FTS Real Time System Project: Using Options to Manage Price Risk

Question: How can you manage price risk using options?

Introduction

The option "Greeks" provide measures of sensitivity to price and volatility changes in the underlying asset as well as other important contractual variables.

Project Overview

In this assignment you will first take a position in the underlying asset. If you are working with stock index options then the position will be the Exchange Traded Fund (e.g., SPY for the S&P 500 index). If you are working with the stocks and index options case, then you will have a stock position and will have to hedge it with the index options.. You can take a long or a short position in the stocks – this is up to you but once you take the position you cannot trade it thereafter. You should allocate about 50% of your initial cash to this position.

You cannot trade this position but your goal is to hedge the price risk associated with this position. That is, you want to reduce the volatility of your total position value by using options. In particular your performance will be measured by the Sharpe Ratio and your target expected return is around the financial cost of carry rate (e.g., LIBOR) and your target volatility is small (around 1%).

Example: Suppose the current 1-month LIBOR rate is 0.35%, the current Treasury risk free rate (T-bill) is 0.12% and the target volatility is 1% then your target Sharpe ratio for this exercise is $(0.35-0.12)/1 = 0.23$. Note this is close to zero but not zero. In theory a the riskless hedge would attain a Sharpe Ratio of zero but in practice this is unlikely to be attained for both numerator and denominator related reasons.

So your goal is to make your Sharpe Ratio as small as possible over the duration of this project.

To attain this objective will require working closely with the analytical support provided by the FTS Real Time Client trader. In previous assignments you were introduced to this support but now we will focus on a specific dimension for this support. That is, evaluating the price risk associated with your position.

Analytical Support in FTS Real Time Client:

First, we consider the case of what the support looks like if we purchase 1 call option. In the screen below this is the 1150 strike price option Dec 18, 2010 maturity:

| Edit ▾ US Dollar ▾ | Equity Options: Portfolio Analytics (Implied) ▾ | Parameters | | | | | | UserTip |

	Delta	Gamma	Vega	Theta						
Beta Weighted	61.8454	0.4088	18,712.5700	-11,348.6800						
	Mkt Price	Underlying	Contracts	Imp Vol	User Vol	User Price	Implied Delta	Implied Gamma	Implied Vega	Implie
SPX Call Eur 900 Dec 18 2010	251.00	1,169.77	0	N/A	0.1893	272.5111	0.9958	0.0000	0.6611	-
SPX Call Eur 950 Dec 18 2010	191.00	1,169.77	0	N/A	0.1893	223.0017	0.9927	0.0001	5.1597	-
SPX Call Eur 1000 Dec 18 2010	164.50	1,169.77	0	N/A	0.1893	173.9969	0.9764	0.0005	23.7309	-
SPX Call Eur 1050 Dec 18 2010	119.00	1,169.77	0	N/A	0.1893	126.8878	0.9222	0.0015	69.1042	-
SPX Call Eur 1100 Dec 18 2010	79.50	1,169.77	0	0.1489	0.1893	84.4973	0.8560	0.0030	109.8613	-
SPX Call Eur 1150 Dec 18 2010	50.00	1,169.77	1	0.1878	0.1893	50.2744	0.6185	0.0041	187.1257	-1
SPX Call Eur 1200 Dec 18 2010	21.60	1,169.77	0	0.1646	0.1893	26.3009	0.3912	0.0047	189.0539	-
SPX Call Eur 1250 Dec 18 2010	7.50	1,169.77	0	0.1573	0.1893	11.9945	0.1826	0.0034	130.5203	-
SPX Call Eur 1300 Dec 18 2010	1.50	1,169.77	0	0.1446	0.1893	4.7595	0.0512	0.0015	51.8805	-
SPX Call Eur 900 Mar 19 2011	0.00	1,169.77	0	N/A	0.1893	261.3217	0.9740	0.0003	32.1033	-

Your position delta is provided above in the "Beta Weighted" row. This is general support system that covers the case of multiple options with different underlying assets and also a mixed position of stocks and index options. *An example of how this is calculated is provided in the appendix.* Note that 1 option contract controls 100 times the underlying index value so implied Delta, Gamma and Vega for your current 1 option position is 100 times the implied values for 1 unit of the underlying index. For example, implied delta is 0.6185 for the 1 contract position above and the position delta is 61.85.

To maintain a delta neutral position you want to attain a position with a delta around zero. This position in theory will have a Sharpe Ratio of zero but in practice it will deviate from zero. As a result, as you add additional contracts to your position this will change your position delta. We illustrate this next by taking a position in the underlying index (i.e., the ETF that mimics the index).

Now suppose as required we take a long position in the SPY (the ETF for the S&P500 index) of 5000 shares. This will change significantly our position delta. From the support this appears as follows:

| Edit ▾ US Dollar | | Equity Options: Portfolio Analytics (Implied) | | ▾ Parameters | | | | | | 📄 UserTip |

	Delta	Gamma	Vega	Theta						
Beta Weighted	5,061.8450	0.4088	18,712.5700	-11,348.6800						
	Mkt Price	Underlying	Contracts	Imp Vol	User Vol	User Price	Implied Delta	Implied Gamma	Implied Vega	Impl
SPX Call Eur 900 Dec 18 2010	251.00	1,169.77	0	N/A	0.1893	272.5111	0.9958	0.0000	0.6611	
SPX Call Eur 950 Dec 18 2010	191.00	1,169.77	0	N/A	0.1893	223.0017	0.9927	0.0001	5.1597	
SPX Call Eur 1000 Dec 18 2010	164.50	1,169.77	0	N/A	0.1893	173.9969	0.9764	0.0005	23.7309	
SPX Call Eur 1050 Dec 18 2010	119.00	1,169.77	0	N/A	0.1893	126.8878	0.9222	0.0015	69.1042	
SPX Call Eur 1100 Dec 18 2010	79.50	1,169.77	0	0.1489	0.1893	84.4973	0.8560	0.0030	109.8613	
SPX Call Eur 1150 Dec 18 2010	50.00	1,169.77	1	0.1878	0.1893	50.2744	0.6185	0.0041	187.1257	
SPX Call Eur 1200 Dec 18 2010	21.60	1,169.77	0	0.1646	0.1893	26.3009	0.3912	0.0047	189.0539	
SPX Call Eur 1250 Dec 18 2010	7.50	1,169.77	0	0.1573	0.1893	11.9945	0.1826	0.0034	130.5203	
SPX Call Eur 1300 Dec 18 2010	1.50	1,169.77	0	0.1446	0.1893	4.7595	0.0512	0.0015	51.8805	

Now the position delta for 5,000 SPY shares plus 1 option contract is: 5,061.84 – in other words this position is exposed to the price risk that the general market may decline. A positive delta implies it will increase if the market increases and decline if the market declines.

To attain the objective for this project you can manage the price risk of this position by taking options with negative deltas to reduce the overall positive delta. You can do this with either puts or writing call options.

Finer Points:

You would also like to control the frequency with which you have to adjust your derivative position over time. A second number that is relevant to this issue is the position Gamma. That is, the position Gamma provides a measure of how sensitive the position delta is to price risk, and therefore how frequently a delta hedge needs to be adjusted to maintain t as a delta neutral hedge. As background information for the option "Greeks" you may want to work through the next section.

Background: Managing Price Risk using Delta and Gamma.

The terms "Delta Neutral" and "Delta Hedging" are commonly used in finance. Combined they describe a hedging strategy that focuses on a single number – position delta and tries to maintain this number around zero. At zero the position is predicted to be insensitive to changes in the underlying price. However, as you know option price spreads are large and so the transaction costs associated with trading options are large --- even if you pay very little commissions. As a result, you would like to adjust your hedged position as little as possible to eliminate having to pay large transaction costs. The control here is to consider a second number "Gamma" which describes the rate at which delta changes. Thus a position that is delta and gamma neutral is predicted to require less frequent adjustments than a position that is delta neutral.

To see how this works lets refer to the FTS Option Calculator Module.
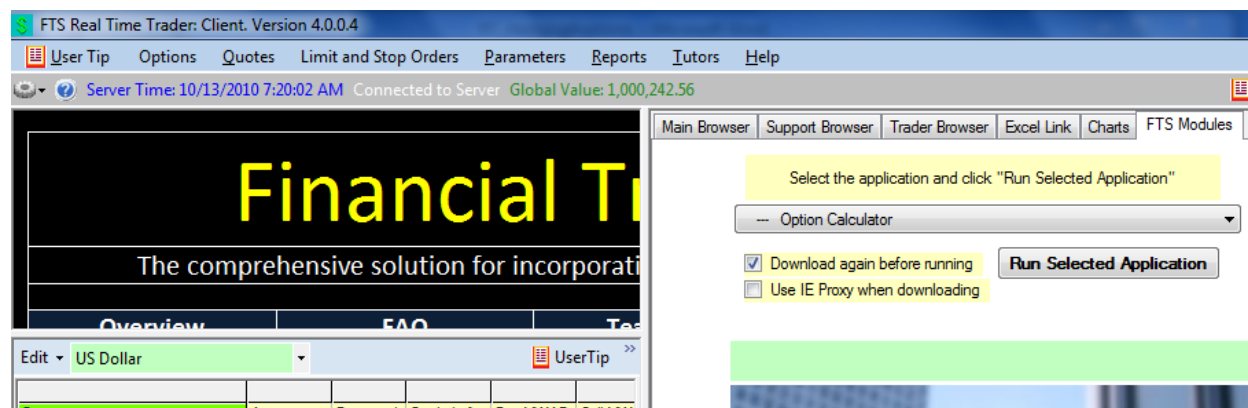
By launching this application the following option calculator is opened and by clicking on the sensitivity button you will get a graphical depiction of the option Greeks for the option parameters entered into the calculator. The default parameters are depicted below (European Call Option):
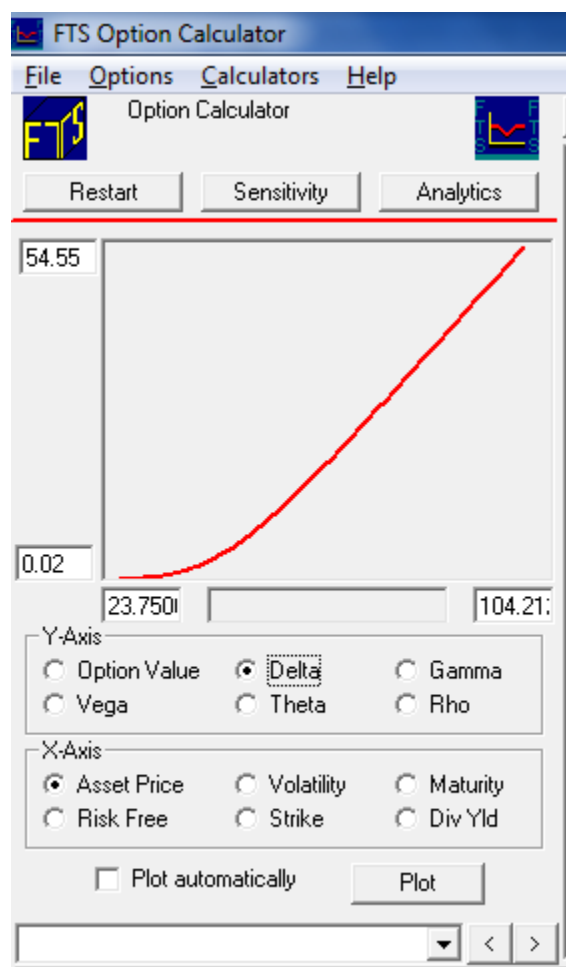
This calculator lets you plot Delta by underlying asset price (depicted) as well as Gamma by underlying asset price.

By pointing the cursor to a point on the graph and righting clicking your mouse the coordinates are displayed in the text box. For example, it lets you read off at what underlying price the maximal Gamma is. Furthermore by scrolling the RHS screen down you can click on "generic lessons" above to work through lessons on the Option Greeks:
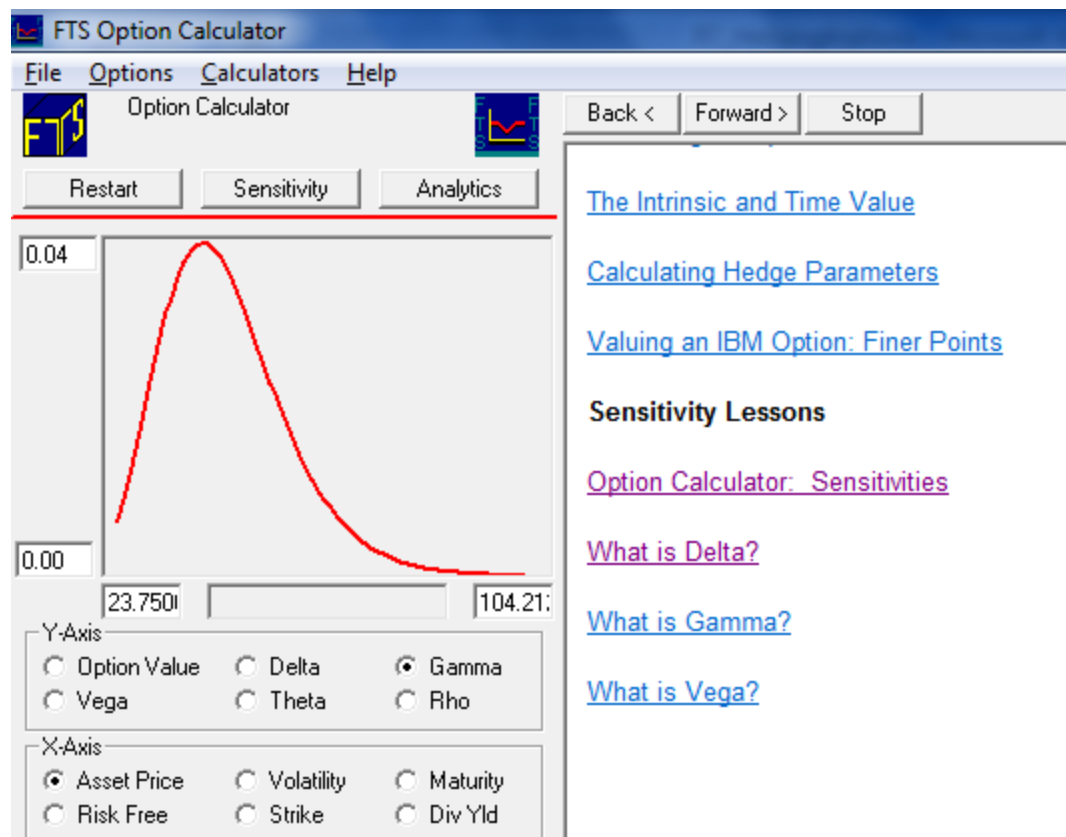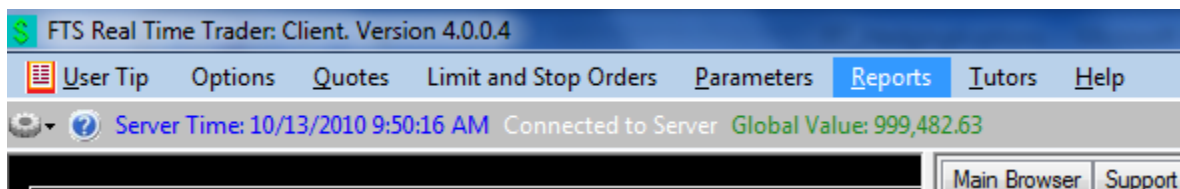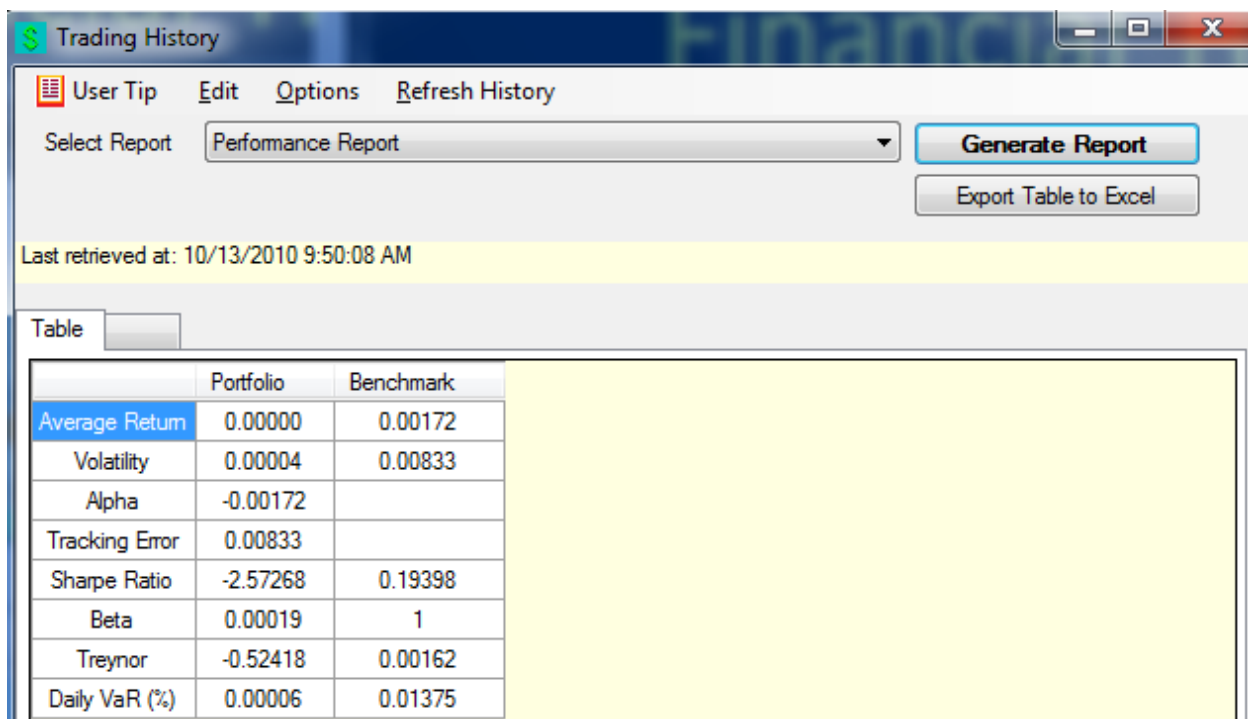
Project Requirements:

First, form a view of the market over the next week or two and take a position in the underlying asset. If you are working with stock index options then the position will be the Exchange Traded Fund (e.g., SPY for the S&P 500 index). If you are working with the stock option case then you will take positions in the stocks in the case (e.g., IBM or CSCO). You can take a long or a short position– this is up to you but once you take the position you cannot trade it thereafter. You should allocate about 50% of your initial cash to this position. **Once you take this initial position you are no longer permitted to trade it.**

A. Second, for time period 1 (e.g., 2 weeks) your task is to hedge the price risk associated with your non tradable ETF or stock position by using options. That is, you should take a position in the options' markets to neutralize your underlying price risk. Over time you should adjust this position to keep it within your target position delta. You are also trying to maintain a Sharpe Ratio as close to zero as possible so therefore you need to tradeoff the frequency of adjusting your position hedge with attaining Sharpe Ratio goals. Recall, that transaction costs will generate a negative return (and hence a negative Sharpe Ratio) if you adjust too frequently.

(1) Describe precisely the position you constructed to achieve A. What was the realized return and did this attain your trading objective? (Support your answer with why or why not).

(2) Describe how your Sharpe Ratio performed over time. To get information about your Sharpe Ratio periodically click on Reports:

And then select Performance Report and click on Generate Report:

	Portfolio	Benchmark
Average Return	0.00000	0.00172
Volatility	0.00004	0.00833
Alpha	-0.00172	
Tracking Error	0.00833	
Sharpe Ratio	-2.57268	0.19398
Beta	0.00019	1
Treynor	-0.52418	0.00162
Daily VaR (%)	0.00006	0.01375

You should record your Sharpe Ratio over time.

(3) Describe what steps you took to try and manage your Sharpe Ratio and how successful were these steps.

(4) Finally, how did the theory perform. In particular, did managing delta help you manage the price risk of your position?

Appendix: Example of The Beta-Weighted Calculation: Hedging a stock portfolio with index options

<u>On the beta weighted delta</u>

Suppose you hold some stocks. Let M be the "market index" and let $S_i = P_i*Q_i$ be the value of stock i. The beta-weighted calculation uses CAPM to approximate changes in a stock's price due to changes in the market index.

The return approximation is:

$$\frac{\Delta S_i}{S_i} = \beta_i \frac{\Delta M}{M}$$

This says that the return on the stock is proportional to the return on the index, and the proportionality factor is beta.

Therefore, the response of the stock to $\Delta M = 1$ is

$$\Delta S_i = \beta_i \frac{S_i}{M}$$

If you buy N put options, and the option's delta is denoted by δ, then the beta-weighted portfolio delta is:

$$\frac{\sum_i \beta_i S_i}{M} + 100N\delta$$

To be hedged, this number needs to be close to zero.

<u>Example</u>

Suppose you have the following stock and option position:

Currency	Amount Available	Borrowed	Credit Left
US Dollar	435,303.43	0.00	100,000.00
Stocks	Position	Last	Last Value
AT&T (T)	2,800	36.60	102,480.00
BANK OF AMERICA (BAC)	8,300	11.55	95,865.00
CHEVRON (CVX)	865	117.93	102,009.50
MERCK (MRK)	2,350	43.25	101,637.50
WAL-MART STORES (WMT)	1,440	73.72	106,156.80
Equity Options	Position	Last	Last Value
SPX Put Eur 1500 Dec 20 2013	6	7,500.00	45,000.00

The analytical support shows:

	Delta	Gamma	Vega	Theta				
Beta Weighted	6.5485	1.0649	318,410.4000	-37,953.5100				
	Mkt Price	Underlying	Contracts	Imp Vol	User Vol	User Price	Implied Delta	I
SPX Put Eur 1100 Dec 20 2013	8.80	1,539.79	0	0.2472	0.1627	0.8156	-0.0558	
SPX Put Eur 1200 Dec 20 2013	15.17	1,539.79	0	0.2232	0.1627	4.1388	-0.0966	
SPX Put Eur 1250 Dec 20 2013	25.00	1,539.79	0	0.2292	0.1627	8.0286	-0.1414	
SPX Put Eur 1300 Dec 20 2013	26.70	1,539.79	0	0.2026	0.1627	14.3326	-0.1657	
SPX Put Eur 1350 Dec 20 2013	34.80	1,539.79	0	0.1917	0.1627	23.7952	-0.2131	
SPX Put Eur 1400 Dec 20 2013	44.00	1,539.79	0	0.1783	0.1627	37.0791	-0.2695	
SPX Put Eur 1500 Dec 20 2013	75.00	1,539.79	6	0.1593	0.1627	76.8237	-0.4263	

Here is a check of the numbers (there is small rounding error because the delta is only shown to 4 decimal places):

	P	Q	Beta	Q*Beta*P
T	36.6	2800	0.44	45091.2
BAC	11.55	8300	1.77	169681.05
CVX	117.93	865	1.17	119351.0565
MRK	43.25	2350	0.29	29474.875
WMT	73.72	1440	0.38	40339.584
				SUM
M	1539.79			403937.7655
		N		Beta weighted
Put delta	-0.4263	6		6.55302301

To hedge the stock position, you need the beta-weighted delta to be close to zero. Here, this means buying between 5 and 6 put options.