Derivative Securities: Assignment 3

Due November 2, 2011

1. Compute the implied dividend and the implied volatilities for the options in the Worksheet ``spyjan12'', consisting of all listed options on SPY expiring on Jan 12, 2012. Reference date: October 17, 2011. (You need to write an American-option pricer and also invert that formula for each of the options considered. Alternatively, you can use the MATLAB toolbox of financial functions).

2. Using the results of Part 1, consider a trader with a long position in 1000 call spreads with strikes 100 and 140 (i.e. long 1000 SPY Jan 100 Calls, short 1000 SPY Jan 140 Calls). What is the Delta of the position? Consider a portfolio which is Delta-neutral, i.e. the trader is also short Delta*100 shares of SPY. Consider the data in the spreadsheet ``backtesting''. Using the VIX data, compute the previous 252 daily returns of SPY and VIX (as percentages), denoting them by $(R_t^{SPY}, R_t^{VIX}), t = 1,2,..,252$. Net, assume that the current (Oct 17) volatilities of the options and the spot price of SPY are perturbed as follows:

$$SPY \to SPY * (1 + R_t^{SPY}), \sigma \to \sigma * (1 + R_t^{VIX}), t = 1,2, \dots,252$$

   (i) Compute the corresponding variation in the value of the trader's portfolio corresponding to the 252 shocks. What is the worse potential loss in value corresponding to these scenarios? Find which date in the past year gave rise to the worse loss.
   (ii) Repeat the exercise for a trader that has no Delta hedge.
   (iii) Repeat the exercise for a trader who sold risk-reversals (short 1000 SPY Jan 100 puts, long 1000 SPY Jan 140 Calls).

3. Consider the options in Problem 1. Which contracts should be exercised on October 17, 2011 (trade date)?

4. A (large) Nebraskan investor *sold* long-dated, 15-year, at-the-money European-style puts on the S&P 500 index on December 17, 2007, collecting 3.5 Billion USD in premium on the sale.

(i) Using the data in the worksheet ``backtesting'', calculate the ***approximate notional amount of index*** (or number of options, if you prefer) that the investor sold (assume r=2%, d=2%, volatility=30.00%, Index=1445.9, T=15Y, K=1445.9).

(ii) For the purposes of this part of the exercise, assume that the daily implied volatilities of the options *following the date of the sale* are given by the equation $\sigma_t = (.30) * \frac{VIX_t}{VIX_0}$, where VIXo = 24.52% is the VIX level on the day of the trade. We can then attempt to compute the performance of this trade. Based on these assumptions, calculate the daily mark-to-market value of the investor's portfolio since December 17, 2007 until the present date. What is the worse drawdown that he realized over the period of time considered? Calculate the annualized rate of return of the trade on Dec 17 2008, Dec 17 2009, Dec 17 2010 and Oct 17 2011.