

ABSTRACT

Playing the Odds with Black-Scholes Portfolio Analysis and Simulation for better Investing.

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Option analysis adds another dimension to investment management by accounting for potential value of future conditions and opportunities. With automated numerical analysis tools we are now able to provide complex portfolio simulations and analysis in real time enabling us to optimize our portfolio positions.

The Black-Scholes equations provide a closed form solution to valuation of options based on inputs including time, current and exercise price, risk free rate, and stock volatility.

Binomial tree analysis uses a probability tree to derive the chances of a discrete set of outcomes from a given point. An advantage of the binomial method over Black-Scholes is the ability to account for intermediate transactions that may occur in American options.

Monte Carlo analysis generates predictive outcomes through averaged random simulations based on stock characteristics. Like the binomial model Monte Carlo uses a branching structure, but through automation the number of levels may be extended, and thousands of simulations may be run to provide mean and statistical investment analysis.

An automated solution is presented for each analysis including Black-Scholes options pricing, Binomial Tree analysis, and Monte Carlo simulation. By leveraging these tools the user will be more informed prior to committing to investment decisions, and can evaluate risk management alternatives based on the most recent market data.

Presentation Body

The programs developed and presented with this abstract were based on material provided in the NDNu MBA class BA-225 Derivatives and Risk Management course. For those interested in using the financial models, a web site is provided at the end of this document with the location of files.

Options provide a financial instrument for controlling risk by adjusting the volatility of the expected return for a portfolio. An investor that purchases a PUT option buys the right to sell a stock at a future date for a fixed “exercise price”. The PUT has value if the stock price has fallen below the exercise price during the term of the option. The CALL option allows the owner to buy a stock at a fixed price at some time in the future. The CALL has value when the stock price rises above this value, which allows the owner to buy low and immediately sell high to realize a profit.

The Black-Scholes equations can be used to calculate the value of an option based on option duration (Time), option exercise price, stock price, stock volatility, and the risk free rate. This model uses normal distributions for percentage returns, and log distributions for the stock price. The Black-Scholes model then calculates the value of the distribution based on the option parameters. The Black-Scholes model is used in the “Portfolio Analysis” portion of this

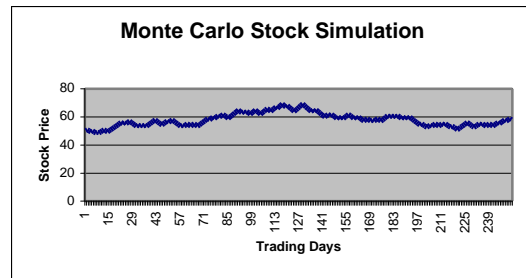
$$\begin{aligned}c &= S_0 N(d_1) - K e^{-rT} N(d_2) \\p &= K e^{-rT} N(-d_2) - S_0 N(-d_1) \\ \text{where } d_1 &= \frac{\ln(S_0 / K) + (r + s^2 / 2)T}{s\sqrt{T}} \\ d_2 &= d_1 - s\sqrt{T}\end{aligned}$$

presentation.



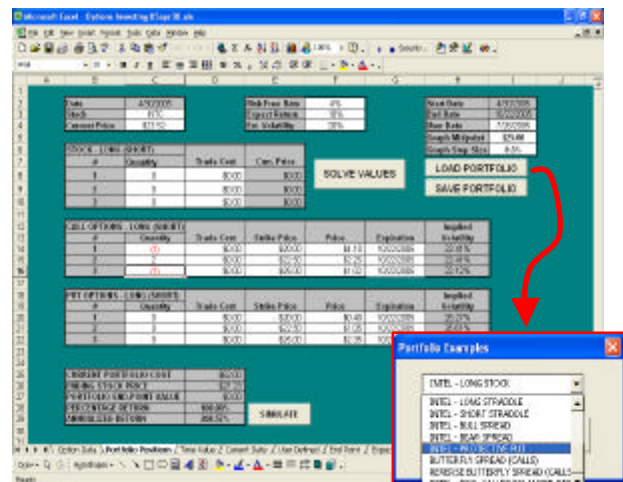
Binomial Tree analysis is a method of analyzing expected returns based on small biased random steps either up or down. By creating a tree with each branch based on the underlying stock characteristics, an analysis of the probable outcome can then be made. Once all of the branches have been developed, option pricing is calculated backwards through the tree from the many branches back to the current price. The binomial model provides a valuable alternative to Black-Scholes as it incorporates a mechanism to allow early exercise of an American option.

Monte Carlo, like the binomial model, is used to analyze the value by taking random steps up or down. In Monte Carlo many random simulations are run creating discrete paths through the possible outcomes. The results of each simulation may be plotted in a histogram, and averaged to determine the expected option value.



In the Option Analysis application the Black-Scholes models were applied to analyze the characteristics of portfolios consisting of mixed combinations of a stock, CALL, and PUT options. In each case the stock or option can be bought or sold – positive numbers representing a purchase (long position) and negative a short position.

While the Option Analysis program provides graphs to show the portfolio performance for various stock prices, the tool also includes a simulation option to allow evaluation of the portfolio for a give Monte Carlo simulation.



Each of the programs provided with this presentation may be used to provide a better understanding of an option investment both prior to investing, as well as after investing and experiencing market adjustments. Through careful analysis an investor can tailor their portfolio to a level of risk and reward that meets the individuals investment goals.

Financial Analysis Program Location

The programs presented with this abstract are available online at:
http://www.sunsetmaui.com/finance_models.htm

The files will remain online through the end of 2005.