Optimal Exercise Prices for Executive Stock Options: Spreadsheets and Methodology

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I. The Value of Non-Tradable Options

The value of a non-tradable option to a risk-averse executive is measured by the amount of riskless cash compensation the executive would exchange for the option. We estimate option values using the "certainty equivalence" approach. In particular, we suppose that an executive has non-firm-related wealth of w, holds s shares of company stock, and is granted an option to buy one share of stock at exercise price X in T years. Assuming that w is invested at the risk-free rate, r_f, and that the realized stock price at T is P_T, the executive's wealth at time T is given by $W_T \equiv w(1+ r_f)^T + sP_T + max(0,P_T\text{-}X)$. If, instead of the option, he were awarded V in cash invested at the risk-free rate, his wealth at time T would be $W_T^V \equiv (w+V)(1+ r_f)^T + sP_T$. We define the executive's value of the option as the certainty equivalent V that equates

$$(1) \qquad \int U(W_T^V)f(P_T)dP_T \equiv \int U(W_T)f(P_T)dP_T$$

To solve (1) numerically, we assume the executive has constant relative risk aversion ρ, and assume (using the Capital Asset Pricing Model, CAPM) that the distribution of stock prices in T years is lognormal with volatility σ and expected value $(r_f + \beta(r_m\text{-}r_f) - \sigma^2/2)T$, where β is the firm's systematic risk and r_m is the return on the market portfolio.

The "Master" worksheet on the downloadable spreadsheet ExecValue1.xls computes

"Executive Values" for a single exercise price and for a variety of different stock prices. User inputs are in cells C4 through C23 (with the exception of C10 which is calculated). The input definitions are given in the following table.

User-Inputs in Constructing Executive-Value Lines

Cell	Label	Description
C4	Risk-Free Rate	
C5	Risk Premium	The premium of the market return less the risk-free rate
C6	Beta	The company's equity beta
C7	Volatility	The annual standard-deviation of log(1 + stock return)
C8	Yield	The company's annual dividend yield
C9	Option Term	Expiration term of the option (years)
C10	CAPM Return	Calculated as: *Risk-Free Rate + Beta*(Risk Premium)*
C12	Exercise Price	Exercise price of options to be granted
C13	Number of Options	Number of options to be granted
C15	CEO Wealth	Total wealth including stock and "safe" wealth, but excluding the current option grant
C16	% of Wealth in Stock	% of total wealth invested in company stock
C17	Risk Aversion	Coefficient of relative risk aversion
C19	Z increment	Integration factor for numerical calculations (which involves numerically integrating a standard normal from Z=lower Z to Z=upper Z by the Z increment). Smaller increments are more accurate, but involve longer computing times
C20 C21	Lower Z Upper Z	Lower and upper bound on standard normal distribution. Setting this value below Z=-6 or above Z=+6 increases computing time but has negligible effect on results
C23	Price Increment	This spreadsheet produces estimates of option values for a variety of stock prices, beginning at $.001 and $1 and increasing by the increment specified in C23

Once you've entered your desired parameters in C1-C23, the ExecValues are computed by running the Macro "Compute Value" under "Tools:Macro:Macros." This macro takes each row of the table, and finds the "Cash Equivalent Value" (column H) which equates the left and right sides of equation (1) (columns L and K, respectively). The results are sensitive to the choice of "Z increment." The results in our paper are based on a Z increment of .002, but be forewarned that estimation over tiny increments can take hours of computing time. When finished, column G contains the familiar Black-Scholes value of the option, column H contains the computed cash equivalent value of N options, and the Executive Value is simply the cash equivalent divided by the number of options granted.

The spreadsheet ExecValue1.xls includes two additional worksheets, labeled "r=2, s=33%" and "r=2, s=66%." These worksheets provide our final calculations used to construct Figure 1 in our paper. These worksheets were produced using a macro called "RunMany." If you wish to produce several such spreadsheets (by leaving your computer cranking while going away for a long weekend, for example), it is straightforward to edit the macro to change which ever parameters you wish and (by cutting and pasting program lines) to produce as many worksheets as you wish.

II. Incentives from Executive Stock Options

The "Master" worksheet on the downloadable spreadsheet ExecPPS.xls computes the "slope" of the Executive Value Line for a given dollar-value grant of executive stock options at a variety of exercise prices (where the dollar value is computed using Black-Scholes as representing the company's cost of the option grant). The user-input fields are similar to those in the table above, except that C13 is now the total "Cost of Option Grant" and we've added one calculated field ("Shares Owned").

Column F of the spreadsheet provides the Black-Scholes value for each option, while column H provides the number of options (simply the cost of the grant divided by the Black-

Scholes value. The "Total Incentives" column I is the number of options (column H) multiplied by the slope of the Black-Scholes line (column C): this column shows how the total Black-Scholes value from a given total option costs varies with a $1 change in stock prices.

The executive incentives are computed by running the embedded macro "ComputeValue." Basically, this macro computes the cash equivalent of the option grant (column J) and the cash equivalent of the same option grant when the stock price increases by $.10 (column K). The Executive Incentives, designed to capture the slope of the executive value line, is the difference in these two estimates divided by .10. The results, once again, are sensitive to the selection of Z increment, and the graphs in our Figure 2 are based on an increment of .002.

The spreadsheet ExecPPS.xls includes several additional worksheets showing our final calculations used to construct Figure 2 in our paper. As before, these worksheets were produced using a macro called "RunMany." If you wish to produce several such spreadsheets (by leaving your computer cranking while going away for a long summer vacation, for example), it is straightforward to edit the macro to change which ever parameters you wish and (by cutting and pasting program lines) to produce as many worksheets as you wish.