On the Accounting Valuation of Employee Stock Options

Mark Rubinstein[†]
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Abstract

In its Exposure Draft, "Accounting for Stock-based Compensation," FASB proposes that either the Black-Scholes or binomial option pricing model be used to expense employee stock options, and that the value of these options be measured on their grant date with typically modest ex-post adjustment. This brings the accounting profession squarely up against the Scylla of imposing too narrow a set rules that will force many firms to misstate considerably the value of their stock options and the Charybdis of granting considerable latitude which will increase non-comparability across financial statements of otherwise similar firms. This, of course, is a common tradeoff afflicting many rules for external financial accounting.

It is not my intention to take a position on this issue, but merely to point out the inherent dangers in navigating between these twin perils. To examine this question, this paper develops a binomial valuation model which simultaneously takes into consideration the most significant differences between standard call options and employee stock options: longer maturity, delayed vesting, forfeiture, non-transferability, dilution, and taxes. The final model requires 16 input variables: stock price on grant date, stock volatility, stock payout rate, stock expected return, interest rate, option strike price, option years-to-expiration, option years-to-vesting, expected employee forfeiture rate, minimum and maximum forfeiture rate multipliers, employee's non-option wealth per owned option, employee's risk aversion, employee's tax rate, percentage dilution, and number of steps in the binomial tree. Many of these variables are difficult to estimate. Indeed, a firm seeking to overvalue its options might report values almost double those reported by an otherwise similar firm seeking to undervalue its options.

The alternatives of expensing minimum (zero-volatility) option values, whether at grant or vesting date, can easily be gamed by slightly redefining employee stock option contracts, and therefore would not accomplish FASB's goals.

As an alternative, FASB could give more careful consideration to exercise date accounting, under which an expense is recognized at the time of exercise equal to the exercise value of the option. This would achieve the long sought external accounting goal of realizing stock options as compensation, while at the same time minimizing the potential for the revised accounting rules to motivate gaming behavior or non-comparable statements.

[†] Mark Rubinstein is a professor of finance at the University of California at Berkeley. This paper arose out of a consulting project for Intel Corporation. The author thanks Robert Sprouse for his accounting courses at Stanford, Jim Ohlson for instructive conversations on accounting over many years, and Stephen Penman for assistance with employee stock options.

On the Accounting Valuation of Employee Stock Options

Employee stock options are call options given by employing firms to their employees in compensation for labor services. Typically, at the time an option is granted, its strike price is set equal the firm's concurrent stock price. Usually, during the first portion of its life (the vesting period), the employee cannot exercise his options and in fact must forfeit them should he be fired or voluntarily resign. After the vesting date, typically three years after the grant date, the employee can exercise his options at any time until maturity (usually seven years after the vesting date) but cannot sell or otherwise transfer them. Indeed, if he leaves the firm during this period, he is usually forced to choose between forfeiting or exercising his options within a short time after his departure.

A survey by Coopers & Lybrand indicates that "long-term incentive executive compensation" for U.S. corporations grew from 20% of total compensation in 1982 to 31% in 1992.[1] About 40% of corporations with revenues less than $100 million have long-term incentive plans, and 78% of those with revenues above $10 billion have such plans. Non-qualified stock options, the subject of this paper, are by far the most popular method of long-term compensation.

Currently, in the United States, such options granted at-the-money, even though they are granted in lieu of cash compensation for labor services, are not considered an expense under generally accepted accounting principles. That is, they are not charged against earnings at grant, at vesting date, upon exercise, or at any other time.

For example, compare two otherwise identical firms, one that uses only cash compensation and the other that substitutes stock options for half its compensation. Under current rules, the second firm will report less compensation expense and therefore greater aggregate earnings and, at least initially, greater earnings per share. This situation clearly violates a key objective of the Financial Accounting Standards Board (FASB): nearly identical firms should report nearly identical earnings. Perhaps, the chief reason FASB has not corrected this situation earlier has been the difficulty of measuring the expense. More recently, persuaded by advances in option pricing methods, in the Exposure Draft "Accounting for Stock-based Compensation," FASB proposes that a modified version of either the Black-Scholes or binomial option pricing model[2] be used to value employee stock options and that this value be recognized as an expense on the grant date.[3]

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[1] Coopers & Lybrand, *Stock Options: Accounting, Valuation and Management Issues*, New York (1993).

[2] See Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* 81, No. 3 (May/June 1973), pp. 637-659 and John Cox, Stephen Ross and Mark Rubinstein, "Option Pricing: A Simplified Approach," *Journal of Financial Economics* 7, No. 3 (September 1979), pp. 229-263.

[3] Financial Accounting Standards Board, "Accounting for Stock-based Compensation," Exposure Draft, #127-C (June 30, 1993). FASB's confidence in modern option valuation techniques is indicated by the following quotation from the Exposure Draft:

> "Trading of options in the financial markets has increased significantly in the last 20 years. During that time, mathematical models to estimate fair value of options have been developed to meet the needs of investors. Software available for personal computers reduces the application of those models to a fill-in-the-blank exercise."

The public reaction to FASB's proposal was extraordinary. Several groups representing corporate executives and boards of directors, institutional investors, all of the big six accounting firms,[4] and Secretary of the Treasury Bensten vociferously lobbied FASB, the U.S. Congress, and the SEC to drop the proposal. Responsive to this pressure, FASB held public forums as well as an academic roundtable in April, 1994, (which I attended) to reconsider the question. On May 3, the United States Senate for the first time in its history conducted a debate over external (not tax) accounting standards. It passed a non-binding resolution, 88 to 9, expressing opposition to FASB's proposal.[5] In June, as a result of this and further analysis, FASB decided to postpone implementation of its proposal and to restudy the question of expensing employee stock options.

What could have caused such an unprecedented reaction? If FASB's proposal were adopted, many firms, particularly in high-tech areas, would report substantial reductions on the order of 25% in earnings per share.[6] It is feared that such reductions would be translated into commensurately reduced stock prices. Note that it is not the disclosure of the estimated option values that has met with objection, but rather the recognition of these values in income statements and balance sheets. Additionally, many firms favoring stock options as a means of top management compensation may not want the high levels of this compensation to become transparent. It is also argued that incentives provided by stock options have been the engine of growth in successful newly developed U.S. industries, and that discouraging the use of these options through required expense recognition would deprive some of the country's most important corporations of a management tool crucial to success against foreign competition.

These arguments are all seriously flawed. While reported earnings per share would certainly fall to permanently lower levels for many firms, the claim that this will lead to lower stock prices presumes either that the revised earnings supplies new information to the market or that the market is quite inefficient at digesting available information in security prices. Since there seems to be little objection to disclosure, the presumption behind the argument must be extreme inefficiency, which in the light of most academic empirical evidence – relating both to previous accounting changes such as the shift from FIFO to LIFO accounting and recognition of pension obligations, as well as to many other studies of market efficiency – seems highly unlikely. Moreover, if stock prices decline, one could easily argue that the recognition of the expense simply increases market efficiency and improves resource allocation in the economy. After all, stock prices can be inefficiently priced too high as well as too low. It is also possible that recognition of stock option compensation may

[4] To quote from a letter signed by all the big six accounting firms to the FASB dated July 15, 1994:

> "... we believe that the best solution is to withdraw the proposal to change the accounting and, instead, expand disclosures. ... If the Exposure Draft proceeds to a final standard, many companies have indicated that their stock-compensation plans will have to be curtailed or otherwise modified to manage an expense charge that they do not accept as either meaningful or representationally faithful."

[5] Senator Joseph Lieberman went so far as to co-sponsor a bill that would, if passed, have overruled any final FASB decision to change accounting for stock options.

[6] The Coopers & Lybrand study, from a sample of 27 firms, reports that the estimated average reduction in earnings after the phase-in period required in the Exposure Draft is 3.4% for "mature" firms and 26.5% for "emerging" firms.

improve the allocation of resources within firms by forcing them to come to grips with true cost of their compensation plans. In any event, it is not the intended role of FASB to concern itself with the consequences of accounting rules for resource allocation; rather its role is to provide a framework in which the relevant corporate information is made cheaply available for all investors, permitting them to make informed investment decisions, whatever they may be.[7]

A more serious and sophisticated objection, and one which I will argue has merit, is that adoption of FASB's proposal in its current or reasonably modified form could lead to even greater non-comparability of accounting statements than we have in the current situation where most stock option plans are valued at zero. In the fields of finance and economics, the primary interest lies in how assets and securities are valued. But in the field of accounting, knowledge of valuation is not sufficient; *in addition, firms need to be induced to report correct values.* That is one reason why GAAP do not value inventories and plant and equipment at market. Too often market prices are not directly observable, and attempted marking-to-market would give firms free reign to make highly subjective estimates which may make external accounting statements less comparable.

I will argue that employee stock options differ from standard call options in significant ways. Nonetheless, for the most part, these can be incorporated into a generalized binomial model. Unfortunately, it seems that reasonable individuals can easily make different estimates of critical inputs that can lead to substantially different values. In addition, recent empirical work has questioned the validity of either the Black-Scholes or standard binomial model, even as it is applied to short-term exchange-traded options.

I. Problems in Applying Standard Option Pricing Techniques to Exchange-Traded Options

Assuming the Black-Scholes or standard binomial model is correct for valuing short-term exchange-traded options, there still remains the difficult task of estimating volatility. Commonly used historical estimates of volatility can vary over a significant range depending on the length of the historical period and the sampling frequency selected during the period. For example, selecting a period at random, estimating volatility for the S&P 500 index on September 30, 1986 from recent past historical index changes produces the following estimates:

[7] A caveat: FASB must also deal with the difficult trade off between providing relevant information and requiring firms to release information that could damage their competitive position in their industry.

Table I
Sensitivity of Historical Volatility to Sampling Period and Frequency

sampling period	sampling frequency: 5 minutes	1 day	2 days
1 day	31%		
1 week	25%	19%	
1 month	34%	28%	26%
2 months	28%	22%	21%
3 months	26%	22%	21%

Choice of the sampling period and frequency is currently an art, not a science. As a result practitioners use a wide variety of procedures, including complications related to differential measurement of intra-day, overnight, weekend, and holiday volatility, and, in more sophisticated approaches, explicit methods for measuring volatility in the presence of acknowledged non-stationarity of historical time-series. For example, consider a benchmark standard European call at-the-money with underlying stock price and strike price of $100, time-to-expiration of one-year, an annualized dividend yield of 3.5% and an interest rate of 8%: near the extremes of volatility shown above, 21% and 34%, such an option would have a Black-Scholes value of $10.09 or $14.88, respectively.

II. Differences Between Exchange-Traded Options and Employee Stock Options

Complicating these issues further, apart from accounting treatment, employee stock options differ from exchange-traded options in seven important respects:

(1) Maturity: their maturity is much longer, typically 10 years;

(2) Delayed Vesting: through delayed vesting, exercise is usually not permitted for a period after grant, typically 3 years;

(3) Forfeiture: employees will lose unvested options when they leave their jobs and may be forced to exercise prematurely then unexercised but vested options;

(4) Non-Transferability: employees are usually not permitted to sell their options; so that the value of an option to the employee and his optimal exercise strategy is affected by his personal aversion to bearing risk, by his personal probability beliefs concerning his employer's future stock price, by the nature of his labor income, and by any other options or assets he may be holding;

(5) Taxes: non-qualified employee stock options[8] granted at-the-money are not taxed at

[8] Most employee stock options granted since the Tax Reform Act of 1986 are non-qualified (NQO). In contrast, the profits of incentive stock options (ISO) are not taxed to the employee until the stock acquired though exercise is sold, and then the tax is assessed at the capital gains tax rate. However, this advantage is usually more than offset by the fact

grant, but are taxed at exercise at the employee's ordinary income tax rate based on the difference between the firm's stock price at that time and the strike price, and simultaneously give rise to an offsetting taxable expense for the firm;[9]

(6) Capital Structure Effects: the exercise of the options causes the associated firm to issue new shares of common stock and to receive the strike price in cash upon exercise, which increases both the number of outstanding shares and the total level of funds in the firm; in addition, instead of paying for the options in cash, employees pay with their labor services, which leaves additional cash in the firm which can be used for other purposes;[10]

(7) Operating Income Effects: compensation in the form of options can have the effect of increasing revenues, reducing expenses, or increasing risk-taking through altered work incentives.

These differences significantly complicate the problem of valuing these options even if the Black-Scholes or standard binomial approach is used. FASB's Exposure Draft describes corrections to these approaches which attempt to deal with differences (3) and (4) only. To handle difference (3), for options valued with either the Black-Scholes formula or binomial trees, the resulting option value is adjusted downward by multiplying the value that would otherwise have obtained by one minus the probability of forfeiture through the vesting date. To handle difference (4), users of the Black-Scholes formula are to value an option by replacing the time-to-expiration of the option with its expected time-to-exercise or expiration, whichever comes first.

Below we consider the efficacy of these modifications in the light of a more complete model of employee stock option valuation that takes account of differences (1)-(6).

Difference (1) Maturity: The basic inputs into either the Black-Scholes or standard binomial option valuation approach are the underlying asset price, volatility and payout rate, the interest rate, and the option strike price and time-to-expiration. Particularly over long periods of time, it becomes difficult to estimate underlying asset volatility and payout, and even slight errors in payout measurements (which over shorter periods would not have been as important) can radically change calculated option values. For example, consider our benchmark standard European call at-the-money with stock price on the grant date and strike price of $100, annualized stock volatility of 30%, and interest rate of 8%. The following table shows how a long time-to-expiration of the call can make its Black-Scholes value very sensitive to the assumed dividend yield:

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the employing firm receives no tax deduction for this form of compensation.

[9] If the option is granted in-the-money, compensation expense to the firm and income to the employee equal to the in-the-money amount may be required to be recognized at the time of grant.

[10] In contrast, stock appreciation rights are satisfied by a cash payment from the firm to its employees equal to the difference between the stock price and strike price on the exercise date. In this respect, they are similar to cash-settled exchange-traded index options.

Table II
Sensitivity of Black-Scholes Option Values to Dividend Yield

annualized dividend yield	years-to-expiration 1	10
2.5%	$13.99	$41.61
3.5%	$13.41	$35.59
4.5%	$12.84	$30.33

Options are European and at-the-money, with underlying stock price and strike price equal to $100, annualized stock volatility of 30% and interest rate of 8%. The options are valued using the Black-Scholes formula.

While an error of 1% in projected payout creates only about a 4% error in the calculated value of options maturing in one year, it creates a 15%-17% error for options maturing in ten years.

Estimation of dividend yield, while usually quite reliable over a single year, can be quite difficult over longer periods. Corporations that are currently growing rapidly and currently pay little or no dividends should be able to make a persuasive case that dividends could well increase markedly after about five years as the corporation matures and its growth rate diminishes. But such a forecast, while possibly accurate, is subject to considerable uncertainty and manipulation.

Errors resulting from volatility estimation, while not as sensitive to maturity, can nonetheless be quite substantial. For example, under the above situation with a dividend yield of 3.5%:

Table III
Sensitivity of Black-Scholes Option Values to Volatility

annualized volatility	years-to-expiration 1	10
25%	$11.56	$32.67
30%	$13.41	$35.59
35%	$15.25	$38.49

Options are European and at-the-money, with underlying stock price and strike price equal to $100, annualized dividend yield of 3.5% and interest rate of 8%. The options are valued using the Black-Scholes formula.

Here too, corporations that are currently growing rapidly can reasonably argue that volatility should gradually decline as the corporation's market matures and it becomes increasingly diversified across product lines, so that after 10 years volatility may reach much lower levels. Using the Black-Scholes formula, one should input the average volatility to be experienced during the life of an option, but in this case, this is likely to be considerably lower than the current volatility possibly implied in the market prices of its exchange-traded stock options.

A recent study, submitted by the firm Thermo Electron to FASB, examines over-the-counter warrants with lives of 5 to 10 years.[11] Of the roughly 300 existing warrant issues, 20 were of the right maturity and near-the-money at the time of the study. Using simple historical estimates of dividends and volatility, the study compares the standard binomial values of the warrants to their market prices. Of the 16 warrants with a history of zero dividends, 15 were overvalued by the model, using either 100-day or 3-year historical volatility. The average overvaluation of all 16 warrants was about 100%, and 13 of the 16 were overvalued by at least 30%. Interestingly, all 4 warrants with a positive history of dividends were *undervalued* by about 23%. This study is very suggestive of the naivety of estimating inputs to option models under the presumption that history is expected to repeat.[12]

FASB's Exposure Draft allows two alternative valuation approaches: Black-Scholes and binomial, and requires that the Black-Scholes approach use the expected life of the option in place of its time-to-expiration. Unfortunately, this can lead to exactly the wrong correction in many circumstances. Binomial trees are widely used for exchange-traded options, principally because – unlike the Black-Scholes formula – they explicitly take account of optimal early exercise permitted for American-style options. Since employee stock options can also be exercised early, binomial models should provide more accurate values. However, since other things equal, American exchange-traded option values are higher than Black-Scholes values and reducing the time-to-expiration in the

[11] See "Valuation of Employee Stock Options," position paper presented at April 18, 1994 roundtable discussion of the Financial Accounting Standards Board, Thermo Electron Corporation.

[12] In "Pricing Warrants: An Empirical Study of the Black-Scholes Model and Its Alternatives" (*Journal of Finance*, September 1990), Beni Lauterbach and Paul Schultz also present evidence of difficulties of applying standard option models to long-term options.

Black-Scholes formula reduces the values of calls, FASB's modification may tend to move computed values of employee stock options in the wrong direction. To get an idea of the magnitude of this bias, using the benchmark option, we can use a binomial tree to calculate the (risk-neutral) expected life of the option, known in the trade as the option "fugit".[13] For our benchmark option, the fugit is 9.14 years. Below we use this in the Black-Scholes formula to value a European option assumed to expire at that expected life.

Table IV
Sensitivity of Option Values to Exercise Assumption

exercise assumption	exercise	option value
Binomial (optimal early exercise)	optimal	$37.81
Black-Scholes (exercise only at expiration)	10 years	$35.59
Black-Scholes (exercise at expected option life)	9.14 years	$34.98

Options are at-the-money with time-to-expiration of 10 years, underlying stock price and strike price equal to $100, annualized stock volatility of 30%, annualized dividend yield of 3.5% and interest rate of 8%. The binomial calculations use a tree size of 200 steps.

Clearly, in this case, FASB's amended procedure has driven the option value even further than the naive Black-Scholes model from the optimal early exercise binomial value. For firms with dividend yields closer to the interest rate, since early exercise is even more desirable and therefore the fugit is smaller, this bias will be even larger. For example, in an otherwise identical situation, if the dividend yield were 4.5% instead of 3.5%, the fugit is 8.81 years and the Black-Scholes option value with this time-to-expiration is $34.70.

Difference (2) Delayed Vesting: Most option plans do not permit employees to exercise their granted options until after a predefined period of time has elapsed. The options then are neither European (can only be exercised at expiration) nor American (can be exercised at any time), but rather some hybrid which some have termed "Bermudan" (being between the United States and Europe). Fortunately, this difficulty can be easily handled by appropriately modifying the standard binomial model. Working backwards from the end of the tree, provided exercise is possible, at each node substitute the current early exercise value of the option for its current holding value if the former is greater. Then, as one continues to work backwards and enters the region where exercise is not possible, only use the current holding value at each node. However, this complication requires use of a modified binomial model. To see what effect early exercise can have on the value of an option, consider the same situation as above:

[13] Mark Garman, in his article, "Semper Tempus Fugit," *RISK* 2, No. 5 (May 1989), pp. 34-35, shows how to use binomial trees to calculate the risk-neutral expected life of an option by working backwards recursively from the end of the tree.

Table V
Sensitivity of Option Values to Delayed Vesting Method

delayed vesting method	option value
European (Black-Scholes at fugit)	$34.99
Bermudan (modified binomial)	$37.78
American (standard binomial)	$37.81

Options are at-the-money with time-to-expiration of 10 years, underlying asset price and strike price equal to $100, a volatility of 30%, a dividend yield of 3.5% and an interest rate of 8%. The Black-Scholes formula uses as the time-to-expiration the fugit of the Bermudan case of 9.16. The Bermudan and American option values are calculated using a 200 step binomial tree, and the modified binomial assumes that vesting occurs after the end of the third year in the life of the option.

Fortunately, the effect of delayed exercise is small in this case because it will usually not pay to exercise a ten-year option early in its life.

Difference (3) Forfeiture: The current value of granted options must be adjusted downward to account for the probability that an employee will be fired or voluntarily resign. As suggested in the Exposure Draft, this probability can be estimated actuarially across a large pool of employees. The value of the options is then simply adjusted downward by multiplying the value that would otherwise have been obtained by one minus the probability of forfeiture through the vesting date.

The anticipated forfeiture rate is another variable, like payout and volatility, that will have to be estimated. In many cases, it could be reasonably argued that history is a poor guide to the future because employment conditions have changed, and even if history is useful there are questions about how far back forfeiture rates should be averaged. Using past experience to estimate the termination rate is not easy, since past results are no doubt influenced by the degree of past success of the firm. For example, realized forfeiture rates are likely to be lower than ex-ante expectations during times when the stock price has risen rapidly.

The following table indicates how sensitive calculated option values are to this variable:

Table VI
Sensitivity of Bermudan Option Values to Forfeiture Rate

annualized forfeiture rate	option value
3.5%	$33.95
5.0%	$32.39
6.5%	$30.88

Options are Bermudan and at-the-money with time-to-expiration of 10 years, underlying asset price and strike price equal to $100, a volatility of 30%, a dividend yield of 3.5% and an interest rate of 8%. The Bermudan option values are calculated using a 200 step binomial tree with vesting occurring after the end of the third year in the life of the option. Forfeiture is considered by following FASB's procedure and multiplying the value of the option $37.78 by one minus the annualized forfeiture rate raised to the third power.

Even if the forfeiture rate can be measured exactly, there are several reasons why FASB's amended procedure is flawed.

First, the possibility of forfeiture continues to affect the values of most employee stock options even after the vesting date. Should an employee leave his job after his options have vested but before their expiration date, he is usually forced to exercise the options shortly after his departure. Since American call options are normally worth more alive than dead, this reduces the value of the options even further.

Second, FASB's approach ignores that the probability of forfeiture is no doubt negatively correlated with the success of the corporation. In particular, if the underlying stock price rises over the life of the options and perforce the options become quite valuable, employees are probably less likely to be fired or leave their jobs voluntarily. This means that to this extent the suggested approach will overstate the effect of forfeiture on the value of the options. If some firms account for this dependence and others do not, their external financial statements will not be comparable.

Third, the probability of forfeiture may be positively correlated with the time remaining to the vesting date, other things equal. The less time remaining, the less likely an employee will voluntarily resign and the less likely the employee will be fired since the employee has had additional time to prove his value to the firm. Therefore, the suggested approach to handling forfeiture needs to be revised to account for the changing average time to the vesting date of the actuarial pool of employees.

Fourth, simply multiplying by one minus the probability of forfeiture, either as proposed by FASB or as outlined above, presupposes that the market discounts the uncertainty associated with forfeiture as if it were risk-neutral toward this risk. This follows from a basic idea of modern financial economics that calculating the present value of uncertain income by discounting its future expected value by the interest rate is only justified if the risk of this income can be diversified away by holding a well-diversified portfolio. In fact, since for the reasons given above, this risk is likely to be negatively correlated with the underlying stock price, which, in turn, is likely to be positively

correlated with the value of a well-diversified portfolio, its effect on valuation should be handled using risk-adjusted discounting – a serious complication about which the theory of finance has no easy answers.

To get an idea of the significance of some of these flaws in FASB's approach, consider the following revised binomial tree. First, to address complication (1), suppose the annualized probability of forfeiture is a constant 5% and we are using a 200 step binomial tree to value an option maturing in 10 years. Then the probability of retention at any node in the tree is $(1–.05)^{10/200}$ = .99744. Suppose at a given node the value of the option unexercised is A and its value exercised is B. As we work backwards in the tree, revise the calculated value of the option at each node as follows:

> if the option is out-of-the money or the node is before the vesting date, replace the value of the option at that node with .99744 × A;
>
> if the option is in-the-money and the node is after the vesting date, replace the value of the option at that node with (.99744 × max[A,B]) + (1–.99744) × B;

and continue to work backwards in the tree using these values. In our benchmark example, the value of a Bermudan option with 3-year delayed vesting before considering potential forfeiture is $37.78. Under FASB's proposal, the value after forfeiture would be $\$37.78 \times .95^3 = \$32.39$. Using the above revised binomial tree, the value would instead be lower at $30.75.

To address the second complication, suppose we use the value of an employee's options themselves to predict the probability of forfeiture. Presumably, other things equal, the higher the value of these options, the less likely he will be terminated. At very low values, assume he is about twice as likely to be terminated and at very high values assume he is half as likely to be terminated. In between, at step i, node j, assume the probability of being terminated is inversely proportional to $(\log C_{ij})/\Sigma_j P_{ij}(\log C_{ij})$, where C_{ij} is the value of his option at step i, node j, and P_{ij} is the probability of ending up at node j at step i, estimated at the beginning of the tree over all possible nodes at step i so that $\Sigma_j P_{ij} = 1$. Thus, roughly speaking, the higher the value of the option at step i, node j, relative to its expected value at step i, the lower the probability of being terminated at step i, node j. Without this adjustment we would have assumed that the probability of forfeiture at step i, node j was 1–.99744 = .00256. This adjustment gives rise to probabilities of forfeiture $(.00256\times.5) < \pi'_{ij} < (.00256\times2)$ which are negatively correlated with the option value at that step-node. Finally, to be consistent with an overall probability of forfeiture at that step of .00256, these probabilities must be scaled so that the final probabilities π_{ij} satisfy $\Sigma_j P_{ij}\pi_{ij} = .00256$. The following table shows this sensitivity:

Table VII
Sensitivity of Bermudan Option Values to Forfeiture

forfeiture assumption	option value
(FASB method)	$32.39
(revised binomial, constant rate)	$30.75
(revised binomial, correlated rate)	$31.63

Options are Bermudan and at-the-money with time-to-expiration of 10 years, underlying asset price and strike price equal to $100, a volatility of 30%, a dividend yield of 3.5% and an interest rate of 8%. The option values are calculated using a 200 step binomial tree, modified to allow vesting after the end of the third year in the life of the option. The average annualized forfeiture rate is 5%. For the second option, the binomial tree is modified to incorporate a constant 5% annualized forfeiture rate throughout the life of the option. For the third option, the tree is modified to include an expected annualized forfeiture rate of 5% with a realization that is negatively correlated as outlined above with the remaining option value.

Difference (4) Non-Transferability: Unlike exchange-traded options, employee stock options are not traded in a secondary market. Therefore, the only way an employee can liquidate her position is to exercise the options and then sell the stock she receives in the secondary market.[14] Since the wealth of many employees is poorly diversified and heavily tied by way of continued employment, cash bonuses and stock options to the performance of their employing firm (the very intention of a stock option program), employees may not value their stock options at as high a level as the Black-Scholes model or standard binomial model would suggest.

Since the option has two values (and the second a highly personal one depending on the preferences and financial circumstances of each employee), one might ask which should be used by the corporation in its external financial statements for the purpose of communicating with stockholders. Fortunately, the answer is clearly that the corporation should value the option according to the effect the existence of the option, other things equal, has on the value of its stock -- not value the option from the employee's point of view -- a position correctly taken in FASB's Exposure Draft. In addition, the argument below shows that since this "compensating differential" can only arise during the vesting period, it is not likely to be a large amount.[15]

[14] As an alternative, an employee could consider short-selling his employer's stock. Aside from the usual problems faced by most investors from the loss of the interest on the proceeds of short sale, an employee must face the reputational difficulties short-selling might entail from this circumvention of the incentives intent of the stock options. In addition, for officers and directors, Section 16-b of the 1934 Securities Act requires that any profits generated by short selling an employer's stock that occur within a six month period following the short sale, whether or not they are actually realized during that time, must be returned to the firm. As a result of these constraints, I suspect that short sales of employer's stock are quite rare.

[15] FASB's proposal advocates amortizing the value of the options over the vesting period. This would be a reasonable procedure if employees could sell their options in the secondary market immediately after vesting. However, because they can not, vested options continue to provide work incentives for employees until the options are exercised and the stock is sold. After vesting, the employee faces a dilemma: on the one hand, he would like leave his options unexercised because of their remaining time value, but on the other, he would like to exercise them to increase

Even so this difference in the way diversified investors and employees look at the options creates problems in determining the exercise strategy assumed in the valuation. The standard binomial model, implicitly presupposing a secondary market for the option, assumes that it would be optimal to exercise an option whenever its discounted risk-neutral expected value is less than its current exercisable value. However, it is likely that pressures to diversify her source of income may cause an employee to exercise her options much earlier than would be optimal for a well-diversified investor. As long as this potential for premature exercised is considered when evaluating an option, except for the exercise prohibition during the vesting period, there will be no difference between the value of the option to the employee and the cost to the firm since the employee forces its value to her to equal its cost to the firm by following the exercise strategy which is in the employee's best interest.[16]

To get an idea of how much this cause of premature exercise can affect the value of an option, we will superimpose upon our current model a highly simplified exercise strategy specially designed to preserve the single state-variable binomial approach.[17] Assume that for each of **N** granted stock options, an employee has a total of **A** dollars of non-option wealth, all currently invested in riskless assets at interest return over a single binomial move **r**. The value to the employee of his entire portfolio provided he holds the options to expiration is:

$$W(j;n) = N \times \{ \max[0, u^j d^{n-j} S - K] + A r^n \}$$

where **j** is the number of up moves with capital gain return **u** and **n – j** is the number of down moves with capital gain return **d** out of a total of **n** steps in the binomial tree, **S** represents the stock price on the grant date, and **K** is the strike price of the options.

Assume furthermore that the employee's utility function is in the class of myopic functions:

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his diversification. Of course, if he could sell his options he would probably do so, but this alternative is not open. As long as he retains his options, the "forced" concentration of his wealth in his employing firm may cause him to work harder. This argues that correct matching of revenues with expenses requires that only part of the option cost be amortized during the vesting period, and that the remainder be amortized from the end of the vesting period to the date of exercise or expiration, whichever comes first.

[16] Inaccurate handling of the exercise strategies of employees would not be as significant if there were a way to correct these errors retroactively based on realized behavior. Indeed, FASB proposes that after options have either been exercised or expired, the options be revalued using the realized life of the options in place of their expected life and the financial statements trued-up accordingly. Unfortunately, this retroactive procedure does not make sense. To see this, options which end up in-the-money are likely to be exercised early and therefore lead to subsequent downward adjustment in their values. On the other hand, options that remain out-of-the-money, will never be exercised, leading either to no adjustment or subsequent upward adjustment in their values. So we have the embarrassing situation where options which turn out to provide high payoffs to employees will, in the end, after the proposed ex-post correction, be valued much lower than options which turn out to be worthless.

[17] The model used here of the effects of non-transferability on the employee's exercise decision is adapted from Alan Marcus and Nalin Kutalilaka, "Valuing Employee Stock Options," *Financial Analysts Journal* (November/December 1994).

$$U(j;n) = W(j;n)^{1-b}/(1 - b) \text{ for } 0 < b$$[18]

where the greater **b**, the more risk aversion. In this case, since utility is unique up to an increasing linear transformation, the employee's utility will be independent of the scale of his wealth N (so henceforth we will ignore N).

Let **E** be the investor's own subjective annualized expected return of the underlying stock. Assume also that the investor believes that the stock rate of return follows a stationary random walk. In a binomial model, this implies that at each node in the tree, the expected stock return over the next move is:

$$E^h = qu\delta + (1 - q)d\delta$$

where $\mathbf{h} \equiv t/n$ (the ratio of the years-to-expiration of the option divided by the number of steps in the tree), **δ** is one plus the dividend yield over the next move, and **q** is the subjective probability of an up move. Thus, taking E as given, we can derive q as:

$$q = ((E^h/\delta) - d)/(u - d).$$

The employee can calculate his expected utility and exercise strategy recursively by using the following procedure. For an earlier period **k**, conditional on not exercising his options during this period, his expected utility is:

$$E_H[U(j;k)] = qE[U(j+1;k+1)] + (1 - q)E[U(j;k+1)]$$

on the other hand, conditional on exercising his options, his expected utility is:

$$E_X[U(j;k)] = \{ (\max[0, u^j d^{k-j} S - K] + Ar^k) r^{n-k} \}^{1-b}/(1 - b)$$

His actual expected utility will be:

$$E[U(j;k)] = \max\{ E_H[U(j;k)], E_X[U(j;k)] \}$$

This model of early exercise makes three highly simplifying assumptions:

(1) the only assets the employee holds are his non-transferable stock options and cash;

(2) at each date after vesting, the employee either exercises none or all of his options;

(3) upon exercise, the employee immediately sells his stock and reinvests the

[18] If b equals 1, then the utility function is its limit as b approaches 1, which is log(W).

proceeds in cash and remains 100% invested in cash through the expiration date.

Thus, in this simplified model, in addition to the information required before, knowledge only of the investor's initial non-option wealth A, his subjective stock expected return E, and his risk aversion b is enough to determine the employee's optimal exercise strategy. Each of these variables is quite difficult to estimate. Non-option wealth not only includes the employee's holdings of real estate and securities outside his employing firm, but also includes some fraction of the present value of his human capital that is not solely dependent on the fortunes of his currently employing firm. Not only are expected returns subjective but also they are also notoriously difficult to estimate from historically observed returns.[19] For the U.S. population as a whole, various academic studies have estimated risk aversion b in the range of 1 to 10, and many start-up or high-tech firms may self-select employees with even lower risk aversion.

The following table indicates how sensitive calculated option values are to these variables:

Table VIII
Sensitivity of Bermudan Option Values to Non-Transferability Variables

	risk aversion (b)								
	.5			2			4		
non-option	expected return			expected return			expected return		
wealth (A)	10%	15%	20%	10%	15%	20%	10%	15%	20%
30.00	37.60	35.56	35.60	32.82	35.66	37.77	29.12	31.46	32.97
60.00	37.77	35.56	35.56	34.69	37.27	36.56	31.67	33.77	36.00
120.00	37.76	35.56	35.56	36.36	37.75	35.79	33.82	36.14	37.70

Options are Bermudan and at-the-money with time-to-expiration of 10 years, underlying asset price and strike price equal to $100, a volatility of 30%, a dividend yield of 3.5%, an interest rate of 8%, and vesting occurs after the end of the third year in the life of the option. The Bermudan options are calculated with a 200 step binomial tree. The employee is assumed to base his exercise strategy on a myopic utility function of wealth at option maturity with risk aversion b; the only assets the employee holds are his non-transferable stock options and cash (equal to A on the grant date); at each date after vesting, the employee either exercises none or all of his options; and upon exercise, the employee immediately sells his stock and reinvests the proceeds in cash.

The numbers in this table, which do not reflect the possibility of forfeiture, should be compared to $37.78 from Table V. This is an upper bound on the values in Table VIII since restrictions on non-transferability (which lead to non-optimal exercise behavior from the point of view of an investor with access to a secondary market) should only serve to decrease option values.[20]

[19] For example, assume the stock return follows a stationary random walk with standard deviation 30%. Even after an historical sample covering 25 years, the standard deviation of the historically sampled mean is 30%/√25 = 6%. Even worse, since we don't inhabit a stationary random walk world, this should be regarded as a lower bound.

[20] One might have expected that the option values in this table should have been increasing in non-option wealth and expected return, but decreasing in risk aversion. Indeed, had the dividend yield been zero, such would have been the case. With positive dividends, had the options been traded in a secondary market, to maximize their market value it would pay to exercise them early under some circumstances. However, in the absence of a secondary market, increases in non-option wealth or expected return, or decreases in risk aversion, may cause an employee to postpone this

Difference 5 Taxes: Taxes may have many effects on the values of options. Here we only consider the effect of taxation on the early exercise strategy. Since the compensation or profit from options granted at-the-money is only taxed upon exercise, this taxation will delay exercise in an attempt to postpone the tax. Typically, this delay will cause the option values to increase. Assuming a 25% tax on the exercisable value paid on the exercise date causes the option values in Table VIII to deviate from the values reported there in a range of $-0.44 to $1.50.

Difference (6) Capital Structure Effects: Unlike exchange-traded calls that are typically obligations of parties unassociated with the underlying firm, employee stock options are obligations of the underlying firm itself. As a result, like warrants, they give rise to additional capital for current investment (in lieu of immediate employee compensation), potentially newly issued shares in the future, and the receipt of the strike price upon exercise. To analyze this difference, we need to make some assumption about the effects of the granting and exercise of stock options on the investment activities of the firm. To separate cleanly capital structure from investment issues[21], we will assume that the stochastic process of the portfolio total market value of the firm's stock and stock options is unaffected by the granting or exercise of options, and that it is this value that is the underlying variable in our binomial tree. In particular, this means that the total value of this portfolio $\mathbf{V}^*$ on the exercise date of the options will be unaffected by the proportional division of this portfolio between stock and options.[22]

In that case, if the firm has $\mathbf{n}$ shares of outstanding common stock and has granted stock options each with strike price K, which if all exercised would give rise to a total of $\mathbf{m}$ newly issued shares of stock, the value of an option at exercise would be:

$$(V^* + mK)/(m + n) - K = (V^* - nK)/(n + m)$$

Letting $\mathbf{S}^* \equiv V^*/n$ (the value – inclusive of granted options – per share) and $\boldsymbol{\lambda} \equiv m/n$ (the dilution factor), then the payoff of a single option can be rewritten as:

$$\max[0, S^* - K]/(1 + \lambda)$$

If we assume that if exercised, all the stock options are exercised at once, then we need only modify the previous analysis by continuing to model the stationary binomial movement of S^* with volatility σ (now interpreted to include any value of the granted options), and to calculate the

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exercise, thereby reducing the value of the option, not to him, but to the issuing firm.

Here is another curious anomaly. Other things equal, standard options are more valuable the greater the volatility of their underlying asset. In the case of employee stock options, however, increased volatility could lead a poorly-diversified employee to exercise his options even earlier, thereby reducing the value of the options.

[21] Effects of stock options, through alterations in the operating characteristics of the firm, are considered separately in our taxonomy by Difference (7).

[22] This is the same approach taken by John Cox and Mark Rubinstein in *Options Markets* (Prentice-Hall, 1985).

proceeds at exercise by the above formula instead of the usual $\max[0, S^* - K]$.

One final adjustment reflects the effect of forfeiture on the dilution factor. An approximate way to incorporate this is to use $\lambda(1-p)^{\tau}$, where $\mathbf{p}$ is the expected annualized probability of forfeiture and $\boldsymbol{\tau}$ is the years-to-vesting, in place of λ.

Joint Effects of Differences (1)-(6): Our full binomial model of employee stock options requires the following sixteen inputs:

(1) stock price on grant date [$100]
(2) stock volatility [25% – 35%]
(3) stock payout rate [2.5% – 4.5%]
(4) stock expected return [10% – 20%]
(5) interest rate [8%]
(6) option strike price [$100]
(7) option years-to-expiration [10]
(8) option years-to-vesting [3]
(9) expected forfeiture rate [3.5% – 6.5%]
(10) minimum forfeiture rate multiplier [.25 – 1.00]
(11) maximum forfeiture rate multiplier [1 – 4]
(12) employee's non-option wealth per owned option [$30 – $120]
(13) employee's risk aversion [0.5 – 4.0]
(14) employee's tax rate [25%]
(15) percentage dilution [10%]
(16) number of steps in binomial tree [200]

The joint effect of many of these alternative assumptions is examined in the three cases below. In each case, the stock price on the date of grant is $100, the option strike price is $100, the option time-to-expiration is 10 years, time-to-vesting is 3 years, the interest rate is 8%, time to vesting is 3 years, the employee's tax rate is 25%, the percentage dilution (before considering forfeiture prior to vesting) is 10%, and the binomial tree size is 200 steps.

Table IX
Joint Sensitivity of Option Values to Valuation Assumptions
under Grant Date Accounting

	normal case	understated case	overstated case
stock volatility	30%	25%	35%
stock payout rate	3.5%	4.5%	2.5%
stock expected return	15%	10%	20%
expected forfeiture rate	5.0%	6.5%	3.5%
minimum forfeit rate multiplier	.5	1.0	.25
maximum forfeit rate multiplier	2.0	1.0	4.0
employee's non-option wealth	$60	$30	$120
employee's risk aversion	2.0	4.0	.5
option value	$29.10	$18.68	$36.32

Options are at-the-money with time-to-expiration of 10 years, underlying asset price and strike price equal to $100, an interest rate of 8%, and vesting occurs after the end of the third year in the life of the option. The employee's tax rate is 25%, the percentage dilution is 10%, and the binomial tree has 200 steps.

Here the cumulative effect of these different assumptions is to undervalue the option by 36% or to overvalue the option by 25%. In this way, a firm seeking to overvalue its options might report values almost double those reported by an otherwise similar firm seeking to undervalue its options.

III. New Approaches to Option Valuation

It can be argued that the Black-Scholes formula is likely to work best in the market for index options; and yet in recent years the formula has worked very poorly, to the point where most professionals do not really use it.[23] A basic prediction of this formula is that all options on the same underlying asset with the same time-to-expiration (but different strike prices) must have the same implied volatility. While more or less true during the early years of this market and for the early years of the market for equity options, this is far from true today. For example, during early 1990, it was quite common to find six-month index calls that are 9% out-of-the-money with implied volatilities of 13%, while otherwise similar options which are 9% in-the-money have implied volatilities of 23%. This implies that relative to the valuations of Black-Scholes one of these options must have a percentage pricing error of at least 15% or an absolute pricing error of at least $4.00. While the exact implied volatilities are different today, the percentage and dollar errors are no doubt comparable.[24] It may be surmised that the stock market crash of 1987 has permanently

[23] Professionals assign a different implied volatility to each option -- clearly a kluge to deal with the inadequacies of the Black-Scholes formula since there is no obviously superior candidate to replace it.

[24] These minimum errors from Black-Scholes values have been recently documented in Mark Rubinstein, "Implied Binomial Trees," *Journal of Finance* (July 1994).

changed the way index and equity options are valued so that the Black-Scholes approach is no longer adequate even as a rough approximation.

A generalized binomial model along the lines recently suggest by Bruno Dupire, Emanual Derman and Iraj Kani, or Mark Rubinstein,[25] is likely to become the preferred way used by professionals to handle the above problems. While the Black-Scholes or standard binomial model presupposes that the underlying asset at option expiration has a risk-neutral lognormal distribution (so the only variable really in contention is its volatility), these newer approaches allow the user to input a completely arbitrary terminal distribution (as well as an assumed payout history that can depend on the future stock price and time). This means that corporations using this improved model can not only easily justify its use by pointing to the market failure of the Black-Scholes model, but may easily be able to justify using whatever terminal distribution suits their purposes -- since at the current state of knowledge, this is more an art than a science.

The following table gives an indication of the sensitivity of option values to assumptions about the "shape" of the risk-neutral probability distribution of the underlying asset price at the option expiration date. In all these cases, the volatility through the expiration date is fixed at 30%:

Table X
Sensitivity of American Option Values to Shape of Probability Distribution

skewness	kurtosis	option value
.00	2.99	$37.82
-.95	3.93	$34.51
+.91	4.00	$45.51

Options are American and at-the-money with time-to-expiration of 10 years, underlying stock price and strike price equal to $100, annualized stock volatility of 30%, annualized dividend yield of 3.5% and interest rate of 8%. The calculations are based on generalized binomial trees with 200 steps.

IV. Minimum Value as an Alternative

Even with these large potential percentage differences in option values, it may still be argued that some positive valuation is better than zero, which is the current practice. But this is not obvious. For example, consider the case of two otherwise identical firms with options that should properly be valued at $29.10, but where one firm deliberately undervalues them at $18.68 and the other deliberately overvalues them at $36.32 (see Table IX). Before implementing FASB's proposal, both firms would have reported the same profits since the options would have been valued at zero. After implementing the proposal, they would report different profits and their accounting statements

[25] See the "The Supermodel Comes of Age," *RISK* (January 1994), p. 6. For specific papers, see B. Dupire, "Pricing with a Smile," *RISK* 7, No. 1 (January 1994), pp. 18-20, E. Derman and I. Kani, "Riding on the Smile," *RISK* 7, No. 2 (February 1994), pp. 32-39 and M. Rubinstein, "As Simple as One-Two-Three!" *RISK* 8, No. 1 (January 1995).

would no longer be comparable. Of course, it can be argued that since both $18.68 and $36.32 are closer to the correct $29.10 than they are to zero, in an absolute sense both firms are now, after FASB's implementation, reporting profits closer to their true amounts. However, where before the firms had comparable accounting statements, now they do not. It is not clear the former benefit outweighs the latter drawback.

This line of reasoning seems to suggest that if comparability can be maintained and firms could report a value for their employee stock options that, while incorrect, at least brings their reported profitability closer to its true amount, then such a procedure should be adopted. It might seem that the alternative minimum option value technique discussed in the Exposure Draft might have these advantages. Minimum value accounting would require firms to value options on the date of grant at current stock price (adjusted downward for expected dividends) minus the present value of the strike price, provided this were greater than zero, or zero otherwise. To remove any chance for non-comparability to arise from misestimation of the expected life of the options, one could simply value the options as if they would be exercised at the first available opportunity (the vesting date). In addition, to account for forfeiture, one would multiply this value by one minus the probability of forfeiture. To see this concretely, suppose that $\mathbf{p}$ is the annualized probability of forfeiture, $\mathbf{S}$ the current value of the underlying stock, $\boldsymbol{\delta}$ the annualized one plus dividend yield, $\mathbf{K}$ the strike price, $\mathbf{r}$ the annualized interest return, and $\boldsymbol{\tau}$ the time-to-vesting, then the value of an option would be:

$$(1-p)^{\tau} \times \max[0, S\delta^{-\tau} - Kr^{-\tau}]$$

Provided comparable firms estimated p and δ the same, both firms would value their options the same. Not only does this value place a lower bound on the value of the options,[26] it also is quite easy to implement. For example, in the benchmark situation described above where $p = .05$, $\tau = 3$, $S = K = 100$, $\delta = 1.035$ and $r = 1.08$, the option would be worth $9.27. This, of course, is much lower than the true value of $29.10, but at least it moves the financial statements in the right direction, that is, away from zero.

Unfortunately, even this approach has potentially serious problems for three reasons.

First, the $9.27 value is much lower than the true value of $29.10. So the intent of FASB's proposal would only be very partially realized.

Second, there still remains room for significant non-comparability as the table below indicates:

[26] This value is equivalent to the Black-Scholes value obtained with a time-to-expiration of 3 years and a volatility of 0%.

Table XI
Joint Sensitivity of Minimum Values to Valuation Assumptions

	normal case	understated case	overstated case
payout rate	3.5%	4.5%	2.5%
forfeiture rate	5.0%	6.5%	3.5%
option value	$9.27	$6.74	$12.11

Options are at-the-money with time-to-vesting of 3 years, underlying asset price and strike price are equal to $100 with an interest rate of 8%.

However, here the likely effects of non-comparability may be overstated since over the shorter 3-year rather than 10 year period required for the minimum value calculation, it will be more difficult for comparable firms to justify such large differences in assumed payout and forfeiture rates.

Third, and by far the most important, firms can easily circumvent the intention of the minimum value approach by changing the terms of their options. While this could be accomplished in a number of ways, here is a particularly elegant method: change the strike price so that it is increased by the ratio of the interest return divided by the payout return through the vesting date. In the example above, the strike price $K = 100$ would instead be replaced by $K(r/\delta)^{\tau} = 100(1.08/1.035)^3 = \$113.61$. In this case the minimum option value would be 0. Since these options would be granted with a higher strike price, employees would, of course, receive less value per option; nonetheless the total size of the compensation package could be maintained by granting more options. Not only would employee incentives be maintained (indeed, possibly enhanced), but stockholders might well agree that this was a superior compensation plan since employees would only be rewarded by the options if the stock price plus dividends were to grow faster than the interest rate -- an alternative easily available to the stockholders without investing in the stock. In the end, what would FASB have achieved by adopting the minimum value approach? Many firms would continue to report their employee stock options at zero value, but would have perhaps altered their plans solely for accounting, not economic, purposes.

V. Effects on Earnings Per Share

For the purpose of calculating primary earnings per share, the number of shares is set equal to the actual number of outstanding shares plus the number of additional shares that would need to be issued with just sufficient proceeds to buy back outstanding options at their currently exercisable values. For this calculation, the Exposure Draft would have firms only consider the number options that are expected to survive the vesting period.[27] A problem with this approach is that currently out-of-the-money options create no reported dilution even though they can be expected to create at least some dilution in the future (since there is a positive probability the options may end up in-the-

[27] In contrast, fully diluted earnings per share would count all outstanding options, whether or not they are likely to vest.

money and be exercised). The correct way to handle this, given that a reliable method can be found to value the options, is to add to the number of outstanding shares, the number of additional shares that would need to be issued to buy back outstanding options at their current values. In particular, since out-of-the-money options have positive values, to that extent they would increase the number of assumed shares for the purposes of calculating EPS.

VI. Vesting Date Accounting

In response to the storm of protest over its Exposure Draft, FASB is considering measuring the option expense on the vesting date rather than on the grant date.[28] In particular, the stock option is valued as a standard call using the stock price on the vesting date, a time-to-expiration equal to the expected time to expiration or exercise remaining after the vesting date, and the actual number of options vested. This revision has three estimation advantages:

> (1) because maturity is nearer on the vesting date, the problems of estimating dividends and volatility are reduced (mitigation of Difference (1));
>
> (2) the option model need not be revised for delayed vesting (elimination of Difference (2));
>
> (3) there is no need to adjust the value of the options downward to account for the probability of forfeiture through the vesting date (mitigation of Difference (3));

In addition, realizing the inconsistency of its previously proposed ex-post adjustment for the realized life of the option, FASB seems to be dropping this adjustment.

Two conceptual arguments help justify vesting date accounting: the view that contingent contracts are not liabilities and that the proper measure of the actual service rendered is the increase in the stock price between the grant and the vesting date. It can be argued that as long as there is the precondition of continued employment before exercise is possible and as long as the employee has not agreed to anything, an employee does not really have an option.

To get an idea of how much switching from grant to vesting date accounting will reduce opportunities for non-comparable financial statements, reconsider the comparison made in Table IX. Suppose that the stock price and option strike price are both \$100, the interest rate is 8%, time-to-expiration is 7 years, the option vests immediately, the tax rate is 25%, percentage dilution is $10\% \times (1-.05)^3$, and the binomial tree size is 200 steps.

[28] A member of FASB's staff stated that FASB was considering the vesting date as an alternative, not because it was conceptually superior to grant date, although a reasonable conceptual case can be made for it, but primarily because it solves several problems related to grant date accounting.

Table XII
Joint Sensitivity of Option Values to Valuation Assumptions
under Vesting Date Accounting

	normal case	understated case	overstated case
stock volatility	30%	27%	33%
stock payout rate	3.5%	4.0%	3.0%
stock expected return	15%	10%	20%
expected forfeiture rate	5.0%	6.5%	3.5%
minimum forfeit rate multiplier	.5	1.0	.25
maximum forfeit rate multiplier	2.0	1.0	4.0
employee's non-option wealth	$60	$30	$120
employee's risk aversion	2.0	4.0	.5
option value	$27.86	$17.49	$31.61

Options are at-the-money with time-to-expiration of 7 years, underlying asset price and strike price equal to $100, an interest rate of 8%, and vesting is immediate. The employee's tax rate is 25%, the percentage dilution is $10\%\times(1-.05)^3$, and the binomial tree has 200 steps.

This situation is only somewhat improved over grant date accounting. This could have been anticipated since, as Table V indicated, eliminating delayed vesting from the calculation should have had little impact on values.

In the spirit of vesting date accounting, FASB has more recently considered a relaxed minimum value approach under which an option is expensed at approximately its minimum value calculated based on the stock price measured on the vesting date. The specific proposal is to expense the option valued as if it were a standard call on the vesting date with a 90-day maturity. Again this approach is likely to engender another slightly more sophisticated, but almost as efficacious, form of gaming. As before, as a response to minimum value at the grant date, firms might grant options out-of-the-money, but set a floating vesting date such that the option automatically vests on the day the stock price first hits the strike price.[29] Conceivably, this might actually improve the incentive effects of stock options while at the same time leading to a very small accounting cost of compensation.

VII. Exercise Date Accounting

The Exposure Draft advocates expensing options based on their grant date values with ex-post truing-up for the realized forfeiture rate during the vesting period and the realized life of the options. Note that errors in other model inputs such as volatility and dividends are not to be trued-up. This means that the cumulative balance sheet retained earnings figure will never be corrected over the

[29] This is an example of an up-and-in barrier call where the barrier equals the strike price. Black-Scholes type formulas for barrier options can be found in M. Rubinstein and E. Reiner, "Breaking Down the Barriers," *RISK* 4, No. 8 (September 1991), pp. 67-70. However, in this case, ignoring possible forfeiture, with the barrier equal to the strike price, the option is equivalent to a simple out-of-the-money call.

life of the corporation. This may be unlike any other form of accounting treatment. Accounting depreciation, for example, while it may be very different than actual market value depreciation during the life of plant and equipment, will nonetheless be trued-up to actual market value transactions when the plant and equipment is finally sold or decommissioned.

As an alternative, FASB gives brief consideration to expensing options based on their realized payoffs at exercise or expiration. This is known as "exercise date accounting". Under this approach, options would still be expensed when granted based on some pricing model, but as their expiration date approached this estimate would be periodically retroactively adjusted for the changed value of the options. A final model-free adjustment would be made upon exercise, setting the option value equal to its ex-post realized exercise date payoff or upon expiration setting its value to zero. This extreme form of truing-up to actual transactions minimizes the damage created by inaccurate valuation during the life of the options, since eventually model- and estimate-free truth will out. Errors in volatility, payout, and forfeiture rate estimates, incorrect modeling of the employee's exercise strategy, and use of an incorrect option pricing formula or algorithm, are all eventually corrected under exercise date accounting. Not only does this reduce the incentives for firms to misvalue their stock options to manage earnings or to game the accounting rules by revising the terms of their options, but also it substantially reduces the informational damage to the market from doing so or even from unintentional errors.

So why does FASB balk at requiring exercise date accounting? Unfortunately, it would force it to reconsider some fundamental issues in accounting, notably, the very definitions of liabilities and equities. Exercise date accounting effectively treats employee stock options, not as equity, but as a liability of the firm. To be consistent, other securities such as warrants would also need be reclassified as liabilities. But, given the proliferation of corporate securities, like convertible bonds that have some equity and some liability features under current definitions, it may be time to do so. Let me suggest that employee stock options, warrants, preferred stock, etc. be lumped together as a third as yet unnamed class of securities, and reserve the term "equity" to refer only to the last residual claim on assets – common stock. From the perspective of preexisting common stock holders, these securities are clearly not equity, and just as the stock holders are interested ultimately in the realized return, rather than the expected return, of an investment, so too they are interested ultimately in the realized exercise date cost of an employee stock option, rather than its expected cost as estimated on the grant date.