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Valuation of Employee Stock Options And Other Equity-Based Instruments

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Valuation of Employee Stock Options and Other Equity-Based Instruments:

An Analysis of FASB's 2004 Exposure Draft on Share-Based Payment and Implications for Firms

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Purpose

On March 31, 2004, the Financial Accounting Standards Board (FASB) published an Exposure Draft (ED) on accounting for equity-based compensation. The ED requires that firms expense ESOs and provides guidance as to how they should be valued. This report summarizes the new valuation guidelines and provides commentary, where appropriate, including potential implications for firms. Also included is a primer on the two most widely used valuation models (Black-Scholes and binomial lattice), and a discussion on modifying the binomial model to reflect the unique features of ESOs. The report also discusses the potential impact the new guidelines will have on the design of equity-based compensation.

Executive Summary

Employee stock options (ESOs) are fundamentally different instruments from exchange-traded options. They typically contain features that make them more complex from a valuation perspective, including vesting schedules, transferability restrictions, forfeiture provisions and blackout dates. FASB's recent ED on accounting for equity-based compensation requires that firms expense ESOs and provides guidance on how they should be valued. These expensing guidelines are likely to have a significant impact on the way firms compensate employees. Because all types of equity-based compensation will need to be expensed on the income statement, including standard "at-the-money" options, many firms are likely to find that other types of instruments will better meet their needs. Optimizing equity-based compensation will require tailored instruments that minimize the cost to the firm while maximizing the perceived value to employees.

The key points of FASB's ED are as follows:

- Equity instruments granted to employees for their services "give rise to recognizable compensation cost" and are to be recognized in the financial statements. Companies are to recognize the fair value of such instruments as of the grant date.

- The cost of the equity-based instruments, as measured on the grant date, is to be recognized over the service period, which requires an analysis of the terms and conditions of the award. For standard graded-vesting options, each tranch is essentially considered a separate award and is to be measured as such, with recognition occurring over its distinct service period. For such options, attribution of compensation expense is therefore larger at the front end and declines over the vesting period.

- In the absence of market prices for comparable instruments, fair value is to be based on an option valuation model that considers the same six factors considered in Statement of Financial Accounting Standards 123, including the expected term of the option (EOT). However, the ED now requires that EOT reflect the instrument's contractual term as well as employees' expected exercise and post-vesting employment termination behavior.

- The guidelines are designed to be flexible. While firms are not required to adopt any particular type of model, the ED does state a preference for lattice-based models (e.g., binomial models) over closed-form models (e.g., Black-Scholes models) because they can (1) be modified to reflect the unique characteristics of employee stock options; (2) reflect the expected term structure of the risk free rate, volatility, and expected changes in other inputs during the instrument's contractual life, and (3) "…accommodate estimates of employees' option exercise patterns and post-vesting employment termination during the option's contractual life and thereby can result in an adjustment for the non-transferability of employee share options that is more accurate than the adjustment resulting from a closed-form model using a single weighted-average expected life of the option."[1]

[1] Page 124, Paragraph C23 of the ED.

- For closed-form models, the duration input is similar to that required in FAS 123, except that EOT rather than "expected option life" is to be substituted for the option's contractual term. For lattice models there is ambiguity concerning the proper duration input to use. In several places, FASB either states or implies that the lattice model should be based on an instrument's contractual life. Yet in other places (e.g., Footnote B9 of Appendix B and in Issue 4(d) on Page iii) the ED states that to account for non-transferability fair value is to be estimated using the instrument's expected term, rather than its contractual term.

- While the ED clearly states how EOT is to be used in closed-form models, it does not clearly state how it is to be used in lattice models. For lattice-based models that have been modified to take into account an option's contractual term and employees' exercise and termination behavior, EOT is to be an *output* from the model as opposed to an input to the model.

- The ED does not discuss how to use this EOT calculation in lattice-based models for the determination of fair value. Since companies using lattice-based models are to both estimate EOT and to output this measure, one interpretation is that lattice models are to be calibrated to this measure. That is, companies could adjust the lattice-based model so that the value it outputs for EOT equals the actual observed measure of EOT. Another interpretation is that EOT is to be used instead of the option's contractual life as the duration input.

- Although FASB states a preference for lattice-based models, it does not require firms to use them, noting that some firms may lack the data required to reflect employees' expected exercise and post-vesting employment termination behavior.

- As discussed in the body of this Report, lattice models can be constructed that both comply with the ED requirements and use data that are readily available from most employee stock option programs. Professor Stephen Ross, one of the developers of the original binomial model, states in the minutes to FASB's Options Valuation Group meeting that the inputs required to estimate expected term are the same as those that would be incorporated into a time-dependent lattice model.[2] When the required data do not exist, it may be possible to use data from a basket of similar companies as a proxy. Hence, the data necessary to reflect employees' exercise and post-vesting departure behavior appears to be readily available.

- Although the ED guidelines are designed to be flexible, it does gives fairly precise guidance concerning how model inputs are to be calculated by (1) specifying factors that should be considered when estimating specific inputs, such as volatility; (2) requiring firms to consider how inputs, such as the risk-free rate and volatility, are expected to change during the contractual term of the instrument (so called "term structure" effects); and (3) requiring firms to consider the possibility of mean reversion when estimating volatility (i.e., the tendency of volatility to return to equilibrium levels).

- The ED states that there is likely to be a range of estimates for expected volatility, dividends, and option life and that if no value within the range is any more likely than any other value, then an average of the range (its "expected value") should be used for each of these inputs. Thus, even if the time paths of the inputs can be accurately estimated, a firm should instead use the average of the values in the model. As discussed in the body of this paper, this approach may be inconsistent with methods used by experts in the field and with the goals stated in the ED.

[2] See Minutes of the FASB Option Valuation Group Meeting, July 8, 2003.

- Instruments subject to performance conditions (e.g., growth in market share) are to be valued by multiplying the value per option by the firm's forecast of the most likely number of options to vest. However, this method may result in errors because it fails to reflect the correlation between the performance metric and the stock price. That is, this method does not reflect that high values of the performance metric may be associated with high levels of the stock price at the measurement date and consequently with high, not average, values for each option granted.

- The ED attempts to ensure consistency and comparability through various methods. For example, it gives precise guidelines as to how inputs are to be calculated. It precludes firms from switching back and forth between models. And once a firm elects to use a lattice-based model it is, with rare exceptions, precluded from reverting back to a closed-form model. Finally, the ED specifies minimum disclosure requirements (MDRs). The MDRs require firms to provide a description of the methods used to estimate fair value and to estimate model inputs.

I. Introduction and Background on ESO Valuation

The purpose of this report is to outline and examine the critical valuation issues addressed in FASB's recent Exposure Draft (ED) on share-based compensation. The ED essentially does two things: first, it requires firms to report equity-based compensation as an expense on the income statement; second, it provides guidance as to how firms are to calculate this expense. In Section A of the Introduction, we first provide some context for the proposed guidelines by giving an overview of stock options and the features that differentiate employee stock options (ESOs) from exchange-traded options (ETOs). We then include, in Section B, a primer on the Black-Scholes and binomial models, the two most commonly used methods for valuing ESOs. This section focuses on the binomial approach and how it can be modified to comply with the ED requirements for determining the fair value of equity-based instruments. In Section C, we discuss the accounting rules that have governed ESO valuation for the last 30 years, and how the new guidelines are likely to impact compensation design in the future.

Chapter II is a summary of the major issues outlined in the ED, including the requirements for compliant valuation models, FASB's preference for lattice-based models that can explicitly address the features of the instrument being valued and changes in the ED compared to FAS 123. The chapter also includes commentary, as appropriate, including insights on statements that may be construed as ambiguous or contradictory. Lastly, Chapter III discusses the effect these guidelines are likely to have on firms with regard to the adoption of compliant models for ESO valuation. The appendix describes how firms might modify a lattice-based model to meet the new requirements.

A. Overview of Options and ESOs in Particular

An *exchange-traded stock option* is the right to purchase or sell a particular stock at a given price within a specified period of time. Call options give the holder the right to buy a stock at the defined strike price; put options give the holder the right to sell at the strike price. By way of example, a holder of a Microsoft call option with a strike price of 20 has the right to purchase that stock, prior to expiration, for $20 even if the stock is trading at a much higher price. If the stock is trading at $25, the option will be worth in excess of $5: $5 of *intrinsic value* (25-20) plus a premium for the *time value* reflecting the possibility that the stock will go even higher prior to expiration. The primary drivers of this time value--defined as the value of the option less the intrinsic value--are typically the time left until expiration and the expected volatility of the price of the underlying stock. In other words, the time premium will decrease as the probability of further changes in the stock price decreases. If it is "in the money" at expiration, the option is worth its intrinsic value but nothing more.

By way of another example, IBM was recently trading at $87 per share. Yet IBM calls with a strike price of $90, expiring in five months, were trading at $3.90. The time value is the value of the option less the intrinsic value: 3.90 – 0 = 3.90. Thus out of the money options can have real value as defined in the marketplace even though they have no intrinsic value.

Employee stock options (ESOs) have fundamental characteristics that make them distinct instruments, materially different from exchange-traded options (ETOs). Their use as a form of employee compensation has grown dramatically over the last 20 years to the extent that 99% of S&P 500 companies now provide ESOs to employees.[3] An estimated 12 million employees in the U.S. currently hold these instruments[4], worth hundreds of billions of dollars.

The features that differentiate ESOs from ETOs are:

[3] Testimony on employee stock option before the U.S. Senate Finance Committee, by John H. Biggs, President, Chairman, and CEO of TIAA-CREF, April 18, 2002, page 2.
[4] "Stock Options: An Important Part of Employee Compensation", by Nancy Newman-Limata, CPA, June 2, 2002

1. Lack of Transferability

Unlike ETOs, ESOs cannot be traded. Hence, there is no market price for them, and the only way for employees to obtain value is to exercise them. However, unlike with ETOs, the value the employee receives from exercising an ESO is limited to its intrinsic value. This value is usually less than the market price of a freely tradable option, as the employee can never capture the embedded premium for time value. In addition, employees, unlike outside investors, are generally unable to hedge the risk that the option will decrease in value and are typically poorly diversified.

For these reasons, employees tend to place a lower value on ESOs and exercise them earlier than would an outside investor. The net result is that, if properly valued, ESOs will usually be less costly to the company and worth less to employees than predicted by models that are designed to value ETOs, such as the Black-Scholes model and the Cox, Ross and Rubinstein (CRR) binomial model. As noted by FASB, because they fail to properly reflect the features that differentiate ESOs from ETOs, use of these unmodified models will significantly overstate the true cost of ESOs.

2. Vesting Requirements

Unlike ETOs that can be exercised at any time up until expiration, ESOs can be exercised only after they are vested. Typically, a certain percentage of the ESOs vest each year over several years (e.g., one quarter of the shares granted vest each year for four years). For performance-based option programs, vesting occurs only after certain performance conditions are met (e.g., a stock price threshold or defined target for EPS or market share).

3. Blackout Periods

Similar to vesting restrictions, blackout periods are another type of restriction on an employee's ability to exercise ESOs. Blackout dates are periods during which employees are forbidden from exercising ESOs. For example, it is common for certain employees to be precluded from exercising ESOs immediately before and after a company's quarterly earnings report. In addition to such formal blackout periods, employees are also forbidden from exercising if they are aware of material non-public information about the company. Thus, while vesting restrictions typically occur for a given number of years from the ESO's grant date, blackout dates can occur any time throughout the life of the ESO.

4. Duration

Unlike ETOs, which typically have durations of three to 12 months, ESOs typically have durations as long as 10 years. As Professor Kevin Murphy notes: "…the Black-Scholes formula assumes constant dividend yields, and stock-price volatilities, assumptions which seem sensible for short-term traded options (usually expiring in six months or less) but less sensible for options expiring in a decade."[5] Consequently, an important feature of an ESO valuation model is the ability to allow key input parameters to vary with time.

5. Forfeiture Provisions

ESO plans usually require employees who leave the firm to forfeit unvested ESOs and to either forfeit or exercise vested options shortly after leaving the firm. Holders of vested ESOs will, of course, exercise only if they are in the money. The possibility of forfeiture or forced exercise reduces the value of an ESO compared to an ETO.

[5] Murphy, Kevin J. *"Executive Compensation."* In Ashenfelter, O. and Card, D. (Eds.) Handbook of Labor Economics, Vol. 3, Amsterdam: North-Holland, 1999, pages 2485-2563.

6. Nonstandard Features

Lastly, some ESO programs have additional, nonstandard features that further differentiate them from ETOs. A few examples are:

- *Repriceable ESOs*, which allow the strike price to be reset if the option is too far under water;
- *Performance vested ESOs*, which vest only if certain performance conditions are met;
- *Indexed ESOs*, which allow the strike price to vary according a market index;
- *Purchased ESOs*, which require the employee to pay a portion of the strike price at the grant date and the remainder of the strike price when the ESO is exercised;
- *Reload ESOs,* where upon exercise, the employee receives new options equal to the number of shares tendered to pay the strike price. The exercise price of the new options is set equal to the current stock price and their duration equal to the time remaining on the original options; and
- *Capped ESOs,* where the maximum spread between the stock price and the exercise price is limited to a prescribed multiple of the strike price.

B. Description of the Black-Scholes Model, Traditional Binomial Model and the Binomial Lattice Model Envisioned in the Exposure Draft

Both the Black-Scholes and Binomial models are the most commonly used models for valuing exchange-traded options. They are both based on the same six inputs: 1) the exercise price of the option; 2) the time until exercise; 3) the current price of the underlying stock; 4) the volatility of the stock price; 5) the risk-free rate of interest, and 6) the dividend yield. Changes in these factors affect the price of the option. Also, both models assume that the underlying stock price evolves according the same underlying stock price process.

1. The Black-Scholes Model

The Black-Scholes option-pricing model, developed by Fisher Black, Myron Scholes, and Robert Merton in 1973, remains a commonly used method for valuing exchange-traded call and put options.

Black-Scholes was designed for valuing European options. A European option can only be exercised on the expiration date, which greatly simplifies the solution process since it is unnecessary to determine the optimal time to exercise the option ("exercise strategy"). As a result it is possible to obtain a closed-form solution. That is, it is possible to merely plug the six inputs into an equation to determine the value of the option. Without going into the calculus of the stochastic differential equation, the model essentially outputs a value determined by the cost of dynamically hedging a short position in the option.[6]

2. The Binomial Model

The binomial model, developed by John Cox, Steven Ross, and Mark Rubinstein (CRR binomial model) in 1976, was designed for valuing American options. An American option can be exercised any time on or before the option's expiration date. This greatly complicates the solution process because the optimal

[6] For both the Black-Scholes and CRR models, ESOs are valued so as to prevent arbitrage (achieving a riskless profit). To do this, both models use what is termed the contingent valuation method. This method values assets by forming a portfolio that replicates the asset's cash flows. For example, the cash flows associated with an option can be replicated by forming a portfolio consisting of shares in the underlying stock and risk free bonds. The value of the option is thus the cost of setting up this initial portfolio, which is equivalent to assuming that the return on the underlying shares (from both price appreciation and dividends), and the discount rate on all cash flows, is equal to the risk free rate. Consequently, when constructing the binomial tree or lattice, the underlying stock price is assumed to increase at the risk-free rate net of the dividend yield.

exercise strategy must be determined as part of the solution. Because of this complication, it is not possible to obtain a closed-form solution to the value of an American option. Instead, the CRR binomial model is solved backwards in time by iteratively determining the value of the option at each node of the lattice structure describing the up and down movements of the stock price.

The binomial model is based on the simple assumption that during a short period of time, the price of the stock underlying the option can either increase or decrease from its current level by prescribed percentages. These two possible movements of the stock price are why the model is termed a binomial model.[7] The parameters of the model (i.e., the increase and decrease percentages and probabilities of the up and down moves) are determined so as to match the desired underlying stock price process and to prevent arbitrage. The binomial model values options by recursively comparing the option's intrinsic value (at a particular node of the tree or lattice) with the present expected value of continuing to hold the option ("continuation value"). If the intrinsic value is greater than the continuation value, then exercise is optimal.

The solution process for a very simple binomial lattice model is shown in Figure 1.

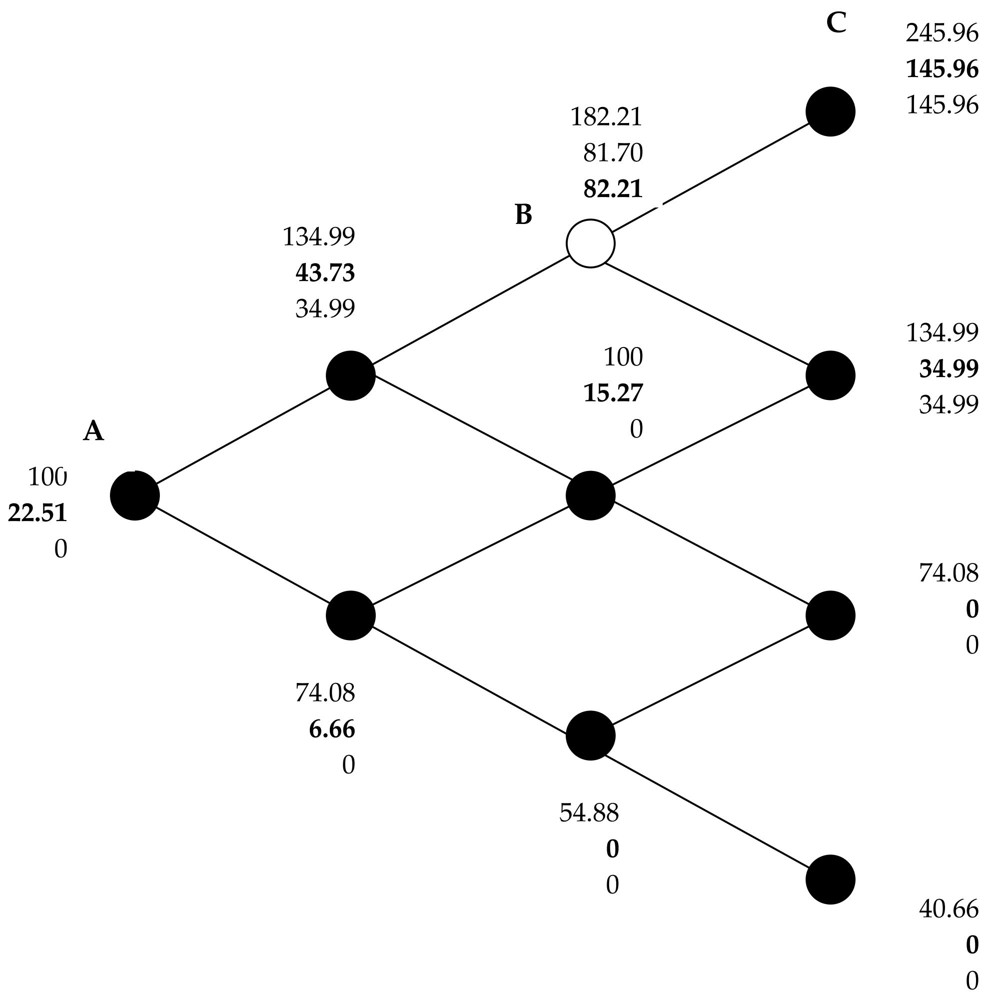

Figure 1

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[7] In addition to a binomial model, a model which allows the stock price to make one of three moves at each node, termed a trinomial lattice model, is often used to value more complex instruments, such as barrier options.

Figure 1 shows the binomial tree or lattice for an exchange-traded American option. For each node there are three numbers. The top number is the stock price, the middle number is the continuation value (explained below), and bottom number is the intrinsic value. In each case, the value in bold is the value of the option at that node. When constructing the lattice, we have assumed that the grant date stock price is $100, the strike price is also $100, the option's contractual life is three years, the number of time steps is three (i.e., each time step is one year), volatility is 30%, dividend yield is 3%, and the risk free rate (continuously compounded) is 5%. Based on these values, during each time period, the stock price will increase by either 35% or decrease by 26%, and the probabilities of and up and down moves are 45.87% and 54.13%, respectively. Lastly, the discount factor (assuming continuous compounding) is 0.95123. That is, we multiply by this factor to discount cash flows back one period.

The binomial model values options by working backwards in time from the end of the tree (i.e., the option's expiration date). We begin the process by computing the intrinsic value for each of the terminal nodes. The intrinsic value is computed as the greater of the difference between the stock price and the strike price and zero. For example, note that the option value at Node C is $145.96 (245.96 - 100). After having computed the option values for each terminal node, we compute the option values for the other, non-terminal nodes. For each non-terminal node we compute the value of the option as being the greater of the option's continuation value and the intrinsic value. The continuation value is the expected present value of option values at the two nodes that can be reached from the node being evaluated. For example, to compute the continuation value for Node B, we weight the option value associated with an increase in the stock price ($145.96) by the probability of an increase in the stock price (0.4587) and add this to the option value associated with a decrease in the stock price ($34.99) weighted by the probability of a decrease in the stock price (0.5413). This result is then discounted back one period by multiplying by the discount factor (0.95123). These calculations produce the continuation value shown at Node B in Figure 1 of $81.70. However, since the intrinsic value at Node B is $82.21 (182.21-100), which is greater than the continuation value, the option should be exercised. Thus the option value at Node B is $82.21. The values for the other nodes are calculated in the same manner. The value of the option is thus ultimately determined by the value associated with the initial node of the binomial lattice ($22.51).

The simple binomial tree in Figure 1 has only one node (Node B) where exercise is optimal. For more realistic problems with a larger number of time steps, early exercise would occur at many more nodes. Figure 2 shows the shape of the optimal exercise boundary for our problem assuming that the number of time steps becomes fairly large.

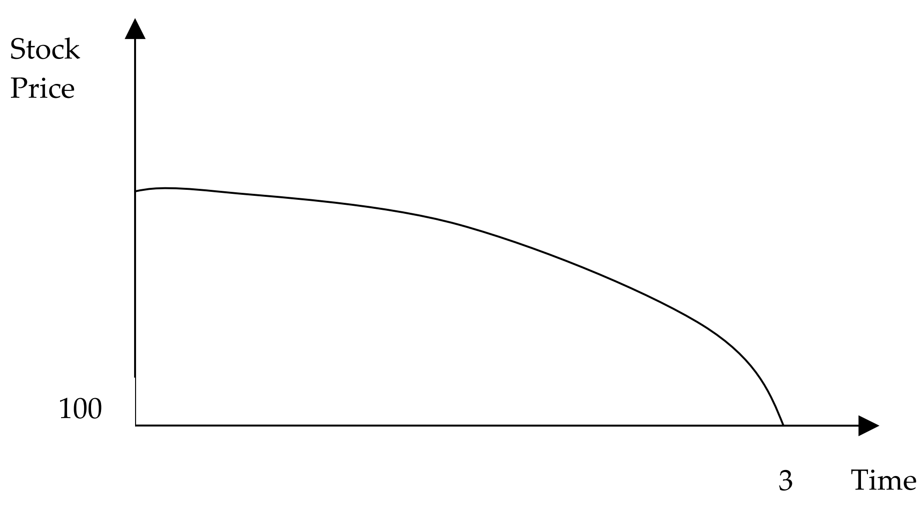

Figure 2

Employees would optimally exercise their options if the stock price at a given node is greater than or equal to the boundary. Note that at the expiration date, the option should be exercised if the stock price is greater than or equal to the strike price of $100. It should be noted that the Black-Scholes model and the CRR binomial model are related. The CRR binomial model is a generalization of the Black-Scholes model in that it converges to the value produced by the Black-Scholes model for options on stocks that do not pay dividends. However, for options on stocks that pay dividends, the CRR binomial model produces values that are greater than those produced by the Black-Scholes model because early exercise is optimal in this case. (This is because the payment of dividends represents an opportunity cost associated with holding the option (option holders do not receive dividend payments). If the stock did not pay dividends, then it would never be optimal to exercise early because of the time value of the option (i.e., the added value associated with the possibility of future stock price increases).

In the case of an option on a dividend paying stock, the binomial model will produce a greater value than the Black-Scholes model because it affords the opportunity to exercise any time on or before the expiration date (whereas the Black-Scholes model can only be exercised on the expiration date). The greater number of additional exercise opportunities is the reason the binomial model produces a greater value than the Black-Scholes model (for options on stocks that pay dividends). The magnitude of the difference between the two models will depend on the size of the dividend yield.

3. The Binomial Lattice Model Envisioned by FASB in the Exposure Draft

By failing to reflect the unique features of ESOs, both the Black-Scholes and CRR binomial models produce values that are typically substantially overstated. The same is true for versions of these models that are modified in accordance with the FAS 123. [8] For example, our research has shown that the FAS 123 modified Black Scholes model (adjusted for forfeiture during the vesting period) produces values that are typically between 17% and 45% greater than the value produced by a binomial model that has been specifically designed to account for the unique characteristics of ESOs.[9] The magnitude of the overstatement is even greater for the FAS 123 modified binomial model.

The results, discussed above, are based on the proprietary Equity and Stock Option Valuation (ESOVAL) model developed by Analysis Group. ESOVAL is based on accepted financial and economic principles and is explicitly constructed to reflect the unique features that distinguish ESOs and other equity-based compensation instruments from exchange-traded options. These features include non-transferability, vesting schedules, forfeiture provisions and blackout dates, as well as the non-traditional features contained in indexed and performance-based options. In addition to calculating the cost to the firm of a given equity-based instrument, the ESOVAL model can determine the perceived value to the employee receiving the instrument. The binomial lattice framework was chosen because it provides the power and flexibility to allow all inputs, including stock price volatility, to change during the instrument's contractual term.

Table 2 compares the cost, for various vesting periods, of ESOVAL to the Black-Scholes model, the FAS 123 Modified Black-Scholes model and the FAS 123 Modified Black-Scholes model adjusted for Forfeiture.[10] The values in Table 2 are based on the inputs shown in Table 1.

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[8] Statement 123 required substituting the expected life of the option for its contractual life. According to Statement 123, this modification was made to reflect the lack of transferability associated with ESOs.

[9] Ron Rudkin, A New Binomial Lattice-Based Model for Determining the Cost of Employee Stock Options and Other Equity-Based Instruments, 2004.

[10] The terminology "Modified BSM" refers to the Black Scholes model with the option's expected life substituted for the option's expiration date. The terminology "Modified BSM with Adjustment for Forfeiture" refers to the Modified BSM multiplied by the probability the option vests. The probability the option vests is computed by the procedure recommended by FASB in Statement 123.

Table 1
Model Inputs

Parameter	Value
Stock price	$35
Strike price	$35
Option duration	10 years
Volatility	32 percent
Dividend yield	3 percent
Risk-free rate	5 percent
Annual departure rate	3 percent
Vesting period	3 years
Expected option life	5 years

Table 2
Comparison of Analysis Group's ESOVAL
Binomial Model to Various Black-Scholes Models (BSM)

Vesting Period	AG ESOVAL Model	Black-Scholes	Percent Difference	Modified BSM	Percent Difference	Modified BSM with Adjustment for Forfeiture	Percent Difference
1 year	$5.10	$11.64	128%	$7.64	50%	$7.41	45%
2 years	$6.55	$11.64	78%	$8.74	33%	$8.23	26%
3 years	$7.46	$11.64	56%	$9.53	28%	$8.70	17%

Note: Percent Difference measures difference between each Black-Scholes model and the ESOVAL Binomial Model.

Compared with AG's ESOVAL binomial model, which is designed to properly account for the distinctive features of ESOs, the Black-Scholes model overstates the cost of the option by 128%, 78%, and 56% for vesting periods of one, two, and three years, respectively. The overstatements using the modified Black-Scholes model range from 50% to 28%. Finally, the modified Black-Scholes model, adjusted for forfeiture during the vesting period, overstates the cost of an ESO by from 45% to 17% as the vesting period goes from one to three years.

The relationship between vesting period and ESO cost underscores the difference between ESOs and ETOs. For ETOs, cost declines with increases in vesting period. This occurs because increases in the vesting period limit the investor's ability to make value-enhancing exercise decisions. However, for ESOs, increasing the vesting period tends to increase the cost to the firm as risk-averse employees are precluded from making early exercise decisions that would be non-optimal to an unconstrained investor.

Because the binomial or lattice framework can be adapted and generalized to address the features of more complex instruments, it is commonly used by Wall Street practitioners to price complex options and is the approach preferred by FASB for valuing ESOs. The ED envisions the use of a binomial lattice model that has been modified to reflect the features of ESOs, including the interplay between early exercise, vesting, blackout dates, departure and forfeiture.[11]

To reflect the interplay between these factors, the traditional binomial model would be modified as follows. For nodes where post-vesting termination does not occur and exercise is possible (i.e., the option is vested and the period is not a blackout date), the binomial model would be modified to reflect that exercise will occur when it is economic to do so (i.e., the benefit from exercise is greater than the benefit from continuing to hold the option). For nodes where exercise is not possible, the binomial model would be modified by precluding exercise (i.e., only the continuation value would be calculated at the node). However, in addition to reflecting the possible stock price movements, the continuation value would also be modified to reflect the possibility of termination occurring during the next period. For post-vesting nodes where termination occurs, the binomial model would be modified to reflect that the option will be exercised if it is "in the money" and exercise is possible; otherwise it will be forfeited. The probability of termination occurring at each node would be based on the company's annual termination rate (i.e., the fraction of employees holding options that leave the company each year).

As evidenced by several recent articles in the business press, there is a widespread misconception that all binomial models produce essentially the same value as the Black-Scholes model.[12] The fallacy of this view is evidenced by FASB's departure from FAS 123, which essentially maintained that merely changing the inputs to the binomial model was sufficient to address the unique features of ESOs. To properly address the specific features of ESOs it is necessary, as required in the ED, to modify or generalize the model itself.

As discusses in Section I, given the same inputs, the CRR binomial model will produce values that are greater than or equal to those produced by the Black-Scholes model. It takes more than simply changing the model's inputs to produce valid estimates. This is the reason that FASB believes "...that a lattice model is preferable because it offers the greater flexibility needed to reflect the unique characteristics of employee share options and similar instruments." As stated above, the binomial or lattice framework can be modified or generalized to address the specific features of ESOs and other instruments. When this is done, a binomial model will produce more accurate values that are typically lower than those produced by the Black-Scholes model, the CRR binomial model, or the FAS 123 modified versions of these models.

C. Expected Changes in the Design of Equity-Based Compensation

The accounting treatment of options granted to employees has been governed by APB 25 since the opinion was issued in 1972. It allowed companies to report no expense for certain types of ESOs, specifically, those issued "at the money" and those issued with a strike price above the current price of the underlying stock ("out of the money" options). Most firms granting options to their employees thus chose to issue these specific types of instruments that obviated a line item on the income statement. In effect, this accounting rule has determined the type of equity-based compensation most commonly issued by firms: we estimate that at-the-money options represent more than 95% of all options granted to employees.

In 1995, FASB issued FAS 123, which required firms to report, at a minimum, ESO cost in the footnotes to the financial statements. But it did not require firms to report this expense on the financial statements, and only a handful of firms chose to do so. As a result, it did not afford a compelling reason for companies to consider alternative forms of equity-based compensation.

The ED's proposals change this. Now *all* types of equity instruments used in compensation programs will hit the income statement. As a consequence, the optimization function of the firm will change; the optimal instrument will no longer be perceived as the one that allows the firm to keep compensation expense hidden. Companies will need to determine how to best compensate employees while lowering costs, maintaining proper alignment of interests and attracting and retaining employees. In an environment where all equity-based compensation will be expensed, many firms are taking a fresh look at their

[11] The Appendix provides information about the characteristics of an Exposure Draft compliant binomial lattice model.
[12] See the article by Craig Schneider in the March edition of <u>CFO</u> magazine, entitled "Less Ado About Options."

compensation programs and asking if there are other types of instruments that can maintain or improve performance while minimizing ESO cost on the income statement.

One approach is to examine ways to increase the benefits of the program for a given level of cost. Doing this requires tools that allow the firm to value equity-based instruments from the perspective of both *cost to the firm* and *value to the employee*. An effective compensation program will be one that reduces the wedge between the two, minimizing company cost and maximizing value to the employee.

Increasingly, companies are also discussing ways to reduce the market's impact on the value of their ESOs by exploring indexed options tied to the S&P 500 or a sector basket. Others want to tie vesting or strike price to specific performance metrics, e.g., the revenues of a particular division or subsidiary, the acquisition of new customers, or the firm's stock price. As a result of the new expensing requirements, we thus expect to see increasing use of capped, indexed, and performance-based options and, additionally, increasing use of non-option equity-based instruments, such as restricted stock, restricted stock units, and stock appreciation rights. Moreover, we expect that some of these instruments will have performance triggers, similar to those used for certain employee stock options. We also expected to see greater differentiation in the types of equity instruments granted to the various employee and management levels within the organization.

II. Summary and Observations of the 2004 Exposure Draft on Share-Based Payment

A. Required Input for the Determination of Fair Value

In the absence of market prices for comparable instruments, the ED requires fair value to be determined by an option valuation model that takes into account, at a minimum, the same six factors required in FAS 123:

- The risk free rate which corresponds to the expected term of the option,
- The expected volatility of the underlying stock price,
- The strike price of the option,
- The price of the stock at the grant date,
- The expected dividends on the underlying share, and
- The expected term of the option (EOT).

B. Calculation and Use of the Expected Term of Employee Stock Options

According to the ED, all option pricing models used to estimate fair value must take EOT into account. When computing EOT, companies are to reflect the instrument's contractual term as well as *employees' expected exercise* and *post-vesting employment termination behavior (*"exercise" and "termination behavior"). For closed-form models, the duration input is similar to that required in FAS 123, except that EOT rather than expected option life is to be substituted for the option's contractual term. However, for lattice-based models that have been modified to take into account an option's contractual term and employees' exercise and termination behavior, EOT is to be an *output* from the model, not an input to the model.

Commentary: Since companies using lattice-based models that have been modified to take into account exercise and termination behavior are to both estimate EOT and to output this measure, it appears that lattice-based models should be tied to or calibrated to EOT. That is, one interpretation of the ED is that companies are to adjust the lattice-based model so that the value it outputs for EOT equals the actual observed value of EOT. The notion of calibrating the model to historical data is an important concept. Unlike exchange-traded options, ESOs do not have prices to which they can be calibrated. Hence, accuracy is greatly improved by ensuring that option valuation models correctly predict actual observed measures of exercise and termination behavior, such as EOT.

Another interpretation is that companies are relatively unconstrained with respect to the data and methods to be used to account for expected exercise and departure behavior. The only constraint, under this view, would appear to be that companies are to use data and methods that, according to the ED, are consistent with "… established principles of financial economic theory and generally accepted by experts in that field…and reflects any and all substantive characteristics of the instrument." This suggests that firms using lattice models are to modify the traditional binomial model to reflect both the characteristics of the instrument being valued and employees' expected exercise and termination behavior. They will also need to determine appropriate measures of employees' expected exercise and termination behavior. These measures would include EOT, which by definition accounts for both employees' expected exercise and termination behavior, as well as other measures. As was the case with the first interpretation, presumably the model would include a mechanism that would enable it to be tied or calibrated to observed measure(s) of exercise and termination behavior. This issue of calibration is discussed in more detail below.

A final interpretation is that EOT is to be used instead of the option's contractual life as the duration input for lattice-based models in addition to closed-form models.

C. Appropriate Duration to Use for Lattice Models

As noted above, for lattice models there is ambiguity concerning the proper duration input to use. Several places in the ED (e.g., first full paragraph on page 46 or Appendix B, describing the calculation of the risk free rate for lattice-based models) state or imply that the lattice model can be based on an instrument's contractual term. However, Footnote 9 of Appendix B states: "To reflect the effect of employee's inability to sell their vested options, this Statement requires that the fair value of an employee share option be based on its expected term rather than its contractual term."[13] This footnote is also inconsistent with Paragraph 20 of Appendix B, which states: "However, if an entity uses a lattice model that has been modified to take into account an option's *contractual term* (emphasis ours) and employees' expected exercise and post-vesting employment termination behavior, the expected term is estimated based on the resulting output of the lattice." For a lattice model, use of the option's expected term to account for non-transferability is contrary to how lattice models are used by valuation experts, the above quote and the guidance given by the Option Valuation Group (OVG) convened by FASB.[14]

D. ED Recommendation that Both Types of Models Be Used to Determine EOT

In a Footnote on page 48 of the ED, FASB gives additional direction concerning an acceptable method for using a lattice model to estimate EOT for financial reporting purposes. The method involves using a lattice model's estimate of fair value as an input to a closed-form model. The closed-form model is then solved for the value of the duration (EOT) that will cause the value produced by the closed-form model to equal to the value produced by the lattice model.

Commentary: As noted in the ED, a lattice model can be modified to output EOT. Experts in the field may thus consider it unnecessary to use both types of models in the determination of fair value, as combining two will result in values that differ from those derived by an appropriately modified binomial lattice model.

E. The Use of the Exercise Multiple to Model Early Exercise

The ED recommends that for the purpose of outputting EOT and estimating fair value that the lattice model be modified to reflect that exercise occurs whenever the stock price exceeds some predetermined multiple of the strike price.

Commentary: While it is necessary to use some type of mechanism to reflect the lack of transferability and other factors affecting early exercise, there are important issues to consider with regard to the proposed mechanism. First, the exercise multiple fails to explicitly reflect factors that are known to lead to early exercise for non-traded instruments, such as risk aversion and lack of diversification. Both of these

[13] A similar statement is made in Issue 4(d) on Page iii.
[14] See No. 20, Pages 5 and 6 of Minutes of the FASB Option Valuation Group Meeting, July 8, 2003, which states: "… the inability to transfer an ESO is to be captured through the…early exercise behavior considered in an option-pricing model."

factors, which come into play because of lack of transferability, are cited both in the financial literature and in the International Accounting Standards Board final rule.[15] Second, the method recommended in the ED implicitly assumes that the optimal exercise boundary is constant. The optimal exercise boundary, even for models that reflect risk aversion and lack of diversification, is not constant, but instead continually declines as one approaches the expiration date. Consequently, the use of EOT could lead to errors in the estimation of fair value. Third, this method essentially imposes a barrier at the level of the stock price where exercise is assumed to occur. This complicates the solution process, because it is well known that failure to place a node of the lattice at the level of the barrier will cause measurement errors. This is the reason that American barrier options are usually valued by using a trinomial lattice model, because of its ability to ensure the correct placement of the lattice.

F. The ED Does Not Require Firms to Use Any Particular Model

Unlike FAS 123, which required (or was interpreted as requiring) firms to use either the Black-Scholes model or the binomial model, the ED does not require firms to use any particular model. In fact, the ED does not even use the terms binomial model and Black-Scholes model, as was done in FAS 123. Instead, it uses the more generic terms of lattice (binomial) and closed form (Black-Scholes).

G. The ED States a Strong Preference for Lattice-Based Models

While the ED does not require a particular model, it does state a strong preference for lattice-based models: “[Board members] believe that a *lattice model is preferable* (emphasis ours) because it offers the greater flexibility needed to reflect the unique characteristics of employee stock options and similar instruments.” Lattice-based models can also reflect the term structure of risk-free rates and volatilities and expected changes in dividend yields over the option’s contractual term.

H. FASB Believes Lattice-Based Models May Not be Suitable for Some Firms

While the ED states a preference for lattice-based models it does not require firms to use them. According to the ED, FASB did not require firms to use such models because some firms may lack the required historical data on employee exercise and post-vesting termination patterns.

Commentary: While companies may not have the penultimate data for reflecting early exercise and post-vesting termination behavior, a lattice model can be constructed that uses readily available data to meet ED requirements. For example, the model can be calibrated to such readily available measures of exercise and termination patterns as EOT (which by design incorporates this behavior), the ratio of expected stock price at exercise to the strike price (the exercise multiple), or the expected time-to-exercise. The term “calibrated” means that parameters in the model (e.g., parameters controlling early exercise behavior) are adjusted so that the model outputs the correct value of the desired calibration measure. For example, if by examining its historical data, a company determined that an EOT of 6.2 years could be expected for a particular ESO grant, the input parameters of the lattice model would be adjusted until the model’s outputted EOT equaled 6.2. Moreover, if a firm lacks the data required to compute EOT or other appropriate calibration measures, it is often possible, as noted in the ED, to use data from like companies as a proxy.

[15] Hall, Brian J. and Murphy, Kevin J. *“Stock Options for Undiversified Executives.”* Journal of Accounting and Economics, 33 (2002) 3-42. International Accounting Standards Board, International Financial Reporting Standard: IFRS 2 Share-based Payment, March 2004, Paragraph B16, page 32.

I. Guidance Concerning the Calculation of Model Inputs

The ED gives fairly precise guidance concerning how model inputs are to be calculated: (1) it specifies factors that should be considered when estimating specific inputs, such as volatility; (2) it requires firms to consider factors that might cause the future to be different from the past and how inputs, such as the risk-free rate and volatility, are expected to change during the contractual term of the instrument (so called "term structure" effects); (3) when estimating volatility, it requires firms to consider the possibility of mean reversion (i.e., the tendency for volatility to return to some long term level) and (4) when estimating dividends payments, historical patterns should be considered. The requirement to consider mean reversion when estimating volatility suggests that firms are to consider the use of sophisticated statistical techniques such as GARCH-type models.

For the most part, allowing the inputs to a lattice model to vary with time will not present any difficulties. The one exception is volatility. Unless care is exercised, allowing volatility to vary with time will cause technical difficulties with the construction of the binomial lattice (i.e., prevent the lattice from recombining). When this occurs, the number of nodes increases exponentially instead of linearly as it does for recombining lattices. This will make it impossible to value all but options with a small number of time steps.

J. Requirement to Calculate Expected Values for Inputs

The ED states that there is likely to be a range of estimates for expected volatility, dividends, and option life and that if no value within the range is any more likely than any other value, then an average of the range (its expected value) should be used for each of these inputs.

Commentary: Based on the wording of this statement and on the illustrations in Appendix B of the ED, even if the time paths of the inputs can be accurately estimated, a firm should instead use the average of the values in the model. This method is inconsistent with methods used by experts in the field and with the goals of the ED. Consistent with statements in the ED, experts in the field use lattice models that have been modified to reflect the actual term structure and to allow the inputs to vary-year-by year rather than lump the year-to-year changes into a single number.[16]

K. Calculation of Expected Values for Lattice Models

When using a lattice-based model, the ED requires that expected values for volatility, dividends, and option life are to be determined for a particular node (or multiple nodes during a particular period) and not over multiple time periods unless such an application is supported by the instrument being valued.[17] This statement and the one above suggest that these inputs to a lattice model should *not* be allowed to vary across time, but instead should be based on the values that would be appropriate for either a single node (of the lattice) or for a range of nodes, which presumably would then be averaged, for a particular period

Commentary: Given the length of the contractual term of most equity-based instruments, these three inputs may not remain constant over time. Hence, practitioners may argue that these inputs be allowed to change across time for both lattice and closed-form models. Both types of models have been modified to allow the inputs to vary with time (and with the level of the stock price). While, as stated above, it may be reasonable to assume that these inputs may vary with time, this variance may not be dependent upon the level of the stock price. For example, sophisticated models currently used to estimate future values of volatility (e.g., GARCH models) generally do not depend upon the level of the stock price but rather, as recommended in the ED, on a mean reverting process that converges to an equilibrium level of volatility.[18]

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[16] See Clewlow, L. and C. Strickland, Implementing Derivatives Models, Wiley, 1998, Pages 37 to 40.

[17] It is not clear why this requirement does not also apply to the risk-free rate. Presumably the risk-free rate, volatility and dividend yield could all vary with time.

[18] Hull, J, Options, Futures and Other Derivative Instruments, Fifth Ed., Prentice Hall, Upper Saddle river New Jersey, 2002, Page 376 to 377.

L. Methodology for Valuing Instruments with Performance Features

In Illustration 5 of Appendix B, FASB computes the value of a performance-based option by multiplying the fair value of a typical option (from Illustration 4) by the most likely number of options to vest as a result of the performance condition (in this case, growth in the company's market share).

Commentary: This method may lead to valuation errors because it fails to reflect the correlation between the performance measure and the stock price.[19] Since the performance measure will be positively correlated with the level of the stock price, high levels of performance would be associated with high stock prices at the measurement date. A high price at the measurement date would lead to a higher fair value than for a typical option. Hence, the method proposed in the ED will tend to understate valuations associated with high levels of performance, because it uses average value per option rather than a high value per option and overstate valuations associated with low levels of performance. The problem is that the value per option and the number of options expected to vest are determined simultaneously. As a consequence, practitioners may argue that the correlation between the performance condition and the stock price be reflected by using a lattice-based model that, in addition to stock price, includes the performance condition as another stochastic state variable. Such a model would use inputs that are similar to those used to value instruments with indexed strike prices (See Illustration 7 in Appendix B of the ED).

In addition, the ED recommends that fair value be based on the modal or "most likely number" of options that will vest. Another possible approach, discussed by FASB's Option Valuation Group, determines cost using the contingent valuation method, which requires that instruments be based on the expected present value of the cash flows from the instrument. When determining the fair value of a performance-based instrument, this method computes an expected value rather than a modal value.[20]

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[19] The magnitude of the error will depend upon the correlation between the stock price and the performance measure. It will be the greatest for plans that include market conditions (e.g., options that vest only if the stock price exceeds a given value).

[20] Under the contingent valuation method, the present value is to be based on the risk-free rate and the expected value is to be based on a risk-neutral distribution. See for example, Hull, J.C., Options, Futures and other Derivatives, Fifth Ed., Prentice Hall, 2003.

M. Methods Used by the ED to Insure Consistency and Comparability

The ED attempts to ensure consistency and comparability through various methods. For example, it gives precise guidelines as to how inputs are to be calculated. It precludes firms from switching back and forth between models. And once a firm elects to use a lattice-based model it is, with rare exceptions, precluded from reverting back to a closed-form model. Finally, the ED specifies minimum disclosure requirements (MDRs), under which firms must describe the methods used to estimate fair value and model inputs.

N. Clarification of the Illustrations in Appendix B

As in FAS 123, the ED uses the term “forfeitures” throughout most of the document. However, the term “terminations” is substituted for forfeitures in the text of Appendix B. While it may be possible to use the two words interchangeably during the vesting period (since the forfeiture and termination rates will be the same during this period), this is not the case post vesting. After vesting, the two rates will differ because terminations result in forfeitures only if the instrument is out-of-the money. If the instrument is “in-the-money,” the instrument will be exercised upon termination.

Also, the illustrations for graded vesting (Paragraph B70) require further explanation. The results show value increasing with increases in the length of the vesting period. This result is correct but is counterintuitive from the perspective of exchange-traded options, where increases in the length of the vesting period would cause value to decline (because it reduces the number of exercise opportunities). This situation can occur with share options because the vesting restrictions prevent risk-averse employees from exercising options earlier than would be optimal from the standpoint of value maximization.

O. Optimal Exercise

Footnote 27 of Appendix B of the ED asserts that option-pricing theory (presumably for exchange-traded options) generally holds that the optimal (or profit-maximizing) time to exercise an exchange-traded option is at the end of the option’s term and that exercise prior to the end of an option’s term is “suboptimal”. However, for exchange-traded options on stocks that pay dividends, optimal exercise may occur earlier because option holders do not capture dividends. The greater the dividend yield, the earlier it makes sense to exercise. In fact, it is because an American option can be exercised early (when the value from exercise exceeds the value of continuing to hold the option) that its value exceeds that of a European option, which can only be exercised at the instrument’s expiration date (see FAS 123, page 93). Additionally, because of lack of transferability and risk aversion, employees will exercise employee stock options earlier than would an unconstrained investor holding exchange-traded options (ETOs). As recognized elsewhere in the ED, one of the virtues of the lattice model is its ability to accurately reflect the features of ESOs, especially employees’ early exercise and post-vesting employment termination behavior.

III. Potential Implications for Firms

A. Adopting a Lattice-Based (Binomial) Model

Firms adopting an ED-compliant lattice-based model may find it helpful to take the following actions:

a. Assess the accuracy and potential financial impact of a lattice-based model compared to a closed-form model. This, of course, will require running ED-compliant versions of both models for a representative set of the firm's ESOs or other equity-based instruments.

b. Determine whether the firm has the data required to implement a lattice model and the requisite expertise to estimate the model's inputs, including volatility, and calibration measures, including expected option term. Also, the firm should assess its ability to address the term structure for the risk free rate and volatility and potential changes in the other inputs over the contractual term of the option.

c. Explore alternatives for developing or obtaining a lattice model that has the required capabilities. The options to be considered would include developing the model and data internally, leasing the model or having the work done by a third party. Although in house development may be the preferred alternative for some, there are many factors that should be considered: (1) because of the complexity of ESO valuation it may be difficult to develop a model that complies with FASB requirements in the time available; (2) it may cost more to develop the model internally than to use an existing model; and (3) in-house development will preclude a firm from stating that reported cost assumptions were developed by objective third-party experts.

d. Develop programs for training company personnel. This includes developing training methods for all phases of the valuation process, including gathering and aggregating historical data, calculating model inputs, and making appropriate modifications in response to changing conditions.

e. Develop procedures for modifying the model and estimating inputs in order to accommodate changes in regulation, compensation strategy, or the nature of firm or the marketplace (e.g., expected volatility can change if the firm exists an existing sector or enters a new one; the risk free rate will vary with market-driven yields on U.S. treasury securities).

B. Adopting a Closed-Form Model

Firms adopting an ED compliant closed-form model may find it helpful to take the following actions:

a. Assess the accuracy and potential financial impact of a lattice-based model compared to a closed-form model. This, of course, will require running ED-compliant versions of both models for a representative set of the firm's ESOs or other equity-based instruments.

b. Modify their data and estimation techniques to comply with the ED requirement that EOT reflect the contractual life of instrument as well as employees' expected exercise and forfeiture behavior.

c. Develop the required data and estimation capabilities required to estimate the term structure and of the risk free rate and volatility as well as changes in the dividend yield on a forward-looking basis.

d. Separately value each tranch of a grant subject to a graded vesting schedule (i.e., if a grant vests annually over four years, four separate valuations are required). In addition to requiring a greater number of valuations, it will also require companies to develop separate estimates (for each tranch) of EOT and possibly other inputs.

Brief Description of an ED-Compliant Binomial Lattice Model

This appendix provides a brief description of how a binomial lattice-based model can be modified to meet ED requirements based on data that are readily available through typical ESO programs.

First, consistent with the ED as well as financial and economic theory, the lattice model would be based on the instrument's contractual term, not the ESO's EOT.

Second, exercise would occur whenever it is possible (e.g., the stock is vested) and the stock price is above the optimal exercise boundary. For nodes associated with post-vesting employment terminations, exercise would occur whenever it is possible and the option is "in the money."[21] In all other instances, termination would result in forfeiture.

Third, the probability of post-vesting termination occurring at a particular node would be based on the firm's annual termination rate. This is the same input required to determine the number of instruments expected to vest for cliff and graded vesting schedules.[22]

Fourth, the model would be designed to reflect the term structure associated with both volatility and the risk free and to allow the dividend yield to change during the instrument's contractual life.[23]

Finally, our interpretation of the ED suggests that the model would be calibrated or tied to readily available measures of exercise and post-vesting termination behavior, such as EOT (which by design incorporates this behavior), or possibly to other measures of exercise and post-vesting termination behavior. The model would be calibrated by adjusting parameters controlling employee exercise behavior so that it outputs values that match the actual observed measures of exercise and termination behavior.[24]

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[21] The optimal exercise boundary is a non-constant function that decreases as one gets closer to the instrument's expiration date. Due to lack of transferability, exercise behavior will depend on the employee's risk aversion and lack of diversification. (See paragraph B-16, page 32 of the IASB Rule 2.)

[22] While the ED does not require the departure rate or forfeiture rate to be one of the six inputs all valuation models are to address, this input is required to determine the number of options that vest in the case of cliff and graded vesting options. Hence, it appears that, at a minimum, seven inputs are really required. (See illustrations in Appendix B of the ED.)

[23] As noted in the ED binomial models can accommodate time varying inputs. However, it should be noted that care must be taken is the volatility is allowed to change with time, because it can cause the tree to fail to recombine. If a tree does not recombine then the number of nodes quickly becomes too large for the problem to be solved in a reasonable period of time.

[24] Such an approach is consistent with the recommendation by FASB's Option Valuation Group, which recommended that lack of transferability should be accounted for through the employee's exercise decision.

Glossary

"At-the-Money" Option
An “at-the-money option” is an option with an exercise or strike price equal to the current market price of the underlying security.

Dividend Yield
Dividend yield is a return measure, which is calculated by dividing annual dividends per share by average market price per share.

Exercise Price or Strike Price
The Exercise Price is the price at which the underlying stock can be purchased (call option) or sold (put option).

Fair value
The amount at which an asset (or liability) can be bought (or incurred) or sold (or settled) in a current transaction between willing parties, that is, other than in a forced or liquidation sale.

Grant date
The grant date is the date an employer and its employee(s) reach an agreement as to the key terms and conditions of a share-based payment arrangement. The employer becomes contingently obligated on the grant date to issue equity instruments or transfer assets to employees who fulfill vesting requirements.

Intrinsic value
The intrinsic value is the positive amount by which stock price exceeds the exercise price of an option. For example, an option with an exercise price of $20 on a stock whose current market price is $25 has an intrinsic value of $5.

Risk Free Rate
The risk-free interest rate is the interest rate associated with a financial instrument that has no default risk. It is usually computed as the yield to maturity on a zero coupon United States Government bond with the same contractual life as the instrument being valued.

Time value
The time value of an option is the amount by which the fair value of an option exceeds its intrinsic value. For example, consider a call option with an exercise price of $20 on a stock whose current market price is $25. If the fair value of that option is $7, the time value of the option is $2 ($7 – $5).

Vest
A share-based payment award is said to vest on the date the employee receives the right to receive or retain shares, other equity instruments, or cash under the award. As such, the award is no longer contingent on satisfaction of either a service condition or a performance condition.

Volatility
Volatility is a measure of the variability in the stock price return. It is often computed as the annualized standard deviation of the continuously compounded rate of return on the underlying stock.

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International Standard Book Number 1-885065-86-8
Printed in the United States of America
First Printing

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