Energy Derivatives
Professor PirroCL
Homework 4

1. It is 11 April, 2012. June, 2012 Crude Oil ("Oil", "CL") futures are currently trading at $103.43/bbl. The annualized volatility (sigma) for CL futures is .3265. The continuously compounded, annualized risk free interest rate is .015. Options on June futures expire on 22 May, 2012.

a) Use the Black formula to determine the value of a European put option on June CL futures struck at $104.00. Use a binomial model with seven time steps to determine the value of the same option. How far off is the binomial model estimate?

b) What is the delta of the put? What is the gamma of the put? What futures position (measured in barrels) would you use to hedge long puts on 10,000 barrels? What futures position would you use to replicate long puts on 10,000 barrels? (Indicate the size of the position in barrels and whether you are long or short the futures).

c) Use the Black model to value a European call on June CL struck at $104.00. Verify that put-call parity holds. What are the delta and gamma of the call? What futures position would you use to hedge short calls on 10,000 barrels? What futures position would you use to replicate short calls on 10,000 barrels?

d) Value a European call on June CL struck at $106.00. How would you delta hedge a long position in 100,000 BBL of calls?

2. On 11 April, 2012 July 2012 Crude Oil futures traded at $103.94/bbl. July CL options expire on 15 June. A July call struck at $108.50 is selling at $2.38/bbl. What is the implied volatility of the $108.50 call? Assume an interest rate of 1.5 percent.

3. You are making a market in Oil options. On 11 April you sold put options on 100 June, 2012 Crude Oil futures contracts. The options are struck at $102.00/BBL. The relevant volatility is 32 percent, and the relevant interest rate is 1.5 percent. The options expire on 22 May, 2012. The current June 2012 CL futures price is $103.49/bbl. Each contract is for 1000 bbl.

a) What is the price of the options you sold?

b) What are the Delta, Gamma, and Vega of the entire position in the options that you sold?

c) What are the risks associated with this transaction?

d) Devise a delta hedge for this transaction. How many futures contracts should you trade? For what delivery month? Should you buy or sell futures?

e) What risks do you face when you merely delta hedge? How can you mitigate these risks?

f) You have an opportunity to purchase calls on June 11 CL struck at $107.00/bbl. Devise a transaction in the 107 strike Jun 11 calls and Jun 11 futures that offsets the delta and gamma risks of your original sale of puts. How many 107 calls should you trade? Should you buy or sell? How many Jun 11 futures should you trade? Should you buy or sell? What is the vega of your gamma and delta hedged position?