cash compensation, the amount the employee discounts the options he receives is determined. We can calculate both the average discount for the bundle of options as a whole and the marginal discount the employee places on the last option he receives. For our purposes, the latter number is more relevant. To calculate the certainty equivalent (and, by extension, the discount the employee places on the options), we reduce the options the employee is receiving by 1 and calculate the certainty equivalent of this 1 option. For

example, in the case where the employee's compensation is reduced by \$5000 and he must receive 316 options to satisfy his participation constraint, the employee values the 316<sup>th</sup> option at \$15.26 which is a 7.8 percent discount compared to the risk-neutral valuation.<sup>7,8</sup>

Figure 1 shows the use of employee stock options in compensation agreements for the base case. The y-axis on this chart represents our objective function (equation (6) with a floatation cost of 7.1% which is selected from the average floatation cost found by Lee, Lochhead, Ritter, and Zhao (1996)), or the net benefit to the firm (i.e., the savings in floatation costs less the extra compensation to yield the same reservation level of utility). The x-axis represents the percent of options used in compensation. With these parameter values, the Black-Scholes option value is 16.55, and the objective function is optimized when options are 9.3% of compensation. The inverted U-shape demonstrates the tension between the financing benefit and the rising marginal cost of issuing options in place of cash due to the rising employee discount of options. This discount starts at zero as an employee without any stock and with access to a market portfolio has the ability to (nearly) fully diversify so that he values the first option exchanged for cash-salary at (approximately) the Black-Scholes value. As more options are granted, he begins to discount them at greater and greater amounts. At the optimal point, the employee is willing to trade \$4,500 worth of cash salary for 283 options with a value of \$4,686. This is surprisingly close to the median level of \$3,000 in stock options that non-executives hold, according to Core and Guay (2001). At the margin, the employee discounts options

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<sup>7</sup> When calculating the certainty equivalent and employee discount, we allow the employee's allocation of wealth to the market portfolio to change, although the change in the optimal allocation is often small.

<sup>8</sup> The certainty equivalent of the bundle of 316 options (worth \$5226 to a risk-neutral individual) is \$5000, and hence the average discount is 4.3 percent.

at 7.1% (equal to the flotation cost). This shows that the use of options in lieu of cash could potentially preserve millions of dollars worth of capital each year for a company, for example, with as few as five hundred employees.

Table 1 shows various combinations of cash and options in a compensation package that our model indicates would be equally acceptable to a risk-averse employee (i.e., that maintains the same reservation utility). As more and more options are included as part of the compensation package, the employee discounts the value of the option portion to a greater degree because his total investment position becomes more undiversified. From a financing viewpoint by the firm, an optimal savings will occur when the marginal discount from the employee just equals the flotation cost of the firm for external financing. Thus, firms with higher flotation costs would have an incentive to offer employees more options as part of compensation. Note that a modest use of options could easily be justified for flotation costs in the 3-17% range of direct costs as reported by Lee, Lochhead, Ritter, and Zhao (1996). Of course, traditional incentive theory would have difficulty explaining this general use of options to non-executive employees because their ability to directly influence the stock price is questionable.

Tables 2, 3, and 4 show the effects of changes in the parameters from our base case for the discount employees place on traditional options.<sup>9</sup> Table 2 shows that employees with a higher risk aversion discount the value of traditional options to a greater degree, and employees with a lower risk aversion discount the value of traditional options to a lesser degree.<sup>10</sup> Table 3 shows that increasing the volatility of the stock

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<sup>9</sup> We also ran cases with a 3-year life and found the marginal discount was about half that in the base case, which provides support that the financing motivation for the use of options in compensation remains if the options are exercised early.

<sup>10</sup> We note that a relatively small decrease in the relative risk aversion reduces the discount on options in

(holding all else constant) increases the discount employees place on options. This effect occurs because increasing the volatility while holding beta constant increases the amount of unsystematic risk that cannot be diversified away. Table 4 shows that increasing the beta of the stock while holding the volatility constant has an ambiguous effect.<sup>11</sup> A higher beta decreases the discount on the options because this increases the expected return of the stock distribution (through CAPM). This effect dominates for the first options that displace cash compensation (i.e., at the top of each panel in Table 4). On the other hand, a higher beta increases the discount on options because of a higher correlation with the market portfolio (increasing the downside risk of the employee, which is then evaluated by his risk-averse utility function as a larger discount). This effect becomes dominant as more and more cash compensation is displaced with options (i.e., at the bottom of each panel in Table 4).

This paper has explored a financing explanation for the use of options among non-executive employees. We have shown a broad cross-section of parameters for which the financing motivation would be applicable to explain at least a partial use options as part of a compensation package for general employees. We leave to future research the use of non-traditional options and restricted stock as alternative means of compensation beyond traditional options.

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compensation significantly. This observation is important in that it broadens the applicability of the financing motivation for using options in compensation.

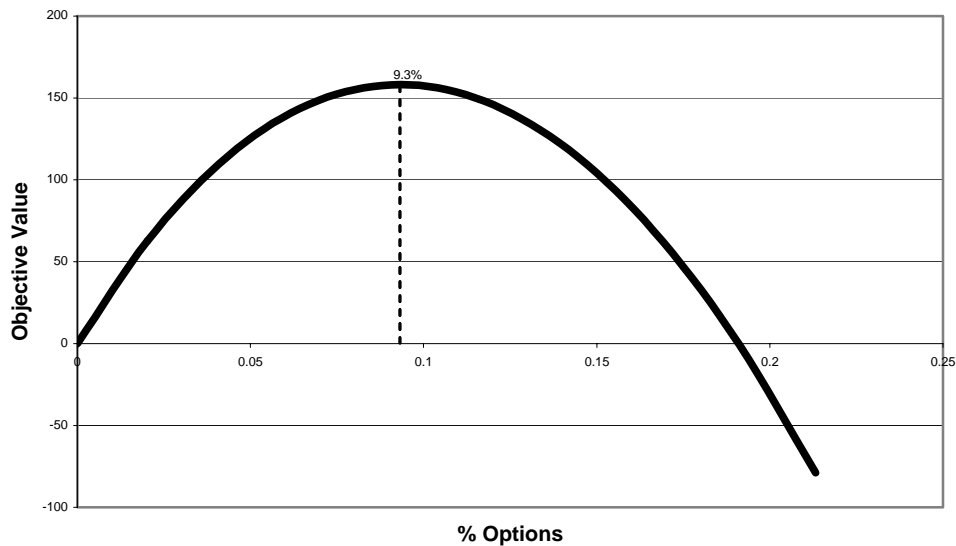
<sup>11</sup> We also used higher betas (e.g., beta = 2) with similar results in terms of the two opposing effects described in the text.

#### **IV. Summary**

Stock options are often used in employee compensation as an incentive to increase the value of the firm. However, there are other reasons firms use stock options. We develop a model based on a financing explanation for the use of stock options in compensation agreements. Our simulation results indicate that an optimal result is the use of options for 9.3% of compensation for a non-executive employee with a compensation of \$50,000. Finding an optimal level of non-cash compensation in this context requires a balancing of two opposing factors. First, the firm receives a benefit as equity is issued at a cost less than the flotation costs in public capital markets. However, the firm must provide additional compensation above an all-cash salary to keep the employee at the same level of reservation utility as an all-cash salary. This result occurs because employees that are not fully diversified will subsequently value the risky part of their compensation at less than the cost to the firm. The optimal use of cash and employee stock options based on a financing motivation provides a reasonable explanation for the use of options in compensation for a broad cross-section of employees, even if they cannot effectively influence the stock price (as required by incentive theory).

**Figure 1**  
**The Optimal Use of Options in Compensation Agreements**

The y-axis represents simulation results of the objective function of the model, which are reduced financing costs less the increased cost of the compensation package of cash and options. The x-axis is the percent options used in a compensation package of cash and options. Parameters used are a coefficient of relative risk aversion ( $\alpha$ ) of 2, employee wealth ( $W$ ) of \$200,000 (all of which can be allocated between a market portfolio and the risk-free asset), flotation cost ( $F$ ) of 7.1%, a risk-free interest rate ( $r$ ) of 6%, a market risk premium of 6.5%, volatility of the market portfolio of 0.2, stock volatility of 0.3, and a stock beta equal to one. The reservation utility is calculated with an all-cash compensation package of \$50,000.



**Table 1**  
**Discount of Option Values by Employees (Base Case)**

This table shows the combinations of options and cash that maintain an employee at a given reservation utility. Parameters used are a coefficient of relative risk aversion of 2, employee wealth (W) of \$200,000 (all of which can be allocated between a market portfolio and the risk-free asset), stock volatility of 0.3, a risk-free interest rate (r) of 6%, a market risk premium of 6.5%, volatility of the market portfolio of 0.2, and  $\beta=1$ . The reservation utility is calculated with an all-cash compensation package of \$50,000.

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,014	49,000	61.3	1,014	2.1
50,043	48,000	123.5	2,043	3.6
50,089	47,000	186.7	3,089	5.0
50,149	46,000	250.8	4,149	6.4
50,226	45,000	315.8	5,226	7.8
50,318	44,000	381.8	6,318	9.1
50,426	43,000	448.8	7,426	10.4
50,549	42,000	516.7	8,549	11.6
50,688	41,000	585.5	9,688	12.8
50,843	40,000	655.3	10,843	14.0

**Table 2**  
**Discount by Employees with Higher Risk Aversion**

This table shows the combinations of options and cash that maintain an employee at a given reservation utility. Parameters used are a coefficient of relative risk aversion of 3, employee wealth (W) of \$200,000 (all of which can be allocated between a market portfolio and the risk-free asset), stock volatility of 0.3, a risk-free interest rate (r) of 6%, a market risk premium of 6.5%, volatility of the market portfolio of 0.2, and  $\beta=1$ . The reservation utility is calculated with an all-cash compensation package of \$50,000.

Panel A: Relative Risk Aversion = 1.5

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,000	49,000	60.4	1,000	0.6
50,012	48,000	121.6	2,012	1.7
50,034	47,000	183.4	3,034	2.7
50,067	46,000	245.8	4,067	3.7
50,111	45,000	308.9	5,111	4.7
50,166	44,000	372.6	6,166	5.7
50,231	43,000	437.0	7,231	6.6
50,308	42,000	502.1	8,308	7.5
50,394	41,000	567.7	9,394	8.4
50,492	40,000	634.1	10,492	9.3

Panel B: Relative Risk Aversion = 3

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,027	49,000	62.1	1,027	3.8
50,080	48,000	125.7	2,080	6.2
50,159	47,000	190.9	3,159	8.4
50,265	46,000	257.7	4,265	10.6
50,396	45,000	326.1	5,396	12.6
50,554	44,000	396.1	6,554	14.6
50,739	43,000	467.7	7,739	16.5
50,951	42,000	541.0	8,951	18.4
51,191	41,000	615.9	10,191	20.2
51,458	40,000	692.5	11,458	22.0

**Table 3**  
**Discount by Employees when Stock Volatility is Higher**

This table shows the combinations of options and cash that maintain an employee at a given reservation utility. Parameters used are a coefficient of relative risk aversion of 2, employee wealth (W) of \$200,000 (all of which can be allocated between a market portfolio and the risk-free asset), stock volatility of 0.4, a risk-free interest rate (r) of 6%, a market risk premium of 6.5%, volatility of the market portfolio of 0.2, and  $\beta=1$ . The reservation utility is calculated with an all-cash compensation package of \$50,000.

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,020	49,000	54.7	1,020	4.0
50,082	48,000	111.7	2,082	7.6
50,185	47,000	170.8	3,185	10.9
50,327	46,000	232.0	4,327	13.9
50,509	45,000	295.4	5,509	16.7
50,729	44,000	360.8	6,729	19.3
50,988	43,000	428.3	7,988	21.8
51,286	42,000	497.9	9,286	24.1
51,624	41,000	569.7	10,624	26.3
52,000	40,000	643.5	12,000	28.4

**Table 4**  
**Discount by Employees when the Stock Beta Changes**

This table shows the combinations of options and cash that maintain an employee at a given reservation utility. Parameters used are a coefficient of relative risk aversion of 2, employee wealth (W) of \$200,000 (all of which can be allocated between a market portfolio and the risk-free asset), stock volatility of 0.3, a risk-free interest rate (r) of 6%, a market risk premium of 6.5%, volatility of the market portfolio of 0.2, and stock betas of 0.8 and 1.2. The reservation utility is calculated with an all-cash compensation package of \$50,000.

**Panel A, Beta = 0.8**

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,000	49,000	60.4	1,000	1.0
50,020	48,000	122.1	2,020	3.0
50,061	47,000	185.0	3,061	4.8
50,123	46,000	249.1	4,123	6.6
50,204	45,000	314.5	5,204	8.4
50,306	44,000	381.1	6,306	10.0
50,427	43,000	448.9	7,427	11.6
50,570	42,000	517.9	8,570	13.2
50,732	41,000	588.1	9,732	14.7
50,915	40,000	659.6	10,915	16.2

**Panel B, Beta = 1.2**

Total Compensation	Cash	Options	Options Value	Marginal Discount (%)
50,000	50,000	0	0	0.0
50,034	49,000	62.5	1,034	3.8
50,079	48,000	125.6	2,079	4.8
50,134	47,000	189.4	3,134	5.7
50,200	46,000	253.8	4,200	6.7
50,277	45,000	318.9	5,277	7.6
50,365	44,000	384.6	6,365	8.5
50,463	43,000	451.0	7,463	9.4
50,572	42,000	518.0	8,572	10.3
50,692	41,000	585.7	9,692	11.1
50,822	40,000	654.0	10,822	12.0

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