EXECUTIVE STOCK OPTION VALUATION

A stock option is a contract giving the holder the right to purchase a stated number of shares of stock at a fixed price in a specified period of time. Typically, the holder is under no obligation to exercise his rights.

In the public marketplace, stock options are marketable, are issued by third parties, and usually have a term of less than one year. The direct issuance of executive stock options ("ESOs") by companies, however, would typically have the following features:

1. While ESOs can be for stock of public or closely held companies, typically the option itself is not freely tradable in the open market.
2. ESOs usually have a term exceeding one year.
3. There is usually a vesting period during which the options cannot be exercised.
4. When employees leave their jobs (voluntarily or involuntarily) during the vesting period they forfeit unvested options.
5. When employees leave (voluntarily or involuntarily) after the vesting period they forfeit options that are of the money and they have to exercise vested options that are in the money immediately.
6. Employees are not permitted to sell their employee stock options. They must exercise the options and sell the underlying shares in order to realize a cash benefit or diversify their portfolios. This tends to lead to ESOs being exercised earlier than similar regular options.
7. When exercised, treasury shares or previously unissued shares are typically issued resulting in dilution of the stock.

The value of a stock option consists of two parts: intrinsic value and time value. Intrinsic value is defined as the difference between the stock's value and the exercise price (the price at which the option holder can purchase the stock). The intrinsic value is never less than zero since the contract involves no liability on the part of the option holder but can be higher. For those options where the exercise price is greater than the current stock price ("out of the money"), the intrinsic value is zero, although such options may still have time value. The time value of a stock option is the present value of the expected difference between the value of the stock at the time of exercise and the option's exercise price. Factors that affect the value of the stock option can be summarized as follows:

1. **Time to Expiration**. The longer the time to expiration, the greater the value of the stock option since it allows a longer time for the stock to appreciate.
2. **Degree of Leverage.** On a percentage basis, option values increase greater than the stock's appreciation.

3. **Volatility of the Underlying Stock.** Fluctuations in the value of the underlying stock theoretically have infinite upside potential but are limited on the downside by zero. Volatile stocks, therefore, tend to have higher option values.

4. **Dividends.** The payment of dividends tends to lower the value of options. This is due to the fact that option holders, unlike stockholders, have no rights to the dividends.

5. **General Level of Interest Rates.** Higher levels of interest rates usually cause stock option value to increase. First, higher interest rates enhance all investments' required rate of return and thus allow for greater expected rate of appreciation. Second, the option holder has little invested and can invest the difference in alternative investments.

6. **Potential Dilution.** If additional shares are issued by the company, dilution will occur. Stock option value is affected by the relative size difference between the shares to be issued and the then existing number of shares.

7. **Degree of Liquidity of the Underlying Stock.** Highly liquid underlying stocks enhance the value of the stock option. Thinly-traded or closely held stocks, when acquired, are not as attractive due to a smaller market of potential purchasers.

8. **Degree of Liquidity of the Option.** If the option lacks ready marketability, a discount for lack of marketability must be recognized in the analysis.

Several models have been developed to determine the value of stock options. Three are discussed in this analysis.

Black-Scholes Option Model. In 1973, Fischer Black and Myron Scholes developed a precise model for determining the equilibrium value of an option. In 1997, Myron Scholes was awarded the Nobel Memorial Prize in Economics for this work (Mr. Black passed away in 1995).

Until this model, analysts were unable to develop a method of putting an accurate price on options, the future right to buy or sell assets. The problem was how to evaluate the risk associated with options, when the underlying stock price changes from moment to moment.

Messrs. Black and Scholes realized that the risk of the option is reflected in the stock price itself. The stock price already includes market participants' expectations about the future of the company that issued the stock. That insight allowed Messrs. Black and Scholes to create a pricing formula that included the stock price, the agreed sale or "strike" price of the option, the stock's volatility, the time until the option's expiration, and the risk-free interest rate offered on an alternative investment. Furthermore, this model assumes that an option can be exercised only at maturity, with no transaction costs or market imperfections, on a stock which pays no dividend and whose stock price follows a random pattern.

The model is as follows:

$$V_0 = V_S N(d_1) - \left(\frac{E}{e^{rt}}\right) N(d_2)$$

Where:

V_o	=	value of the option
V_s	=	the current price of the stock
E	=	the exercise price of the option
e	=	2.71828
r	=	the short-term interest rate continuously compounded
t	=	the length of time in years to the expiration of the option
N( )	=	the value of the cumulative normal density function
d_1	=	$\frac{Ln(V_S / E) + (r + 0.5\sigma^2)t}{\sigma\sqrt{t}}$
d_2	=	$\frac{Ln(V_S / E) + (r - 0.5\sigma^2)t}{\sigma\sqrt{t}}$
Ln	=	the natural logarithm
σ	=	the standard deviation of the annual rate of return on the stock continuously compounded

Noreen-Wolfson Option Model. The Black-Scholes Option Model does not account for dividends or for the dilution associated with the issuance of new stock. In 1981, Eric Noreen and Mark Wolfson adapted the Black-Scholes Model for use in valuing executive stock options. The following model uses the same definitions used above except for the following differences:

$$V_0 = \frac{N}{N+n}\left[\frac{V_S}{e^{Dt}} N(d_1) - \frac{E}{e^{rt}} N(d_2)\right]$$

Where:

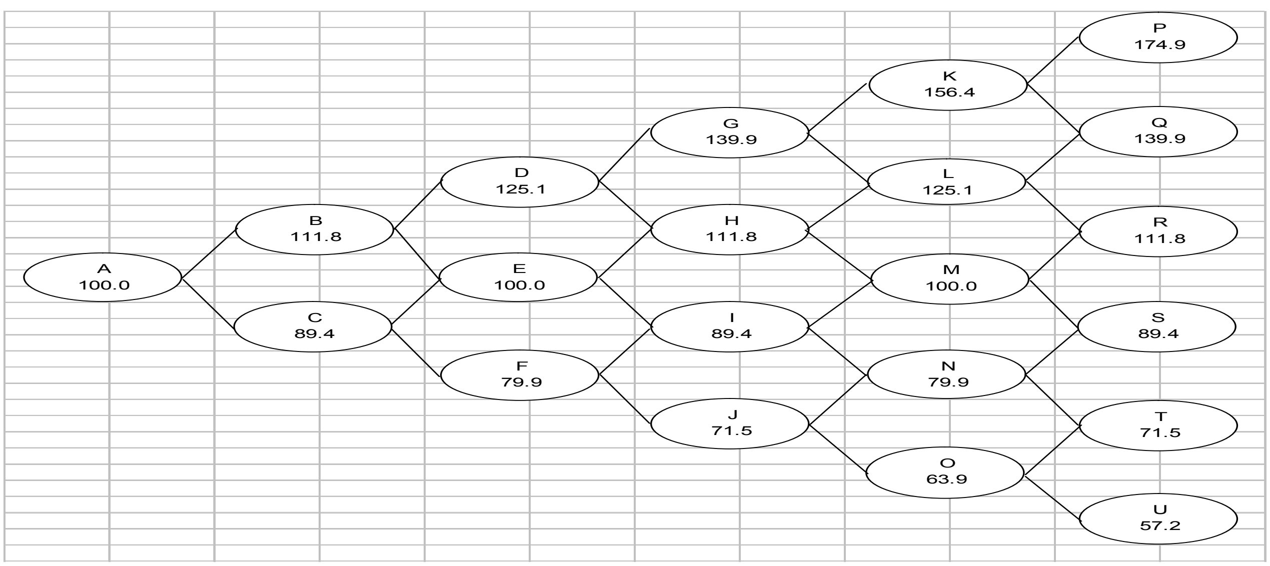
N	=	Number of common shares outstanding
n	=	Number of common shares to be issued if warrants are exercised
D	=	Continuous dividend yield
d_1	=	$\frac{Ln(V_S / E) + (r - D + 0.5\sigma^2)t}{\sigma\sqrt{t}}$
d_2	=	$\frac{Ln(V_S / E) + (r - D - 0.5\sigma^2)t}{\sigma\sqrt{t}}$

As is apparent, when D is zero (no dividends) and n is zero (no dilution), the Noreen-Wolfson Model becomes the Black-Scholes Model.

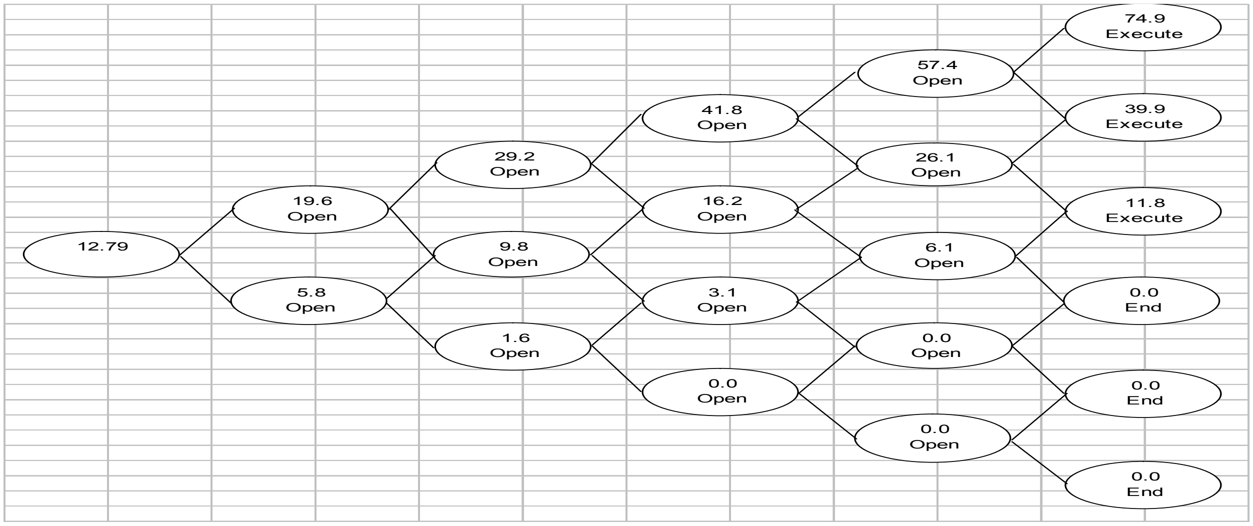
Binomial Model. Both of the previous models value "European" options. They are applicable where the holder of the option can exercise the option only on its maturity date. However, most executive stock options ("ESOs") are "American" options where the option holder can execute the option at any time up to and including the maturity date. Also, executive stock options normally are not transferable and can be exercised only while the executive is employed by the firm.

The binomial model breaks down the time to expiration into potentially a very large number of time intervals, or steps. A tree of stock prices is initially produced working forward from the present to expiration. At each step it is assumed that the stock price will move up or down by an amount calculated using volatility and time to expiration. This produces a binomial distribution, or recombining tree, of underlying stock prices. The tree represents all the possible paths that the stock price could take during the life of the option. At the end of the tree – i.e. at expiration of the option – all the terminal option prices for each of the final possible stock prices are known as they simply equal their intrinsic values.

The following is an example showing the calculation of a European option with an underlying stock price of $100 and an exercise price of $100. Taking into account the volatility and risk-free rates, over five years the price may be between $57.20 and $174.90. The lattice calculates various probabilities over the period.



Next the option prices at each step of the tree are calculated working back from expiration to the present. The option prices at each step are used to derive the option prices at the next step of the tree using risk neutral valuation based on the probabilities of the stock prices moving up or down, the risk-free rate, and the time interval of each step.



The main advantage of the binomial model as compared to the Black-Scholes Option Model is that it can be used to accurately price American options. It's possible to check at every point in an option's life (e.g. at every step of the binomial tree) for the possibility of early exercise. Where an exercise point is found it is assumed that the option holder would elect to exercise, and the option price can be adjusted to equal the intrinsic value at that point.

The same underlying assumptions regarding stock prices underpin both the binomial and Black-Scholes models – that stock prices follow a stochastic process described by geometric Brownian motion. As a result, for European options, the binomial model converges to the Black-Scholes formula as the number of binomial calculation steps increases.

Lack of Marketability. ESOs are typically neither directly transferable to someone else nor freely tradable in the open market. While a discount could be based on an arbitrarily chosen percentage, a more rigorous analysis can be performed using a put option. A call option is the contractual right, but not the obligation, to purchase the underlying stock at some predetermined contractual strike price within a specified time, while a put option is a contractual right, but not the obligation, to sell the underlying stock at some predetermined contractual price within a specified time. Therefore, if the holder of the ESO cannot sell or transfer the rights of the option to someone else, then the holder of the option has given up his or her rights to a put option (i.e., the employee has written or sold the firm a put option). Calculating the put option and discounting this value from the call option provides a theoretically correct and justifiable non-marketability and non-transferability discount to the existing option.

The put option value is calculated as follows:

$$\text{Put Value} = \text{Call Value} - V_s + E/(1 + r)^t$$

Vesting and Forfeiture Rates. Forfeiture rates calculate the proportion of option grants that are forfeited per year through employee terminations or when employees voluntarily leave. Therefore, the forfeiture rate is calculated by the annualized employee turnover rate and calibrated with the proportion of option forfeitures in the past years.

The higher the forfeiture rate, the higher the rate of reduction in option value. The rate of reduction also changes depending on the vesting period. The longer the vesting period, the more significant the impact of forfeitures. This is intuitive because the longer the vesting period, the lower the compounded probability that an employee will still be employed in the firm and the higher the chances of forfeiture, reducing the expected value of the option.

Another factor is suboptimal behavior. ESO holders must exercise their options and sell the underlying shares to realize a cash benefit or diversify their portfolios. This tends to lead to ESOs being exercised earlier than similar regular options.