# Baylor University
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# Department of Finance, Insurance & Real Estate

Risk Management
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Problem Set 8

Name: SOLUTIONS

The price of a share of ABC stock is currently \$100. It is known that at the end of 6 months, the ABC share price will be either \$120 or \$84. The riskfree interest rate is 5% per year.

1. (20 points) Calculate the price of a six-month European call option on ABC stock with an exercise price of \$96 by applying the replicating portfolio approach.

   SOLUTION: The initial cost of the replicating portfolio is $\$(\Delta S + B)$, where $\Delta = \frac{c_u - c_d}{uS - dS} = \frac{24 - 0}{120 - 84} = 2/3$, and $B = \frac{uc_d - dc_u}{e^{r\delta t}(u-d)} = \frac{1.2(0) - .84(24)}{1.0253(0.36)} = -54.62$; therefore,

   $$c = \Delta S + B = 2/3(100) - 54.62 = \$12.05.$$

2. (20 points) Calculate the price of a six-month European call option on ABC stock with an exercise price of \$96 by applying the risk neutral valuation approach.

   SOLUTION: The pricing equation for risk neutral valuation of a call option is $c = e^{-r\delta t}[qc_u + (1-q)c_d]$, where $q = \frac{e^{r\delta t} - d}{u - d}$. Here, $c_u = 24$, $c_d = 0$, and $q = \frac{e^{.05(.5)} - .84}{.36} = .5148$. Therefore, $c = e^{-.05(.5)}[.5148(24)] = 12.05$.

3. (20 points) Calculate the price of a six-month European put option on ABC stock with an exercise price of \$96 by applying the replicating portfolio approach.

   SOLUTION: The initial cost of the replicating portfolio is $\$(\Delta S + B)$, where $\Delta = \frac{p_u - p_d}{uS - dS} = \frac{0 - 12}{120 - 84} = -.3333$, and $B = \frac{up_d - dp_u}{e^{r\delta t}(u-d)} = \frac{1.2(12) - .84(0)}{1.0253(0.36)} = 39.01$; therefore,

   $$p = \Delta S + B = -.3333(100) + 39.01 = \$5.68.$$

4. (20 points) Calculate the price of a six-month European put option on ABC stock with an exercise price of \$96 by applying the replicating portfolio approach.

   SOLUTION: The pricing equation for risk neutral valuation of a put option is $p = e^{-r\delta t}[qp_u + (1-q)p_d]$, where $q = \frac{e^{r\delta t} - d}{u - d}$. Here, $p_u = 0$, $p_d = 12$, and $q = \frac{e^{.05(.5)} - .84}{.36} = .5148$. Therefore, $p = e^{-.05(.5)}[.4852(12)] = \$5.68$.

5. (30 points) Next, add another 6 month timestep; i.e., it is known that at the end of 1 year, the ABC share price will be \$144, \$100.80, or \$70.56. Calculate the price of a 1 year European call option on ABC stock with an exercise price of \$96. Also calculate the price of a 1 year European put option on ABC stock with an exercise price of \$96.

   SOLUTION: The easiest way to solve for the price of a 1 year European call option is to identify the nodes at which it is in the money, and then apply risk neutral valuation. Since the exercise price is \$96, this means that $C_{uu} = \$48$, $C_{ud} = \$4.80$, and $C_{dd} = \$0$. Thus,

$$\begin{aligned} C &= e^{-2r\delta t}\left[q^2 C_{uu} + 2q(1-q)C_{ud} + (1-q)^2 C_{dd}\right] \\ &= e^{-.05}\left[.5148^2(48) + 2(.5148)(.4852)(4.80)\right] = \$14.38. \end{aligned}$$

   Since we know the price of the call, the price of the otherwise identical put option can be determined by applying the put-call parity relationship:

$$P = C + Ke^{-2r\delta t} - S = \$14.38 + \$91.32 - \$100 = \$5.70.$$