

**Energy Derivatives**  
**Professor Craig Pirrong**  
**Homework 3**  
**2017**

1. The June WTI futures price is \$51.57/bbl. The annualized volatility (sigma) for June WTI futures is .2740. The continuously compounded, annualized risk free interest rate is .015.
  - a. Construct a binomial tree of possible futures values in 4 weeks assuming one week time intervals (i.e.,  $\Delta t = 1/52$ ). (Hint: what is  $u$ ? What is  $d$ ?)
  - b. What is the value of  $p$  for this futures contract?
  - c. Determine the value of a European call option on June WTI that expires in 4 weeks that has a strike price of \$52/bbl. What is the value of an American call option on this contract? What is the delta of the American call? How many June futures do I need to hold to hedge a long position in the call? Is my futures position for hedging long or short? How many contracts do I need to replicate a *short* position in the call? Is my futures position for replicating long or short?
  - d. Determine the value of a European put option on the June WTI that expires in 4 weeks that is struck at \$52/bbl. What is the delta of the put? How many contracts do I need to hold to hedge a long position in the put? Is my hedging position long or short? How many contracts do I need to hold to replicate a long position in the put? Is my replicating position long or short?
  - e. Determine the value of an American put option on June WTI futures that expires in 4 weeks that is struck at \$65.00. Identify when the option will be exercised early (i.e., the nodes in the binomial tree where early exercise is optimal).
  - f. Value an American put on June WTI futures that expires in 4 weeks that is struck at \$65, but now assume the interest rate is 20 percent. Identify when early exercise is optimal.