ESO Fair Value Case Study:

FAS 123R Illustration 4 and the Effect of Technique and Assumptions on Fair Value

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The Regulation

Accounting for share-based payments is governed by the ***Financial Accounting Standards Board*** in ***Accounting Standards Codification Topic 718***[1]. ASC Topic 718 states:

> *"The objective of accounting for transactions under **share-based payment arrangements** with employees is to recognize in the financial statements the employee services received in exchange for equity instruments issued or liabilities incurred and the related cost to the entity as those services are consumed. This Topic uses the terms compensation and payment in their broadest senses to refer to the consideration paid for employee services."*

Thus, any public company which provides stock options as part of a compensation package must estimate and report the ***fair value*** of those options as of the date that the award was granted, even though the options in question will not be vested until some later date. In addition, many such Employee Stock Options (ESOs) are American-style, with expiration dates as far as ten years into the future. Given that the Standard does not specify either a technique for estimating the fair value or the assumptions to be used in developing such an estimate, the reader will recognize that the valuation process may be subjective in nature and that a broad range of outcomes may result.

The Purpose

This White Paper illustrates the range of valuation techniques which may be used within the confines of the Standard and the different assumptions regarding volatility, interest rates, exercise behavior, and forfeiture which have a material effect upon the fair value. We consider an example given in the text of FAS 123R, and apply different valuation techniques and assumptions to the stated conditions. Finally, we review the various outcomes and comment upon them in light of current practice and observed real-world behavior.

The Example

Our example is the well-known ***"Illustration 4,"*** presented in Paragraphs A86 through A92 of FAS 123R[2]. In Topic 718, this material is presented as ***Subtopic 718-20-55-3, Example 1***. The options are granted on January 1 of "Year Zero" and vest at the end of three years, which is an explicitly stated ***requisite service period***. The share options do not qualify as incentive stock options for US tax purposes. The assumed tax rate upon the entity is 35 percent.

The assumptions and information about the options are as follows:

Stock Price @ Grant Date	**$30.00**	**Risk-free Rate over CT**	**1.5 to 4.3%**
Exercise Price	**$30.00**	**Expected Volatility over CT**	**40 to 60%**
Contractual Term	**10.0 years**	**Expected Dividend Yield**	**1.0%**
Vesting Term	**3.0 years**	**Suboptimal Exercise Factor**	**2.0**

The ***Suboptimal Exercise Factor (SOEF)*** is the multiple of the Strike Price at which exercise is assumed to occur. In this case, the price is $60.00. Since the exercise may occur before the expiration of the option at the end of the Contractual Term, it is referred to as ***early exercise.*** Since the "best" or "optimal" time to exercise an option is generally assumed to be upon its expiration date, any exercise before expiration is termed ***"suboptimal."*** Suboptimal exercise is possible only with American or Bermudan Style options. We will return to the question of exercise behavior later.

Simplifying Assumptions

Although there is nothing in the Standard which compels us to do so, we will make the following simplifying assumptions prior to valuation:

1. Risk-free interest rate is assumed to be a constant 2.9%, the midpoint of the range.
2. Share price volatility is assumed to be a constant 50%, the midpoint of the range.
3. Dividend yield is assumed to be continuous over the Contractual Term.

Each of these assumptions is subject to modification in light of an increased level of information. For example, the actual dates of periodic dividends may be planned well into the future. The dividend yield may increase as planned ahead of time. Also, a term-structure for US Treasury interest rates may be available and factored into the model. Finally, future estimates of volatility may be made in a number of ways. All of these eventualities will not concern us here.

The Valuation Model

Since the options in question are American-style, a ***Trinomial Lattice model*** as described by ***Boyle***[3] is employed. In other cases, ***Binomial Lattice models*** are constructed in a manner described by ***Cox, Ross, and Rubinstein.***[4] In the lattice model, the option is considered as Bermudan-style, since exercise may not take place before vesting at three years after the grant date. After the three-year requisite service period has been fulfilled, the option becomes American-style, in which exercise may take place at any time. ***Application of the lattice model with the assumptions presented above yields a fair value of $14.69 per option at the grant date. This will be called the Base Case.***

Those readers who desire a complete explanation of the Lattice model may consult the original paper by Cox, Ross, and Rubinstein, or explanatory articles such as the papers by Folami, Arora, and Alli[5] or Baril, Betancourt, and Briggs.[6] The trinomial lattice model is treated in the aforementioned paper by Boyle, and further explained by Rubinstein.[7]

It should be noticed that ***the Standard does not require that any particular model be used***. The ***Black–Scholes–Merton*** closed-form model is preferred by some practitioners under certain conditions. Options traded on an exchange or over the counter may be used to give indications of the value of a particular ESO. In the following case study, we examine the results obtained from application of different models and different sets of assumptions.

The Case Study

Exhibit 1 presents a summary of the results obtained from the application of different valuation models and assumptions to the option introduced in Illustration 4. The ***Base Case*** just discussed is presented along with 12 alternatives. In all cases, the stock price at grant date, strike price, volatility, risk-free interest rate, and dividend yield are held constant. The variation in calculated fair value among the different cases is due to the choice of model, assumed exercise behavior, and assumed forfeiture rates.

First, note the variation in fair value among the 13 cases. The fair value ranges from ***$16.93*** to ***$9.24***, which is a span from ***63% to 115%*** of the ***Base Case*** value. Depending upon the number of such options granted by an entity in a given year, this variation could potentially represent a perturbation in net earnings which is merely material to very significant. Thus, the assumptions surrounding the fair value estimate are worthy of our attention. Let us consider each of the cases and their assumptions in turn.

Individual Cases

Case 1 envisions an at-the-money exchange-traded option. This American-style option may be exercised immediately (which contradicts the conditions of the award contract). The Cox-Ross-Rubinstein (CRR) binomial model is used to calculate the value, which is ***$16.93***. Note that the assumption of a 10-year expiration period is hypothetical, since exchange-traded options are available with expiration periods out to 9 months, and ***Long-Term Equity Anticipation Securities (LEAPS®)***, where available, extend out to three years.

Case 2 represents a hypothetical ***over-the-counter (OTC)*** option with Bermudan-style exercise. The option may not be exercised over the first three years of its life, but may be exercised at any time after the remaining seven years until expiration. The CRR model is used, resulting in a value of ***$16.93***. This is the anticipated result, because the distribution of intrinsic values at the end of the binomial tree is identical with the distribution under the conditions of Case 1. Note that in the CRR model, the option price at any node of the lattice may be adjusted if the initially calculated value results in an intrinsic value of less than zero at a time interval in which the option may be exercised. The intrinsic value of any option is always greater than or equal to zero, which must be reflected in the model.

Case 3 represents another hypothetical option, this time with European-style exercise, in which exercise may take place only upon the date of expiration. The CRR model yields a value of ***$16.58***. The value is lower in this case because exercise is precluded until the date of expiration. This result may seem counter-intuitive, but the ability to exercise before expiration allows the holder the flexibility to capture a dividend at any time. In the case of no dividend yield, the value of the option in this case would be identical to the values in Case 1 and Case 2.

Case 4 is identical to Case 3, except the ***Black-Scholes-Merton (BSM)*** closed-form model is used. Once more, the value is ***$16.58***, identical to Case 3. Under the assumptions of European-style exercise, constant volatility and risk-free interest rate, and constant, continuous dividend yield, the BSM and CRR models are equivalent. The CRR model is simply a discrete representation of the BSM model in this case. Note that the CRR model must be applied with a small enough time subinterval (large enough number of "iterations" or subintervals) to effect convergence with the BSM model.

Case 5 represents the actual ESO, incorporating Bermudan-style exercise, but with a ***Suboptimal Exercise Factor (SOEF)*** of 500. The Trinomial Lattice model is used, resulting in a value of ***$16.58***. The choice of a very large SOEF effectively renders the option as European-style. We note that for this European-style option under the assumptions outlined in Case 4, the BSM, CRR, and Trinomial Lattice models yield identical results.

Case 6 is identical to Case 5, except for the use of an SOEF value of 2.5 (stock price of $75.00). This is not high enough to force the option into a European-style exercise mode, so a lower fair value is anticipated. This is indeed the case, as the Trinomial Lattice model yields a fair value of ***$15.58***.

Case 7 is the ***Base Case*** previously discussed. Since we expect the fair value to decline as the SOEF is reduced, we have the result of ***$14.69*** from the application of the Trinomial Lattice model. This case incorporates assumptions which reasonably approximate real-world conditions.

Case 8 relies upon the BSM model. Since the model requires a European-style option, an ***implied expected term*** must be assumed. This is a trade-off for the simplicity of implementation of the closed-form BSM model. The option is assumed to vest in three years. The time to expiration is treated as a variable, which is chosen so that the resulting fair value is identical to that of the Trinomial lattice model, or ***$14.69***. One would expect the fair value in Case 8 to decline with a reduction in implied expected term and increase with an extension of the implied expected term. In fact, Case 4, with European-style exercise, has an implied expected term of ten years and a higher fair value.

Case 9 is identical to the Base Case, save for the assumption of a ***post-vest forfeiture rate of 3.0%.*** The Trinomial Lattice model yields a fair value of ***$14.39.*** Since 3% of the options are never exercised, funding them becomes unnecessary, which results in a reduction of the fair value. The greater the forfeiture rate, the lower the fair value. In such models, the ***SOEF*** is understood to include ***voluntary forfeiture*** of option, while the ***post-vest forfeiture rate*** accounts for ***involuntary forfeiture*** of the option. Additional details may be found in the MITI ***Working Paper*** on SOEF, Exit Rate, and Duration.[8]

Case 10 is similar to Case 8 in that the BSM model is used and an expected term is assumed. In Case 8, the expected term is chosen arbitrarily to be seven years. In Case 10, the ***SAB 107*** methodology is used, in which exercise is assumed to occur when 50% of the time from vesting to expiration has elapsed. Vesting occurs in three years, leaving seven years to expiration. Half of the remaining time is 3.5 years. When added to the 3.0 year vesting period, you have a 6.5 year expected term. The shorter expected term compared with Case 8 reduces the fair value to ***$14.29***. Note that SAB 107 and its variants represent a distinct approach to the use of a SOEF. With SAB 107, exercise depends upon elapsed time, while with the SOEF; exercise is controlled by the value of the underlying.

Case 11 assumes Bermudan-style exercise and a SOEF of 1.5, compared to the SOEF of 2.0 for the Base Case. Using the Trinomial Lattice model, the fair value is ***$13.13***, reflecting the lower SOEF.

Case 12 assumes a straight American-style option, which vests immediately. Although an SOEF of 2.0 is assumed, the Trinomial Lattice model results in a fair value of ***$12.97***. This is because the stock price could conceivably rise to $60.00 before the three-year vesting period assumed in the Base Case has elapsed. Consequently, some exercise will take place between time zero and time three years. If exercise at these nodes is delayed until the option vests, the intrinsic value will increase, thus increasing the fair value.

Case 13, our final case, is identical to Case 12, except for a reduced SOEF of 1.5. As we have previously seen, reduction of the SOEF results in a lower fair value, which in this case is ***$9.24***.

Implications

The previous cases illustrate the sensitivity of the fair value of an Employee Stock Option award to variation in the assumptions related to exercise behavior and forfeiture. The conscientious practitioner will take all reasonable steps to insure that the assumptions used in any particular valuation are representative of the circumstances to be expected in the real world. For those companies with a history of ESO awards, data on exercise and forfeiture, where available, can serve as a useful guideline for assumptions used in a valuation. When historical data are not available, another company of similar size in the same industry sector may be considered as a model. In all cases, assumptions should be based upon data which are ***reasonable, supportable, and consistent.***

This case study did not examine the effects of variation in volatility or interest rates. These are important parameters with significant effect upon the estimated fair value. The choice of the midpoint values for these parameters was done for the sake of convenience and to focus attention on the variables chosen for this study. Please refer to our ***Working Papers***[9] for detailed material on the estimation of volatility and the term structure of interest rates.

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[1] *Financial Accounting Standards Board, Topic 718, as updated January 2010, No. 2010-05*
[2] *Financial Accounting Standards Board, Financial Accounting Series No. 263-C, December 2004*
[3] *Boyle, P., Journal of Financial and Quantitative Analysis 23, No.1 (March 1988), pp. 1-12*
[4] *Cox, J.C., Ross, S.A., and Rubinstein, M., Journal of Financial Economics 7 (1979) pp. 229-263*
[5] *http://www.nysscpa.org/cpajournal/2006/906/essentials/p38.htm*
[6] *Journal of Accounting Education 25(2007) pp. 88-101*
[7] *http://haas.berkeley.edu/finance/WP/rpflist.html*
[8] http://www.fintools.com/resources/working-papers/
[9] http://www.fintools.com/resources/working-papers/