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Letter of Comment No: 4814  
File Reference: 1102-100

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June 29, 2004

Ms. Suzanne Bielstein, Director of Major Projects  
Financial Accounting Standards Board  
401 Merritt 7  
P.O. Box 5116  
Norwalk, Connecticut 06856-5116

RE: Exposure Draft – Share-Based Payment –  
An amendment of Statements No. 123 and 95  
(Proposed Statement of Financial Accounting Standards)

Dear Ms. Bielstein:

The following letter is in response to FASB's request for comment on the "Exposure Draft – Share Based Payment – An Amendment of Statements No. 123 and 95". It is based on our continuing research program on stock options. Specifically, we have used actual stock option exercise data from a broad-based option program in a large, established firm outside of manufacturing to investigate several issues including the *value employees place on stock options* and the *cost of stock options to firms*. The research for these papers is completed and will be reported in two forthcoming working papers "Estimating the Value of Stock Options to Non-Executive Employees" and "Estimating the Expected Cost of Employee Stock Options." We anticipate these papers will be available before the end of July 2004.

Our research suggests that the value employees place on options is revealed by the *timing* of their exercise decisions and the timing of exercise decisions strongly influences the estimate of the cost of options to firms. While this latter point is recognized in the ED, because the timing of exercise decisions depends on the path of the firm's stock price, costing options using the historical average exercise time from one time period (1990s) may provide substantially misleading estimates of the cost of options to a firm.

While we are not accountants, our past research investigates a variety of compensation issues using statistical methods and unique data. Our current work on options speaks directly to four of the "issues" in the Exposure Draft (ED). In the following letter, we respond to the four issues and then describe some of the results of our work in more detail. Finally, we provide a brief example to show the estimation and simulation method we describe provides a more consistent estimate of the cost of options to firms than using the expected exercise time calculated from a single historical period in Black-Scholes.

## I. Four Issues and our Broad Comments

*Issue 4a: “Do you believe that this proposed Statement provides sufficient guidance to ensure that the fair value measurement objective is applied with reasonable consistency? If not, what additional guidance is needed and why?”*

We do not believe that the ED provides sufficient guidance to ensure that the fair value measurement objective will be applied with reasonable consistency. As we detail below, firms that use the historical mean exercise time for their option grants to up-date the Black-Scholes formula may significantly under (or over) estimate the cost of the options to the firm relative to the “true” cost of the options. Our results are based on simulating exercise decisions over thousands of possible stock price paths – not simply using the historical average for the firm from one (or a few) grants. The first of our forthcoming working papers shows that a host of variables, including characteristics of employees, the market, the options themselves, the stock price of the firm and unobserved employee characteristics such as risk aversion, influence the stock option exercise behavior of employees. We show in the second paper that firms will likely (and unknowingly) substantially over or understate the “true” expected cost of stock options if they simply use the historical average of exercise times in Black-Sholes.

*Issue 4(b): “Do you agree with the Board’s conclusions that the fair value of employee share options can be measured with sufficient reliability? If not, why not? Do you agree with the Board’s conclusion that a lattice model is preferable because it offers greater flexibility needed to effect the unique characteristics of employee share options? If not, why not?”*

We do agree with the Board’s conclusion that the fair value of employee share options can be measured with reliability. However, we do not think that the ED provides enough specific detail to measure the cost of options to firms that will be consistent. At the same time, an “estimation and simulation” method comparable to what we have done in our research can provide a substantially more credible and reliable estimate of the cost of options to firms than the two methods proposed in the ED.

We do agree that using a lattice model has the benefit of some added flexibility. However, a lattice model is not sufficiently flexible to accommodate the multivariate decision model that we find employees use when making exercise decisions. For example, to replicate our simulation results using a lattice model would require constructing a lattice model for each of 270 different hypothetical individuals where for each individual the probability of exercising an option changes at each node in the lattice. Then, one would need to simulate 10,000 exercise decisions through each of the 270 lattices 30 times for each employee. In our judgment nothing is gained by imposing the simulation exercise on a lattice model that cannot be achieved by directly using a simulation to estimate option costs. Simulation methods are used to value options and the method is particularly appropriate where, as in the case of employee stock options, option value depends on the firm’s stock price path (Hull, 2002). The speed of modern desktop computers no longer makes simulation methods infeasible. In our research we were able to simulate 81 million (270 individuals x 30 decisions/individual x 10,000 stock price paths) exercise times in about 5 hours.

*Issue 4(d): “This proposed Statement provides guidance on how the unique characteristics of employee share options would be considered in estimating their grant-date fair value. ... Do you agree that those methods give appropriate recognition to the unique characteristics of employee share options? If not, what alternative method would more accurately reflect the impact of those factors in estimating the options fair value?”*

Our analysis suggests that the methods proposed in the ED do not give appropriate recognition to the unique characteristics of employee stock option grants. To be sure, employees receiving options in

their own firm may value options at a level different from a risk-neutral, diversified, investor. However, our results show that a careful analysis of expected exercise times must go beyond calculating the mean exercise time using the exercise history from a recent option grant in Black-Scholes or the use of simple exercise decisions rules (i.e., stock price = 2 x exercise price) in a binomial model. Since the future stock price path is unknown, our results suggest a “rigorous analysis” of the expectation of exercise times needs to include a careful econometric analysis of exercise decisions and a simulation exercise comparable to what we describe briefly below to generate an unbiased estimate of the expected exercise time.

*Issue 18: “The Board’s objective is to issue financial accounting standards that can be read and understood by those possessing a reasonable level of accounting knowledge, a reasonable understanding of the business and economic activities covered by the accounting standard, and a willingness to study the standard with reasonable diligence. Do you believe that this proposed statement, taken as a whole, achieves that objective?”*

While we believe that the ED is clear to anyone with characteristics described in the previous paragraph, for the reasons stated, we think that there is not enough direction to make a clear and objective costing estimate of the options. This is because the ED states that a “rigorous analysis” must be made. However, as the ED states, this type of analysis could include simply using the closed form Black-Scholes formula with the proviso that the historical expected duration be substituted for the full term of the option. As we show below, the particular historical path taken by the company stock may provide an extremely misleading measure of this adjusted Black-Scholes value. Instead, we recommend that firms model the exercise decisions of employees using historical data and then use the estimation results to simulate exercise decisions over a large sample of possible stock price paths.

## II. Findings from our Research Program and Some More Details

As noted above our current research on employee stock options can be separated into two parts. The first is focused on the *value employees place on stock options* and is forthcoming in our paper “Estimating the Value of Stock Options to Non-Executive Employees.” The *cost of stock options to firms* is considered in the second working paper, “Estimating the Expected Cost of Employee Stock Options.” It turns out that the value employees place on options is revealed by the *timing* of their exercise decisions. Also, and more directly relevant to the FASB ED, is that this timing strongly influences the estimate of the cost of options to firms.

The analysis in the first of our forthcoming working papers on stock options, “Estimating the Value of Stock Options to Non-Executive Employees,” departs from previous research because we estimate the actual dollar value employees place on holding an option using *actual* employee exercise behavior rather than basing the valuation on untested assumptions about the shape of an employee’s utility function or level of risk aversion. To estimate the value of holding an option we use the simple theoretical model that predicts an employee will choose to hold an option for another period if the utility of the income he/she would receive by exercising the option today (the intrinsic value) is less than the value of holding the option and reserving the right to exercise it at a later date. We call this latter value the “Employee Value Function (EVF)”. We estimate the parameters of the EVF using a “random effects probit” model that is estimated by the method of “simulated maximum likelihood estimation” using the exercise decision of employees. The EVF is a function of a variety of variables that capture characteristics of the employee, the options, the stock market, the firm’s stock price and unobservable individual characteristics such as risk aversion. We show that EVF can be identified with data where there are at least two option grants per employee at different exercise prices. We estimate the model using data on options granted to over 2000 middle level managers in a large established non-manufacturing firm.

The statistical model we use is a random effects probit model which, when applied to exercise decisions, is a discrete time duration model where an employee exercises his options the first time the value of holding an option another period is less than the intrinsic value of the option. Therefore, our results on the value of options to employees are also informative about the *timing* of their exercise decisions. While we have applied our method in only one firm and the specific parameter values we obtain may differ in other firms, we think the general point that employee exercise decisions respond to changes in the firm's stock price is a result that will generalize and, therefore, has implications for the ED and the cost of options to firms.

In our forthcoming working paper, "Estimating the Expected Cost of Employee Stock Options," we build on the results of the first paper to consider how our estimates of a model of employee exercise decisions can be used to estimate the cost of options to firms.

In our judgment, the critical issue in costing options is the *timing* of exercise decisions by employees. The fundamental problem with trying to explain why employees exercise options early using Black-Scholes is that employee stock option exercise decisions are not described by Black-Scholes because the theory makes no prediction about how long an individual investor will (or should) own an option. The Black-Scholes model predicts that a diversified investor will never exercise a European call option prior to the moment before it expires because at any earlier date the expected gain from holding the option until the expiration date is always greater than the intrinsic value of the option. In other words, prior to the expiration date of the option, the possibility of a large stock price increase between the current period and the expiration date makes the expected profit a moment before the option expires greater than the profit that could be made by exercising the option at any earlier time. Therefore, individuals holding a market traded European option will not exercise the option early because they can always sell the unexercised option in the market for more than they could get by exercising it. Thus, the model predicts that when an owner of a market traded option wants to liquidate his option she will sell it rather than exercise it. By design there is no market for employee stock options; employees cannot sell their options to other individuals so that each period an employee's only decision is between exercising and not exercising the option. This difference between market traded options and employee stock options means that Black-Scholes makes no prediction about what the distribution of exercise times looks like. Determining the mean and shape of the distribution of exercise times is an empirical question that can only be identified by first estimating a model of the exercise decisions of individual employees and then simulating employee exercise behavior over possible stock price paths using the parameter estimates from the empirical analysis of exercise decisions.

Although Black-Scholes does not make a prediction about how long employees will hold an option, modeling the length of time employees hold options is important because of its impact on the cost of options to the firm. When employees exercise options early, they forfeit the expected gains from holding the option until it expires and by foregoing these gains, other things equal, the cost to the firm of providing an employee stock option is less than the Black-Scholes value of a European option held for the term of the option grant. This relationship between employee exercise decisions and firm option costs is reflected in the ED where the preferred costing method uses firm historical data on the distribution of employee exercise times and a lattice model (e.g., a binomial tree) to account for "early" exercise decisions. If historical data on the distribution of exercise times is unavailable, then the Exposure Draft allows firms to use Black-Scholes or a similar formula for a European option where the term of the option is set equal to the  $E(\text{exercise time})$  for the population of employees receiving options.

The ED recognizes the importance of exercise times for determining the cost of options to the firm. However, it focuses only on the expected time options are held or the distribution of option times generated by a single decision rule that is incorporated into a lattice model. It does not adequately

discuss how the distribution of exercise times affects option costs or how the distribution (or mean) of exercise times should be determined. Our second forthcoming working paper presents and evaluates alternative methods of expensing employee stock options that builds on the analysis of employee exercise decisions in our first paper. In this second paper the parameters of a reduced form random-effects probit model of exercise decisions is estimated and then used to simulate the distribution of exercise times over possible stock price paths. These simulation results are then used to construct and compare different methods of expensing options. Our use of simulation methods to estimate option values has a long history in finance (Hull, 2002, Ch.18).

### III. An Example to Illustrate How Using Our Method Can Provide More Consistent Cost Estimates

In footnote 8 to paragraph B-14 the ED suggests that firms should perform a “rigorous analysis of the employee share option or similar instrument’s expected term in estimating that input for use in the model.” The ED does not note, however, what is meant by a “rigorous analysis”.

How accurate is an estimate of the mean exercise time if a firm were to follow current practice and calculate the mean exercise time from the exercise times from one option grant? One way to answer this question for the firm we’ve studied is to examine the distribution of  $E(\text{Exercise Time})$  calculated from an appropriate simulation and compare these results with the historical data from the firm we study using one of the option grants. The  $E(\text{Exercise Time})$  for one of the grants included in our empirical analysis was 63.31 months following a two year vesting period. Using this value in Black-Scholes, the estimated cost of a \$10, 10 year (granted “at-the-money”) option is \$4.65 ( $\sigma=.3$  &  $r=.06$ ). This is an over-estimate of the cost of options for this firm because our best estimate of the  $E(\text{Exercise Time})$  from the simulation is 46.1 months which produces a Black-Scholes cost of \$4.11. Thus, the firm we study would over-state option costs by 13 percent if it used the unconditional mean of exercise times from one option grant rather than the mean estimate of exercise times over the distribution of possible stock price paths.

A more general assessment of the accuracy of an estimate of  $E(\text{Exercise Time})$  from one grant is obtained by examining the density of exercise times across 10,000 price paths that were used in our simulation. The distribution of these exercise times is shown in Figure 1. This figure shows substantial variation in expected exercise times across stock price paths; the mean of this distribution is 46.1 months and the standard deviation is 14.7 months. This figure implies two identical firms could use very different values for  $E(\text{Exercise Times})$  in Black-Scholes simply because they happen to have historical option data generated by different stock price paths. The figure and its associated data imply that there is a 40% chance that the  $E(\text{Exercise Time})$  will be greater than 50.6 or less than 37.1 months and 20% chance a single mean value will be less than 22.5 or greater than 57.2 months after vesting.

How much variability in estimated exercise costs is introduced by using an estimate of  $E(\text{Exercise time})$  from a single option grant? The expected exercise times over the 10,000 price paths summarized in Figure 1 were used as inputs into Black-Scholes to produce the distribution of option costs one would expect across the 10,000 randomly selected price paths. Figure 2 shows this distribution. The expected cost over the 10,000 simulated price paths and the best estimate of option costs using the adjusted Black-Scholes formula is \$4.11. For the firm we study, there is a 40% chance that the estimated option cost calculated from a single price path is less than \$3.84 or more than \$4.30 and a 20% chance the cost is less than \$3.27 or greater than \$4.51. If returns during the exercise histories for two identical firms were uncorrelated, then there is one chance out of 25 that one firm would have option costs 12 percent greater than the other firm. On the other hand, if the historical returns used to calculate  $E(\text{Exercise Times})$  were correlated because the data came from one time period (1990s) and the firms were in the same industry, then the  $E(\text{exercise time})$  for these firms will be positively correlated with one another. A positive

correlation in estimates of E(Exercise Time) across firms in an industry means firms in the industry will likely systematically overstate or understate option costs.

In summary, these results show a “rigorous analysis” of expected exercise times must go beyond calculating the mean exercise time using the exercise history from a recent option grant. Since the future stock price path is unknown, our results suggest a “rigorous analysis” of E(Exercise Times) needs to include a careful econometric analysis and simulation exercise comparable to what we have completed in our second paper that generates an unbiased estimate of E(Exercise times) over the distribution of possible stock price paths.

The second and preferred method of expensing options described in the ED is to use a lattice model. As the ED notes, a lattice model is more flexible than a closed form model because it can explicitly adjust for changes in model parameters during the term of the option, including early exercise decisions by employees. A lattice model can generate both the expected exercise time and the value of an option where early exercise decisions are made at particular nodes where a threshold is exceeded or some event occurs. The ED notes:

...if an entity uses a lattice model that has been modified to take into account an option’s contractual term and employees’ expected exercise and post-vesting termination behavior, the expected term is based on the resulting output of the lattice. For example, an entity’s experience might indicate that option holders tend to exercise those options when the share price reaches 200 percent of the exercise price. If so, that entity might use a lattice model that assumes exercise of the option at each node along each share price path in a lattice at which the early exercise expectation is met, provided the option is vested and exercisable at that point.

Continuing with the company we have studied, the ED gives little guidance about how a firm is to measure and implement a “tendency” for employees to exercise options at twice the exercise price. We assume a firm would look at its recent history and calculate the exercise hazard on the day or days the stock price crossed this price threshold and determine if this hazard is greater than the hazard at other times. In the firm we’ve studied the hazard rate in the threshold month is slightly higher (.022) than the hazard in surrounding months but certainly less than one because not everyone uses this exercise decision rule. Since the firm’s stock price passed this price threshold only one time for this exercise grant, it is likely to be very difficult to construct a statistical test with sufficient power to usefully test whether this hazard is higher than what might be expected by chance.

However, assuming such a test could be constructed and the firm concludes there is a “tendency” for some employees to exercise at this price threshold, how should this higher hazard rate be used in a lattice model? The ED gives little guidance on this point. One plausible way to proceed is to construct a binomial model where an employee is forced to exercise an option at each node where a stock price exceeds twice the exercise price. The value of the option at time zero could then be calculated by working back through the lattice from the early exercise points and the endpoints of the lattice for prices that are not ruled out by the impact of the threshold. These calculations would then provide an estimate of the cost of an option for the small fraction of employees who use this decision-rule. How then should option costs be calculated for employees who do not use this decision rule? One could either (1) assume these employees hold their options for the entire 96 months and use the lattice model or the Black-Scholes model to estimate the price of a 96 month plus vesting period call option or, (2) the firm could use E(Exercise Time) in Black-Scholes. Neither of these estimates would be a good estimate of option costs.

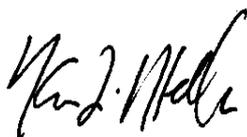
The empirical results we summarized above show exercise decisions are influenced in a significant way by a wide variety of observable and unobservable variables. The model specification used in our analysis included price referents or thresholds that captured the decision process of some

employees as well as the profits that could be made by exercising the option. A lattice model is not well suited for valuing options where exercise decision rules depend on earlier prices or more generally the price path of the stock (Hull, 2002). Our estimates show the decision to exercise options is a multi-dimensional decision and *any* pricing method must reflect the impact of all of the different factors that influence the distribution of exercise times. Constructing a lattice model that incorporates the complex decision model we estimate implies that at each node of the lattice an analyst would have to keep track of the different exercise probabilities of each employee because these probabilities are going to differ along observable and unobservable characteristics and change from one node to the next because each person's exercise probability changes with the stock price change associated with moving to another node. In our preferred simulation we model the behavior of 30 employees with different values of "unobserved heterogeneity" at each of nine points along the employee salary distribution who would have different exercise probabilities at each node of the lattice. There is no easy way to adapt the lattice model so it can incorporate this model of exercise behavior without literally imposing a simulation exercise on top of the lattice model. As noted above, the most feasible way of using a lattice framework would be to create a separate lattice for each of the 270 distinct individuals in the simulation. At each node in each lattice the individual would have a different probability of exercising conditional on having not previously exercised his options. Exercise decisions through each of the 270 lattices would be simulated 30 times for a randomly chosen price path through the lattice. This would then be repeated for 10,000 randomly chosen price paths through the lattice for a total of 81 million simulated exercise decisions. This adds nothing to the results that are obtained from only a simulation and it is quite a bit more complicated.

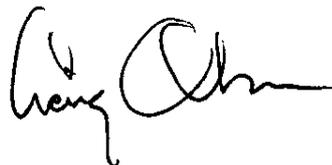
We believe that the results of our work have important implications for the FASB ED. Clearly, the value of options to employees is different from the Black-Scholes value of the option and the cost to firms is also different from Black-Scholes value: both of these ideas have been known for some time. Our research shows that by following the suggestions in the ED, it is possible for firms to either substantially over- or under-estimate the cost of options to their employees. Specifically, timing matters to the costing of options by firms and using the historical average exercise time may produce substantially misleading estimates of the cost of options to firms. We provide an alternative "estimation and simulation" method that will provide much more consistent estimates of the cost of options to firms.

Please feel free to contact us if you have questions about our research papers or our methods.

Sincerely,



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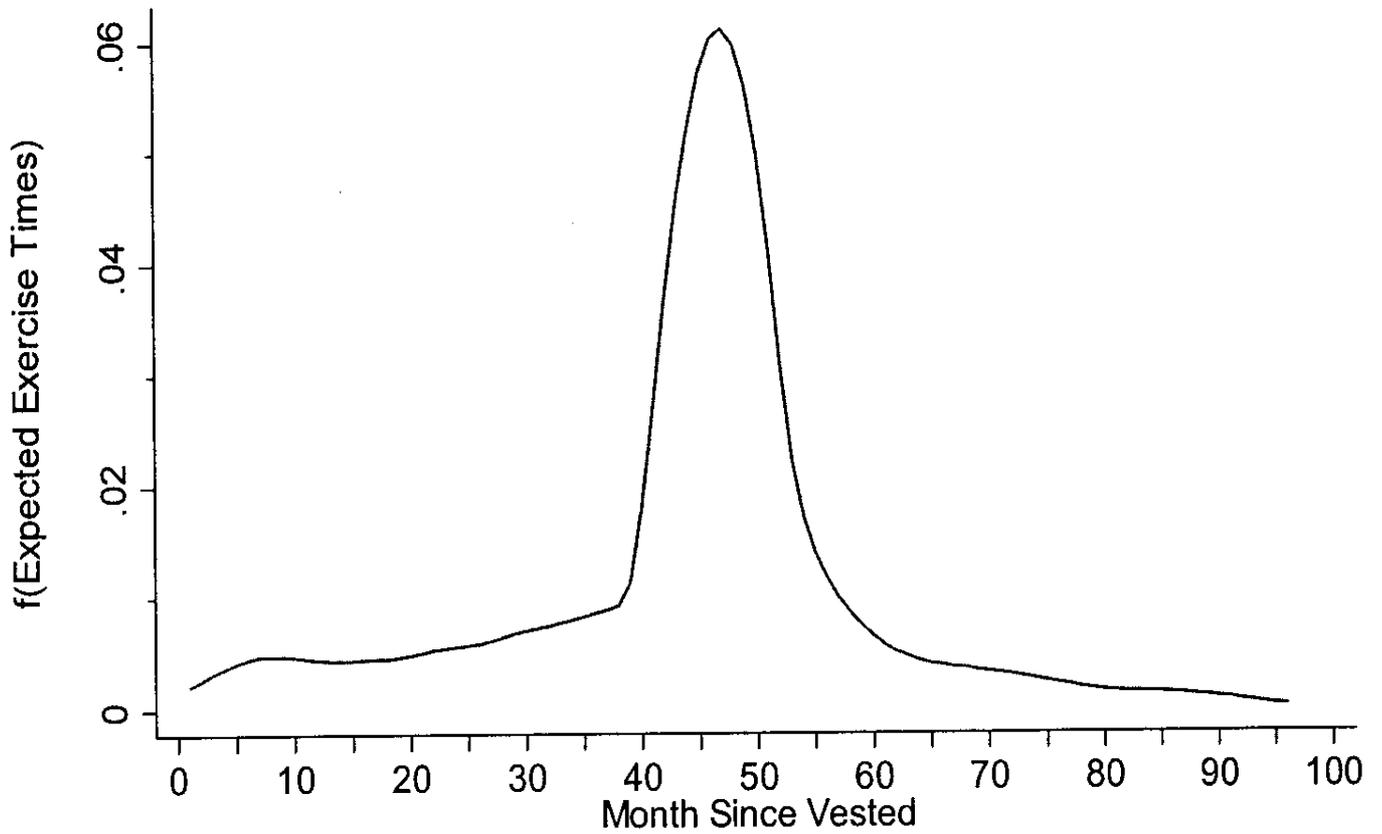


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Attachments: Figure 1 & Figure 2

**Figure 1**

Density of Expected Exercise Times Over  
Stock Price Paths Using Model With  
Observed and Unobserved Heterogeneity

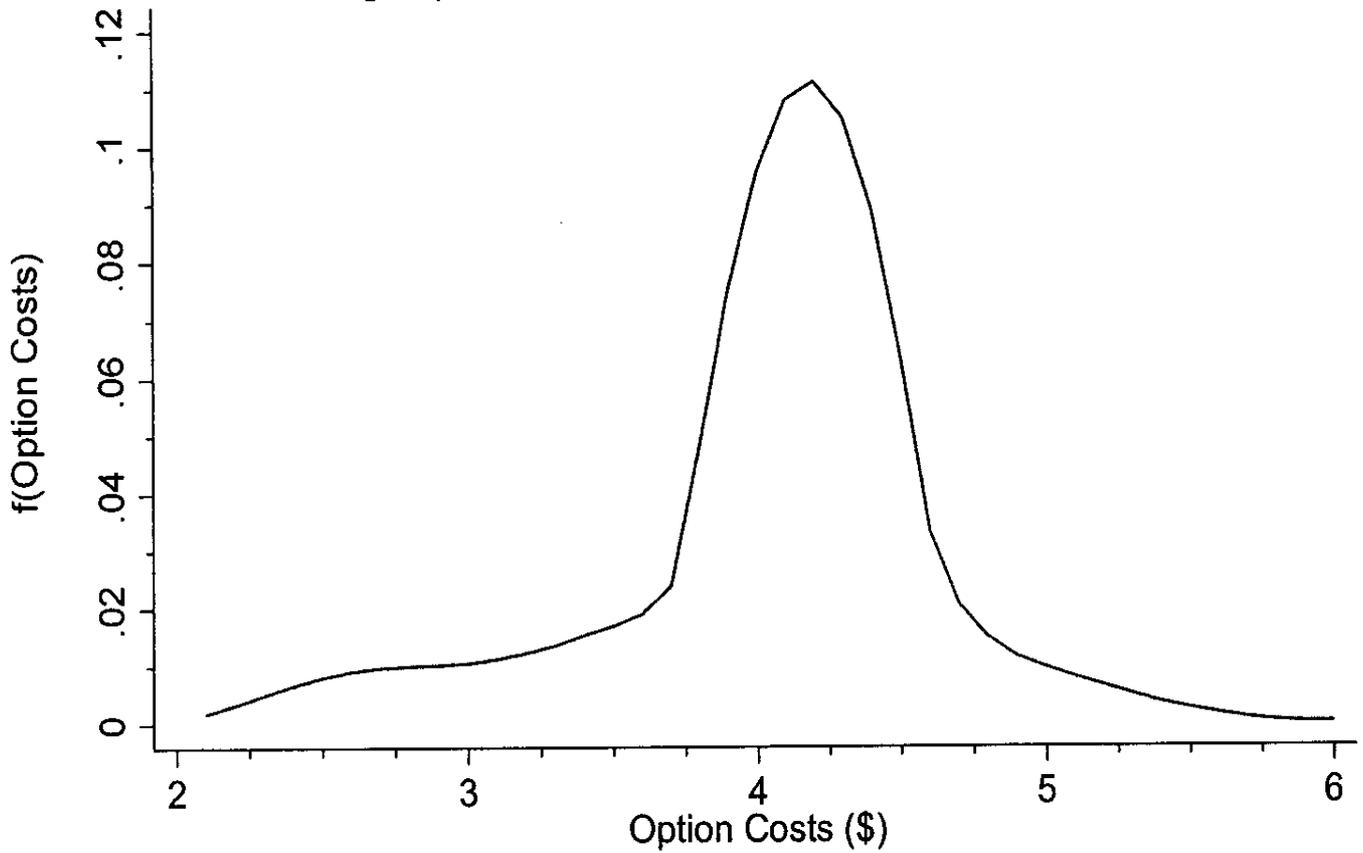


Based on simulated exercise decisions over 10,000 stock price paths.

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**Figure 2**

Distribution of Option Costs Across Stock Price Paths  
Using Expected Exercise Time in Black-Scholes Formula



Based on simulated exercise decisions over 10,000 stock price paths. Cost is for a 10 year \$10 at-the-money option with 2 yr vesting, SD(returns)=.3 and risk free interest rate=.06

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