Employee Stock Option Valuation Methodologies

And What is Accounting Standards Codification (ASC) 718?

According to **ASC 718**, a company that issues equity as compensation needs to list a compensation expense on its income statement that corresponds to the estimated cost of those equity grants. If I work at a tech startup, often my compensation has two parts: salary and equity.

It's easy to show salaries as an expense, but under GAAP, the government also wants to see an expense for the equity portion of employee's compensation. In stock options analysis there are three mainstream methodologies and approaches used to calculate an employee stock option value, these are:

1. Closed form models like Black–Scholes model, also known as the Black-Scholes-Merton model ("**BSM**" or "**Black-Scholes**"), and its modifications such as the Generalized Black-Scholes model ("**GBM**") – see page 5;
2. Monte Carlo path dependent simulation methods – see page 7; and
3. Binomial Lattice – see pages 6 & 8.

The Black-Scholes model, while theoretically correct and elegant, is insufficient and inappropriately applied when it comes to quantifying the fair market value of employee stock options, this is because the BSM is applicable only to the calculation of European options without dividends, where the holder of the option can exercise the option only on its maturity date and the underlying stock does not pay dividends.

Most employee stock options are American type options with dividends, where the holder can execute the option at any time up to and including the maturity date while the underlying stock pays dividends. In addition, employee stock options have a time to vesting before the employee can execute the option, which may be contingent upon the company/or person attaining a specific performance level (e.g., profitability, growth rate, attain certain sales level, the stock price hitting a minimum barrier before the options become live), and are subject to forfeitures when the employee leaves the company or is terminated prematurely before reaching the vested period.

All of these real-life scenarios make the Black-Scholes model insufficient and inappropriate when used to place a fair market value on the stock option grant.

Generally speaking, the Black–Scholes model typically overstates the fair market value of employee stock options where there is sub-optimal early exercise behavior coupled with vesting requirements, and employee forfeitures occur, or when the risk-free rates, dividends, and volatilities change over the life of the option. In fact, companies using the Black–Scholes model to value and expense employee stock options may be significantly overstating their true expense, typically incurring hundreds of thousand to tens of millions of dollars in overstated expenses per year.

The Black–Scholes model takes into account only the following inputs: stock price, strike price, time to maturity, a single risk free rate, and a single volatility. The GBM accounts for the same inputs as well as a single dividend rate. Hence, in accordance with ASC 718/ FAS 123R requirements, the Black–Scholes model and the GBM fail to account for real life conditions.

The **Monte Carlo path dependent simulation methods** are appropriate for complex stock options where the complexity of the option itself makes closed form approached such as Black-Scholes intractable. Rather than solve the differential equations that define the option value in relation to the underlying stock price, a Monte Carlo model determines the value of the option for a set of randomly generated economic scenarios (e.g. future stock prices, option exercise behavior, stock price vs. stock index behavior). The resulting simulation yields an expected value for the option.

The Binomial Lattice valuation methodology can be customized to include the above mentioned input variables plus multiple risk-free rates changing over time, multiple volatilities changing over time, multiple dividend rates changing over time, plus all other real-life factors including but not limited to vesting periods, changing sub-optimal early exercise behaviors, multiple blackout periods, and changing forfeiture rates over time. It is important to note that the customized Binomial Lattice results revert to the GBM if the “real life conditions” are negligible. Therefore, in accordance with ASC 718/ FAS 123 (R), which prefers the binomial lattice, we typical utilize the customized Binomial Lattice valuation methodology in addition to Black-Scholes methodology to calculate the fair market value of the employee

stock options. It is important to note that valuation results through the use of binomial lattices tend to approach those derived from the closed model solutions, hence we always utilize the BSM and GBM models to benchmark the binomial lattice results. The results from the closed model solutions are typically used in conjunction with the binomial lattice approach when presenting a complete employee stock option valuation solution.

Our valuation will take into consideration many factors that influence the fair market value of stock options including, but not limited to, the following:

- The stock price;
- The strike prices;
- The time to maturity;
- The risk-free rate;
- The dividend; and
- Volatility.

The Binomial Lattice approach will also address the following input items:

- Time to vesting;
- Changing forfeiture rate;
- Changing suboptimal exercise behavior multiples;
- Black-out dates;
- Changing risk-free rates;
- Changing dividends; and
- Changing volatilities over time.

Our valuation study will be executed in accordance with practices currently accepted and utilized by the financial and valuation communities and in conformity with the National Association of Certified Valuators & Analysts (NACVA), the American Institute of Certified Public Accountants (AICPA) Statement of Standards for Valuation Services ("SSVS"), The Institute of Business Appraisers (IBA), and the Uniform Standards of Professional Appraisal Practice (USPAP) promulgated by the Appraisal Standards Board of the Appraisal Foundation, and the Appraisal Standards Board of the Appraisal Foundation.

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BLACK-SCHOLES STOCK OPTION PRICING MODEL ("OPM")

Stock Price/ or Business Enterprise Value ("BEV") of a Company	$	2.52	5	4	3	2	1			
Present value of expected dividends	$	-	5	4.5	4	3.5	3	2.5		
Share Price net of dividends	$	2.52	$ 5.00	$ 7.00	$ 8.00	$ 9.00	$ 10.00	$ 12.00		
Exercise price	$	34.86	4.98		5.65	6.05	6.5	7.28		
	Delta		0.57		5	5	4	4	3	3
Time to expiration (years)		5.0		5						
Risk free Rate		2.51%		4						
Standard deviation (Volatility)		53.00%		3						
PV of the Exercise Price	$	30.75	Term (yrs)	2						
				1						
Call Option (the right to buy an asset at some future date at a specified price) value	$	0.05695	2.26%							
Delta		0.0645								
Put Option (the right to sell an asset at some future date at a specified price) value	$	28.29	1122.43%							
Discount for Lack of Marketability ("DLOM")		1122.43%								

		Share Price/Business Enterprise Value less PV Exercise Price:	$	(28.23)
d1	-1.51827	Call Option Value less Put Option Value:	$	(28.23)
d2	-2.70338			
Elasticity	0.00574			
x1 - Delta	0.06447			
x2	0.00343			
N(d1)	0.06447			
N(d2)	0.00343			

Above matrix is based on the Black-Scholes Option Pricing Model approach to valuing stock options which:

o Exercise price equals the current share value.

o For example, a: **5.0** year tradeable "Put" option for 1% of the fully diluted shares of the Company would be worth: **1122.43%** of the value of the underlying equity.

o The lack of a market for the options decreases their value by: 1122.43%

5 Year "Put" Options on Business Enterprise of a Company worth:	$	2.520	be worth:	$ 28.29
2 Year "Put" Options on Business Enterprise of a Company worth:	$	2.520	be worth:	NA
1 Year "Put" Options on Business Enterprise of a Company worth:	$	2.520	be worth:	NA

C+PV(X) P+S

Implied Trinomial Tree

Call

Asset price (S)	$	2.520
Strike price (X)	$	34.8597
Time to maturity (T)		5.00
Risk-free rate (r)		2.51%
Cost of carry (b)		2.51%
Volatility (s)		53.00%
Number of time steps (n)		30
Volatility skew		0.000 %
Option Value	$	0.0555
Discount for Lack of Marketability Percentage (%)		0.16%

c
1
Call
Put

Up transition probabilities

	Time step n			
i	0	1	2	3
0	0.2196	0.2196	0.2196	0.2196
1	-	0.2196	0.2196	0.2196
2	-	0.2196	0.2196	0.2196
3	-	-	0.2196	0.2196
4	-	-	0.2196	0.2196
5	-	-	-	0.2196
6	-	-	-	0.2196

Down transition probabilities

	Time step n			
i	0	1	2	3
0	0.2823	0.2823	0.2823	0.2823
1	-	0.2823	0.2823	0.2823
2	-	0.2823	0.2823	0.2823
3	-	-	0.2823	0.2823
4	-	-	0.2823	0.2823
5	-	-	-	0.2823
6	-	-	-	0.2823

Local volatilities

	Time step n			
i	0	1	2	3
0	0.5309	0.5309	0.5309	0.5309
1	-	0.5309	0.5309	0.5309
2	-	0.5309	0.5309	0.5309
3	-	-	0.5309	0.5309
4	-	-	0.5309	0.5309
5	-	-	-	0.5309
6	-	-	-	0.5309

Arrow Debreu prices

	Time step n				
i	0	1	2	3	4
0	1.0000	0.2812	0.0791	0.0222	0.0062
1	-	0.4960	0.2789	0.1176	0.0441
2	-	0.2187	0.3690	0.2593	0.1361
3	-	-	0.2169	0.3050	0.2401
4	-	-	0.0478	0.2017	0.2647
5	-	-	-	0.0712	0.1868
6	-	-	-	0.0105	0.0824
7	-	-	-	-	0.0208
8	-	-	-	-	0.0023

Monte Carlo Simulation - Single Asset Plain Vanilla "European Option" - Allows Option to be Exercised Only at the Date of Option Expiration

Call

Asset price (S)	$	2.52
Strike price (X)	$	34.8597
Time to maturity (T)		5.00
Risk free rate (r)		2.51%
Cost of carry (b)		2.51%
Volatility (s)		53.00%
Number of time steps		400
Number of simulations		400
Option Value	$	0.0668
Marketability Discount - Monte Carlo		NA
Marketability Discount - Black Scholes - Option Pricing Model (OPM)		1122.43%
Monte Carlo "Call" Option Value	$	0.0668
Total Warrants for Calculation Purposes:		65,464
Fair Market Value of Warrants	$	4,372.94

c
1
Call
Put

Binomial and Trinomial Trees

Call

American

Asset price (S)	$	2.52
Strike price (X)	$	34.8597
Time to maturity (T)		5.00
Risk-free rate (r)		2.51%
Cost of carry (b)		2.51%
Volatility (s)		53.00%
Number of time steps (n)		30
Binomial value	$	0.0491
Trinomial value	$	0.0555
Discount for Lack of Marketability Percentage (%)		NA

a	c
2	1
European	Call
American	Put

Sensitivity Analysis		Asset /Stock Price - In Thousands of Dollars ($000)			
	$ 0.0491	$ 2.520	$ 2.520	$ 2.520	$ 2.520
	49.00%	$ 0.0303	$ 0.0303	$ 0.0303	$ 0.0303
	51.00%	$ 0.0398	$ 0.0398	$ 0.0398	$ 0.0398
Volatility	53.00%	$ 0.0491	$ 0.0491	$ 0.0491	$ 0.0491
	55.00%	$ 0.0662	$ 0.0662	$ 0.0662	$ 0.0662
	57.00%	$ 0.0864	$ 0.0864	$ 0.0864	$ 0.0864
	59.00%	$ 0.1061	$ 0.1061	$ 0.1061	$ 0.1061