Financial Engineering Problem Definition & Scope

February 10, 2011

Brandon Borkholder Mark Dickerson Shefali Garg Aren Knutsen



Dr. KC Chang, Sponsor Ashirvad Naik, Research Assistant

Project Overview (Provided)

- **Background**: In Spring 2010 a project team developed and analyzed a S&P futures option trading strategy to identify potential investment opportunities. While the results were very promising, several recommendations were made for modifying the strategy with more realistic assumptions in order to produce higher fidelity results. Another useful direction is to develop an analytical model to estimate the risk reward ratio and validate it with realistic simulated trading process using real data.
- **Objective**: Develop analytical model to estimate profitability of an option trading strategy and validate it with realistic simulated trading process.



- Derivatives a financial instrument whose value depends on (or derives from) the values of other, more basic, underlying variables.
 - Stock Option Stock value dependent
 - Forwards Contracts value/agreement dependent
 - Future Contracts value/agreement dependent but normally traded on an exchange.
 - Less personal
 - Mechanisms in place to ensure honored contracts



• Futures -An Agreement between 2 parties to buy or sell an asset at a certain time in the future for a certain price. However, and unlike forward contracts, futures contracts are usually traded on an exchange.



- Exchange platform where assets such as commodities (pork bellies, cattle, sugar, wool, lumbar, copper, aluminum, gold, tin, etc...), financial assets (currencies, treasury bonds, stock indices, etc...) are included in various contracts.
 - Chicago Board of Trade (CBOT)
 - Chicago Mercantile Exchange (CME)



- Quick Example
 - Corporation to buy 1million British Pounds from bank @ 2.0483 and Bank to buy back after 6 months – *This is a binding Futures Contract*
 - Exchange rate can fluctuate within 6 months
 - Contract value changes within 6 months (could be positive or negative)
 - For the sake of this example the spot exchange rate rises to 2.1 at the end of 6 months. Futures Contract is now worth:
 - \$2,100,000-\$2,048,900 = \$51,100



USD/GBP



- Derivatives may have related underlying variables.
 - Options trading of gold can impact gold futures
 - Futures contracts can deter options commodity buying when spot is expiring.
 - Stock options for the automotive industry can impact the steel futures
 - Assuming that pigs eat corn from Virginia and a coastal Hurricane wipes out Virginia corn then pork bellies futures can be impacted.



Problem Definition

Problem Definition

- Options investment strategies that are rigorously modeled are usually proprietary and are the efforts of many resources
 - Determine an optimal options investment strategy
 - Balance aggressive investment against catastrophic loss
- Objectives and Goals
 - Extend the efforts of Fall 2009 and Spring 2010 project teams to develop a more realistic simulated trading process
 - Develop an analytical model to predict the risk reward ratio of an investment strategy and validate the strategy with our simulated trading process using real data



Project Scope

- Project team will act as investment broker (seller)
- Selling only options on E-Mini S&P, a stock market index futures contract
 - Traded on the Chicago Mercantile Exchange's Globex electronic trading platform.
 - The notional value of one E-mini contract is US\$50 times the value of the S&P 500 stock index.
 - Project Sponsor has 10 years of End-of-Day E-mini data (1999 2009)

Focus on Short Strangle Option Strategy

- Sell a single pair of put and call options
- Use the Black-Scholes Model
 - Partial Differential Equations whose solution can be used to calculate the price of (European) put and call options
 - Theoretically allows perfectly hedging options
 - Significant disagreements with reality
- Use the Kelly Criterion
 - Determines the optimum fractional allocation of assets to investments
- Ignore slippage
 - Between End-of-Day data and Tick data
 - Between contract stop-order and contract execution



Previous Work

- Fall 2009 and Spring 2010
 - Analyzed strangle strategy
 - Optimized return while minimizing risk of ruin
 - Made simplifying assumptions
- First Project
 - Constrained strategy parameters to asset volatility, strike price, stop-loss points and 1 month expiration
 - Implemented in Matlab and found optimal strategy for each 45-day window over 9 years
 - 2% rate of return per week



Previous Work, cont.

- Second Project
 - Extended previous project and removed some simplifying assumptions
 - Implemented an interactive Java GUI to evaluate all strategies
 - Increased the number of parameters for trading strategies
- Found best possible strategy yielded 700% returns
 - Determined expected ROI given various combinations of parameters
- Gave several recommendations for future work





Near Term Tasks

- Flesh-out WBS and Project Schedule
- Significant research required to understand:
 - Options and futures trading
 - Black-Scholes PDE Model and underlying geometric Brownian motion (Wiener process)
 - Kelly Criterion
- Review and modify Spring 2010 project team Java software
- Weekly, Friday afternoon meetings with Project Sponsor
- Weekly, Monday morning team meetings



References

- *E-Mini S&P*. (2011, February Wednesday, 09). Retrieved February 9, 2011, from Wikipedia: http://en.wikipedia.org/wiki/E-mini_S%26P
- Hull, J. C. (2009). *Option, Futures, and other Derivatives*. Upper Saddle River, New Jersey: Pearson Education, Inc.

