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Financial Engineering

Problem set 3

- Due date is Monday (99/10/8) midnight at 23:55.
- You should upload a file in CW, the names of which should be in the format of "FE-HW3-Student Number". If you also have an excel file compress both files and send a .zip or .rar file named with aforementioned format. Note that the only accepted format for your assignments is word or pdf, and any handwritten reports should be delivered in these formats.
- Score Reduction Policy:
  You are allowed a maximum of 7 days delay (in total) for the submission of all your assignments and your project. Note that the delay will be calculated "daily", not hourly (meaning that a 5-minute delay for a given assignment will be considered as 1 day).
- For the questions needing Excel (if any), also copy the tables of final answers (if it is not too big) in the Word/pdf file as well. Therefore, the Word/pdf file will have everything for all questions but the calculations will be in Excel. In other words, the Word file should be a standalone file.
- Personal integrity is the key to your success in career and life. Any cheating, dishonesty, or plagiarism will NOT be tolerated. If a student is found guilty of academic dishonesty, the student will receive an 'F' for the course in addition to any punishment determined by the university. You are allowed to consult with other students in solving the questions. However, all the work including problem sets and exams should reflect your effort only. **Too similar assignments will get zero, therefore, do not copy the result of others' efforts.**

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1. The price of a stock is $40. The price of a one-year European put option on the stock with a strike price of $30 is quoted as $7 and the price of a one-year European call option on the stock with a strike price of $50 is quoted as $5. Suppose that an investor buys 100 shares, shorts 100 call options, and buys 100 put options. Draw a diagram illustrating how the investor's profit or loss varies with the stock price over the next year. How does your answer change if the investor buys 100 shares, shorts 200 call options, and buys 200 put options?

2. You are the manager and sole owner of a highly leveraged company. All the debt will mature in one year. If at that time the value of the company is greater than the face value of the debt, you will pay off the debt. If the value of the company is less than the face value of the debt, you will declare bankruptcy and the debt holders will own the company.
   a. Express your position as an option on the value of the company.
   b. Express the position of the debt holders in terms of options on the value of the company.
   c. What can you do to increase the value of your position?

3. A diagonal spread is created by buying a call with strike price K_2 and exercise date T_2 and selling a call with strike price K_1 and exercise date T_1 (. Draw a diagram showing the profit at time T1 ($T_2 > T_1$) when
   a. $K_2 > K_1$
   b. $K_2 < K_1$

4. Suppose that the price of a non-dividend-paying stock is $32, its volatility is 30%, and the risk-free rate for all maturities is 5% per annum. Use DerivaGem to calculate the cost of setting up the following positions. In each case provide a table showing the relationship between profit and final stock price. Ignore the impact of discounting.
   a. A bull spread using European call options with strike prices of $25 and $30 and a maturity of six months.
   b. A bear spread using European put options with strike prices of $25 and $30 and a maturity of six months
   c. A butterfly spread using European call options with strike prices of $25, $30, and $35 and a maturity of one year.
   d. A butterfly spread using European put options with strike prices of $25, $30, and $35 and a maturity of one year.
   e. A straddle using options with a strike price of $30 and a six-month maturity.
   f. A strangle using options with strike prices of $25 and $35 and a six-month maturity.
   In each case provide a table showing the relationship between profit and final stock price. Ignore the impact of discounting.

5. Calculate the value of nine-month American call option on a foreign currency using a three-step binomial tree. The current exchange rate is 0.79 and the strike price is 0.80 (both expressed as dollars per unit of the foreign currency). The volatility of the exchange rate is 12% per annum. The domestic and foreign risk-free rates are 2% and 5%, respectively. Suppose a company has bought options on 1 million units of the foreign currency. What position in the foreign currency is initially necessary to hedge its risk?

6. Determine the value of a perpetual American put option on a non-dividend-paying stock with strike price K if it is exercised when the stock price equals H where H<K. Assume that the current stock price S is greater than H. What is the value of H that maximizes the option value? Deduce the value of a perpetual American put option with strike price K.