

Beyond BLACK-SCHOLES

A new model for valuing employee stock options.

BY ALAN WHITE

For many years companies have included some sort of equity as part of the compensation package for senior management. In some cases, management is given regular equity or some form of restricted shares. The restriction usually prohibits the sale of the shares. The objective of this sort of compensation package is to align the interests of management with the interests of stockholders. Investors want the share price to rise, and so does the manager if a big part of his compensation is in the form of shares that he cannot sell. The value of the shares issued to the manager is included in the compensation expense on the income statement, reducing the reported net income. A popular alternative to the use of equity as managerial compensation is the Employee Stock Option (ESO).

EMPLOYEE STOCK OPTIONS

In its most basic form an ESO is a call option on the stock of the issuing corporation that allows the option holder to buy a share for a fixed price. The fixed price is called the exercise price. If the stock price rises above the exercise price before the option expiry date, the employee can exercise the option and buy a share from the company for less than the then current price. By

doing this, the employee captures a gain equal to the difference between the market price of the stock and the price at which he bought the share, the exercise price. This gain can be monetized by selling the recently acquired share in the market. If the stock price never surpasses the exercise price during the life of the option, the option expires worthless. ESOs provide the same sort of alignment of interests as restricted share issues since the management collects a payoff only if the stock price rises above the exercise price.

The accounting treatment of the use of ESOs as compensation is the same as the treatment of the share compensation: the value of the option appears as part of the compensation expense on the income statement. The distinction, however, was that until fairly recently the value of the options was considered to be zero at the time that they were issued. The basis for this view was that the exercise price for the option was set at or above the stock price on the day of issue. As a result, if the option holder exercised the option immediately, he would end up paying a price for the share that is at least equal to the market price so no gain could be earned. Potential future gains or profits from the exercise of the options were considered to be just that, potential.

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At the same time that corporate accountants and their auditors were assigning zero value to ESOs, an active market in traded options on stock was developing. In this market it was plain to see that investors did assign a positive value to stock options even if the exercise price was at or above the current stock price. Further, the traded options had positive value in all cases, even if the option holder was precluded from exercising it until some distant future date. In some cases the option value was a substantial fraction of the stock price.

This dissonance between what was being observed in capital markets and what was being reported in corporate financial statements led investors to conclude that the corporations were understating the level of managerial compensation and overstating the company's net income. From about 2000 to 2004 there was growing demand from the investment community that corporations assign some sort of value to the ESOs being issued to the employees. Many companies bitterly opposed this proposed change, particularly high-growth companies in the technology sector. These companies often had little current income and were using ESOs as a primary source of compensation for their employees. Changes to the accounting rules would have a dramatically negative effect on their reported performance. Finally, under pressure from the investment community, accounting rules regarding the initial value of an ESO were changed in 2005. The new reporting rules required the corporation to report an expense equal to the value of the new ESOs being issued.

The big question is, what is the value of a newly issued ESO? Call options trade in capital markets and the market price is an indication of the value that investors assign to the option. However, ESOs differ from the traded call options that one might normally encounter in many ways. A typical ESO has a life of five to 10 years. The exercise price is usually set equal to the stock price on the day the ESO is issued. There is a vesting period of from one to five years during which the option cannot be exercised. The option cannot be sold, and if the employee leaves the firm before the option is exercised the option is terminated. Traded options usually have a life of less than one year, and there are usually no restrictions on when the option can be exercised and when the option can be sold to someone else.

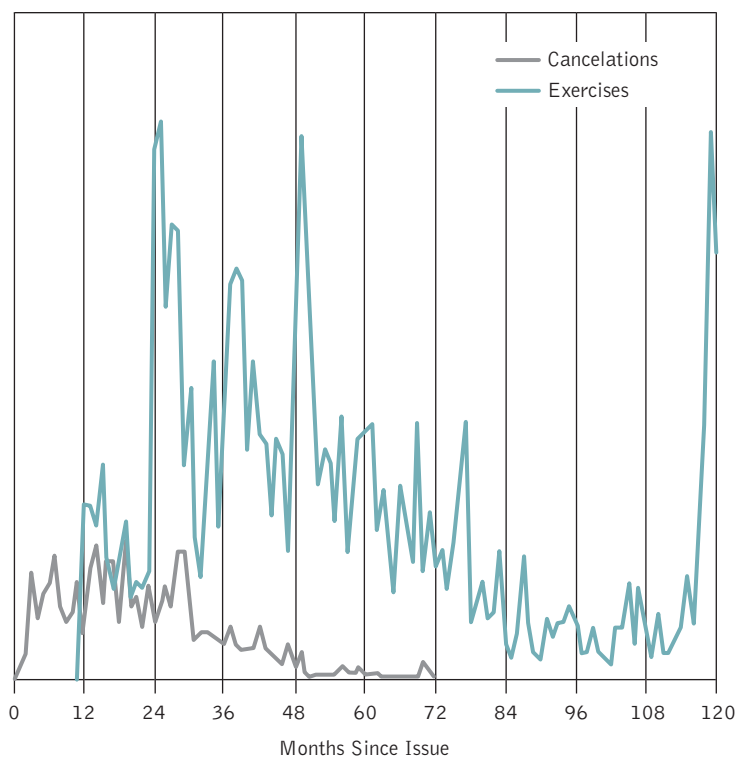
The longer life of the ESO tends to increase its value

relative to traded options. However, the vesting period, the possibility that the employee will leave the firm before the option is exercised, and the inability to sell the ESO all tend to lower its value. In some cases the effect of the restrictions on an ESO on its value are subtle. For example, the reason that the inability to sell the option reduces its value is that, should the employee need cash, the only way to achieve this with the ESO is to exercise the option. This may lead to cases in which the option is exercised in less than ideal circumstances. If it were possible to sell the option, the employee could monetize the asset by selling it to someone who was able to wait until a more propitious moment to exercise it.

Figure 1 illustrates the effect of these restrictions on a typical company. In this example the ESOs last for 10 years and one-quarter vest on each of the first four anniversary dates. In a perfect world in which the options could be sold there would be no exercises until the last year of the option life. If the issuing firm paid no dividends there would be no exercise before maturity, month 120. However, as Figure 1 shows, there are clear

RESTRICTIONS AND VALUE ESOs

FIGURE 1



bursts of exercise on the vesting dates as well as exercises taking place at a lower rate throughout the life of the options. This presumably reflects employees' need for liquidity that can only be achieved by exercising their options. The bursts of exercises on the vesting dates are a result of pent-up demand. Figure 1 also shows the number of options that are cancelled due to employees leaving the firm. In the first two years, as many options get cancelled as get exercised.

VALUATION APPROACHES

The most common approach to estimating a value for an ESO is to use some variant of the Black-Scholes option pricing model. This is the most commonly used model for valuing traded stock options and has been found to be so reliable that it is often used to determine opening prices for new option issues. This model bases the option price on four market variables: the stock price, the interest rate, the company's expected dividend yield, and the stock price volatility; and two contractual characteristics: the option exercise price and the time to option expiry.

In using this model to value ESOs, the stock price, the exercise price and the interest rate are not usually in dispute because they are easy to observe and, in the case of the interest rate, have little effect on the option value. The dividend yield is almost invariably set equal to the firm's historic dividend yield. To do anything else would be equivalent to a statement from management about plans to change the dividend in the future. However, the stock price volatility and the life of the option are difficult to determine.

The stock price volatility, a measure of how variable the stock price is, is contentious because the life of the ESO is so long. We know how volatile the stock price has been in the past and we can infer from the prices of traded options the market's view of how volatile it will be in the near future. But there is great uncertainty about how variable the stock price will be over the next five or 10 years. Forecasting long-term volatility can be a particular problem for high-growth companies where the stock price is very volatile during the growth phase but becomes less variable as the business matures. In practice, most companies measure how volatile the stock price has been over the last three to five years and use this volatility when estimating the value of the ESO.

The effective time to option expiry is also contentious. The time to expiry of the ESO is clearly defined by the contract. In the case illustrated in Figure 1, it is 120

months or 10 years. In theory, no one should exercise their options before the maturity date but as Figure 1 shows, many employees do. To reflect this behaviour it is common to choose the effective time to maturity so that it is less than the contractually specified time but longer than the vesting period, since it is not possible to exercise the option before the end of the vesting period. How the effective life is chosen varies widely across different companies.

For companies with a history of issuing ESOs it is possible to look at the historic behaviour of employees to try to estimate how long they held their options before exercising. The problem with this is that the exercise behaviour is inextricably linked with the stock price performance. If in the past the stock price rose rapidly, the outstanding options quickly moved into the money and it was possible for employees to capture large gains by exercising early. In these circumstances the historic behaviour usually shows that the effective option life was very short. If the historic stock price performance was weak, the possible gains from early exercise of the options were small or non-existent. In this case the historic behaviour shows that employees held their option until close to maturity, resulting in a long effective life. In the end, how long employees held their options before exercising in the past tells you more about the past stock price performance than it does about how employees will behave in the future.

There is no clearly correct way of determining how much the option life should be shortened to reflect the restrictions that employees face. In most cases, the effective life is chosen to be somewhere between one-third and two-thirds of the contractual life. Table 1 illustrates the effect that different choices of volatility and option life can have for an ESO. The case considered is a newly issued ESO with a life of 10 years. The stock price and exercise price are \$20, the firm pays no dividends, the interest rate is 5% and the stock price

TABLE 1: OPTION PRICES WHEN THE STOCK PRICE AND STRICK PRICE ARE BOTH \$20 FOR VARIOUS ASSUMPTIONS ABOUT THE OPTION LIFE AND THE STOCK PRICE VOLATILITY.

Option Life (Years)	Stock Price Volatility		
	20%	30%	40%
3	4.18	5.36	6.55
6	6.56	7.97	9.41
10	9.04	10.51	12.03

volatility has been 30% over the past three years. The table shows the effect of increasing or decreasing the volatility by 10% as well as the price reduction that arises if the life is shortened from 10 to six or three years. Roughly speaking, changing the volatility by 10% changes the price by 10 or 15%. Reducing the option life to one-third of the contractual life cuts the option price approximately in half. The results of negotiations between management and accountants about what the appropriate volatility and option life should be in a case such as this might result in a reported option price of about \$6.50. This would be based on using a volatility close to the historical volatility and an option life somewhere between three and six years.

Different companies exhibit different levels of aggressiveness in estimating the volatility and option life. Most companies base their volatility on history. Unless there has been a recent dramatic change in the nature of the business, it is difficult to explain why the stock price will be significantly more or less volatile in the future than it was in the past. A reasonable choice of the option life is much more difficult to determine but investors should take a close look at any firm that uses a very short effective life when valuing their ESOs.

AN ALTERNATIVE VALUATION MODEL

To help deal with the uncertainty about the effective option life, John Hull and I developed a variant on the Black-Scholes model in which the employee exercises the option as soon as the stock price rises by some predetermined amount or at maturity if the critical threshold is never reached.¹ The purpose of this approach is to try to capture the relation between exercise behavior and increases in stock price in a simple way.

With this approach, the question of how to choose the effective option life is replaced with the question of how do we choose the stock price threshold at which the options will be exercised. Fortunately this new question is easier to answer. You just measure the average stock price at which all exercises before the ESO maturity took place. This is equivalent to measuring the average gain that employees earn when they exercise their ESOs before the expiry date. Experience has shown that most employees exercise their ESOs when the stock price has risen to between 1.5 and three times the strike price.

Recently, Institutional Shareholders Services, a vendor of corporate governance solutions, has started a service that uses this model along with standardized approaches to estimating volatility, interest rates and dividend yields to

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produce standardized values for ESOs issued by all firms. This approach does not result in truth but it does allow comparisons across firms. Further, if a company's reported value is materially different from this standardized value, it is worth considering whether the assumptions that the corporation is making are reasonable.

A MARKET-BASED SOLUTION

Some companies are dissatisfied with any of the model-based valuation approaches that, in their opinion, produce option values that are far too large. In response they have tried to develop a market-based solution for determining the value of the ESOs that they issue. This is more difficult than it might appear.

In 2006, Cisco Systems was the first to discuss this possibility. They proposed issuing options with the exact terms of the Cisco ESOs to be sold to a group of institutional investors. The price that the investors paid for the options would provide some direct market evidence of the market value of the ESOs. The Cisco proposal was rejected by the SEC on the grounds that the restrictions on who might buy the options could lead to under-pricing of the options.

However, it seems equally likely that an attempt like Cisco's could lead to market prices that are too high. One of the main differences between ESOs and regular options is that the holder of an ESO cannot sell his option. In order to monetize any gain, the option must be exercised. This non-marketability constraint is difficult to regulate when options are sold to non-employees. In the derivatives world, contracts are created by the sellers and then sold to the buyers. As a result, while it may be possible to prevent option holders from selling the ESO that they have bought, it is almost impossible to stop them from selling an identical option they have created. In this case the investor has bought an ESO and sold an identical option, resulting in a net zero position. When the buyer of the option exercises it, the investor exercises the ESO

that he originally bought from the firm. Further, as a result of the sale, the investor has received the value of the option, effectively circumventing the non-marketability constraint. With this constraint removed, the option becomes more valuable.²

Recently Zions Bancorporation, a Utah-based financial institution, developed an alternative approach to determining a market value for ESOs. The approach uses a security known as an Employee Stock Option Appreciation Right Security (ESOARS). This security is designed to provide the investor with a payoff equal to the average payoff to all ESO holders. Every time an ESO holder exercises an option he captures a gain equal to the difference between the stock price and the exercise price. The ESOARS holder receives a payment equal to that gain divided by the total number of ESOs issued.³ For example, if the exercise price is \$10 and one-third of all the ESOs are exercised when the stock price is \$15, one-third when it is \$20, and one-third are not exercised, the ESOAR-holder receives two payments: one payment is \$1.67 (one-third of the \$5 gain) and one is \$3.33 (one-third of the \$10 gain).

The ESOARS are sold via a Dutch auction.⁴ As a trial of the strategy Zions held an initial auction in June 2006. Following the success of the trial auction, the SEC was approached to gain approval for the process. The SEC concurred with this basic framework for valuing ESOs but indicated that auctions would be considered on a case-by-case basis in order to ensure that the process resulted in a fair price.⁵ On May 4, 2007, Zions conducted a second auction of ESOARS and is currently waiting to learn whether or not the SEC will accept these results as a means of valuing the Zions ESOs.

This recent auction provides some very preliminary insights into the market value of ESOs. The Zions ESOs underlying the ESOARS are seven-year options, of which one-third vest at the end of each of the first three years. In the past, Zions has used the Black-Scholes model to estimate the value of their ESOs. In 2006, the factors that went into the option value calculation were a dividend yield of 2%, an interest rate of 4.95%, a stock price volatility of 18% and an option life of 4.1 years. The stock price and exercise price of the options were \$81.14. Plugging all these parameters into a Black-Scholes calculator resulted in a value of about \$15 for the 2006 ESO.

For the most recently issued ESO, the exercise price was set to the closing stock price on May 4, 2007, \$83.25. The historic volatility of Zions' stock based on the past three years of stock prices is 16.5%. If we maintain the other

assumptions used in the 2006 valuation exercise, the Black-Scholes value of the ESO would be \$14.21. The market clearing price in the ESOARS auction was \$12.06, about 15% lower than the model value.

THE END OF THE DEBATE?

This first attempt at producing a market estimate of the value of an ESO provides a certain degree of support for the model-based approach to valuing the ESOs. The market clearing price is not wildly different from the model price. Fairly modest changes in the model parameters reduce the model price to something close to the market clearing price. Further, there are a number of reasons why the market clearing price may be somewhat depressed. Since this is one of the first such experiments in issuing these securities it would not be unusual to find that the bidders have been conservative in their bidding. There may also be downward pressure on the price due to a potential lack of liquidity for the ESOARS themselves. It is not clear if a secondary market for the ESOARS will develop. Failing this, investors may factor a liquidity premium into the pricing of the ESOARS.

If Zions is able to interest other firms in issuing ESOARS, or if other banks start to issue similar securities, the market will resolve the outstanding questions. As the market develops and becomes more liquid, the market clearing prices may become closer to the model prices, thus validating the current modelling approaches. Alternatively, the value difference observed in the first auction may be confirmed by subsequent issues, in which case the modellers will have to return to their drawing boards. ■

ENDNOTES

1. "How to Value Employee Stock Options," John Hull and Alan White, *Financial Analysts Journal*, January/February 2004, pp 114-118. An Excel-based version of this model that includes the Black-Scholes model can be downloaded from <http://www.rotman.utoronto.ca/~hull/ESOPS/index.htm>. This work was supported by the Ontario Teachers Pension Plan.
2. There is circumstantial evidence that suggests some employees also surreptitiously use the same strategy to monetize their ESOs. This is only economic if the number of ESOs held by the individual is sufficiently large to attract the interest of the trading desk at an investment bank.
3. To be in accord with the accounting regulation, FASB 123R, the number of ESOs issued is adjusted to correct for the number of cancellations before the vesting date.
4. In a Dutch auction, buyers submit a bid that states both the price per unit and the number of units that they wish to buy. The market clearing price is the highest bid such that the aggregate number of units sought at that price or higher prices equals or exceeds the number of units for sale. All buyers who have bid higher prices have their total order filled at the market clearing price. The bidder of the market clearing price gets the remaining number of units.
5. See <http://sec.gov/info/accountants/staffletters/zions012507.pdf>