Universität zu Köln
Markets for Risk Management

Problem Set #2
3 June 2013
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Problem #1 (33 points)

Suppose a share of stock currently trades for €50. A call option written on this stock with an exercise price of €50 trades for €2, and an otherwise identical put option also trades for €2. The options are both European and expire 1 month from today.

1. (11 points) Describe a trading strategy involving the call, the put, and the share that enables you to synthetically replicate a riskless pure discount bond[1] with a face value equal to the exercise price on these options.
2. (11 points) What is annualized riskless rate of interest implied by the prices of these various securities?
3. (11 points) Suppose that the annualized riskless rate of interest is 5%. Describe an arbitrage strategy that will enable you to make riskless profits with zero net investment. Calculate the profits that are earned, and also numerically confirm that the profits are riskless and do not involve any investment of your own money.

Problem #2 (32 points)

Suppose you are interested in pricing a European put option which matures in 1 year. Currently, the underlying stock for this option is worth €40, and its exercise price is €40. Assume that the (annualized) riskless rate of interest is 5 percent, and that the (annualized) volatility of the stock is 35 percent. Here are some other facts that are important in valuing this option:

- Assume that the "up" move, $u = 1 + \sigma\sqrt{\delta t}$, and the "down" move $d = 1 - \sigma\sqrt{\delta t}$;
- Assume discrete discounting; therefore the present value discount factor ($PVDF$) for an interest rate of r and one time step is $PVDF = 1/(1 + r\delta t)$.

1. (8 points) Using a two-period binomial tree, solve for the current market value of this put option (hint: divide the 1 year period into two 6-month intervals; thus $\delta t = 0.5$).
2. (8 points) What is the current market value for an otherwise identical European call option (i.e., like the put option, this call option also matures in 1 year and has an exercise price of €40).
3. (8 points) Now suppose that both of these options have *stochastic* exercise prices; specifically, the exercise price will be remain at €40 so long as the underlying stock ends up being worth less than €40 one year from now; otherwise, the exercise price for both options will be reset at €50. Given this information, recalculate the price of the put option. Does a stochastic exercise price affect the value of the put option? Why or why not?

[1] A pure discount bond is a bond that only pays interest (as well as principal) on the date of maturity.

4. (8 points) Given the information provided in part C, recalculate the price of the call option. Does a stochastic exercise price affect the value of the call option? Why or why not?

Problem #3 (33 points)

Currently, a share of RWE sells for €25. The annualized volatility (σ) for this stock is 60 percent. Currently, the annualized risk free interest rate is 5%.

1. (11 points) Calculate the value of a European put option on RWE with an exercise price of €20 and an expiration date of 1 year from today.

2. (11 points) Suppose that a European call option on RWE with an exercise price of €20 and an expiration date of 1 year from today is priced at €5. Is this a fair price for this call option? If not, describe a riskless arbitrage strategy that can be implemented to take advantage of the mispricing. Also, calculate the profit you would receive from implementing such a strategy.

3. (11 points) As part of a private financing deal, RWE management has decided to issue warrants on RWE stock with an exercise price of €30 and an expiration date of 2 years from today (note: warrants are privately negotiated (i.e., non-exchange traded) European call options with maturities exceeding 1 year). What is the fair market value for these warrants? Explain why there is a difference in price between the two-year warrants and the 1-year call options.