Chapter 21 Problems

**Short-Answer**

1. LuthorMark Printers has a current stock price of $14 and may rise by $5 per share or fall by $3 per share each of the next two years. Sketch a binomial tree with the possible payoffs on a call two years from today with a strike price of $15. Note: Do not solve for the value of the option today, simply sketch the tree with the option payoffs at the appropriate places on the binomial tree.

   ![Binomial Tree]

2. Assume that Windy’s Flapjacks’ current stock price is $26 and that a call on Windy’s Flapjacks with a $25 strike price currently trades for $4. Assume that this call can be replicated if \( \Delta \) equals 0.8295 and \( B = -18.5667 \) and that the net cost of this replicating portfolio is $3. What specific transactions would create an arbitrage profit for you? Note: you need to list each specific transaction.

   Sell the call; Buy 0.8295 shares; Short sell risk-free bonds worth 18.5667

3. Fjord Motors’ current stock price equals $22 per share but by a year from now will either increase by $5 per share or may decline by $6 per share. Sketch a binomial tree with the possible payoffs a year from today on the stock and a put if the strike price on the put is $20. Note: you do not need to solve for the value of the put, simply sketch the tree with the option payoffs at the appropriate places on the binomial tree.

   ![Binomial Tree]

4. Assume that MotorAlong Mobile-Devices’ stock is trading for $9 per share, has a beta of 1.4, and has an annual volatility of 42%. If the risk-free rate is 4%, set up to calculate \( N(d_1) \) for a call on MotorAlong that has a strike price of $10 and which expires 40 days from today.

   \[
   N(d_1) = \text{normsdist}(\text{Excel}) \text{ of } d_1 \text{ where } d_1 = \frac{\ln \left( \frac{9}{PV(K)} \right)}{\sqrt{\frac{40}{365}}} + \frac{0.42}{\sqrt{\frac{365}{2}}}.
   \]

   \[
   PV(K) = \frac{10}{(1.04)^{40/365}}
   \]
Chapter 21 Problems

5. Assume that you have just valued shares of DonyMac’s Burgers as a call using the Black-Scholes Option Pricing Model. You know the beta of DonyMac’s stock is 1.4. What equation would you need to use to determine DonyMac’s unlevered equity beta? Note: you only need to list a single equation; you don’t need to plug in any numbers.

\[ \beta_U = \frac{\beta_E}{\Delta \left(1 + \frac{D}{E}\right)} \]

6. Detroit Motors Inc. currently has no debt. Detroit’s equity (and assets) have a market value of $40 million and a beta of 0.8. Assume that Detroit is planning to issue debt that matures three years from today for $15 million. Using the Black-Scholes Option Pricing model, Detroit estimates that after the debt issued, its equity will have a market value of $29.76 million and its debt will have a market value of $10.24 million. When calculating these values, Detroit found that \( d_1 \) was 1.654, that \( d_2 \) was 0.536, that \( N(d_1) \) was 0.951 and that \( N(d_2) \) was 0.704. Set up to calculate the beta of Detroit’s debt.

\[ \beta_D = (1 - .951) \left( \frac{40}{10.24} \right) (0.8) \]

7. While the book value of Eli Inc’s equity is $100,000 and of its debt is $300,000, the market value of its equity is $550,000 and of its debt is $240,000. When Eli’s stock is valued as a call on the firm’s assets, the implied volatility of the firm’s assets is 39.7%, \( d_1 \) is 1.70, and \( d_2 \) is 0.81. Calculate the beta of Eli’s debt if the beta of Eli’s assets is 0.7.

\[ \beta_D = (1 - .95543) \left( \frac{550,000+240,000}{240,000} \right) 0.7 \]

8. Given the following information, calculate the beta of TJX’s debt

- Beta of TJX’s assets = 0.85
- Market value of: TJX’s assets = $800 million, TJX’s equity = $600 million
- If the Black-Scholes Options Pricing model is used to value TJX’s equity: \( d_1 = 1.80 \), \( N(d_1) = .964 \), \( d_2 = 0.79 \), \( N(d_2) = .786 \)

\[ \beta_D = (1 - .964) \left( \frac{800}{800 - 600} \right) (0.85) \]

9. Other things equal, what happens to the beta of a call as the price of the stock on which the call is written falls?

Rises
Problems

1. Baltic Enterprises pays no dividends and has a current stock price of $14. In each of the next two years, Baltic’s stock will either go up by $3 or down by $2.50. The one-year risk-free interest rate is 5% per year and is expected to remain unchanged. Using the Binomial Model, calculate the price of a two-year call option on Baltic with a strike price of $15.

\[ \Delta_t = \frac{5 - 0}{20 - 14.50} \]
\[ B_t = \frac{0 - 14.50\Delta}{1.05} \]
\[ C_u = 17\Delta + B \]

\[ C_d = 0 \]

Today:

\[ \Delta = \frac{C_u - 0}{17 - 11.50} \]
\[ B = \frac{0 - 11.50\Delta}{1.05} \]
\[ C = 14\Delta + B \]
2. You are considering buying two call contracts on Blockbuster Inc. with a strike price of $7.50 per share that expire ten months from today. You are considering this purchase because while you expect Blockbuster’s stock price to fall from its current $6.70 per share to $5 per share by 2 months from today, you expect its price to rise to $9 per share by 7 months from today. Seven months from today you plan to close out your position. You expect the standard deviation of returns on Blockbuster stock to equal 62% and the standard deviation of returns on the calls to equal 191%. The return on Treasuries depends on maturity as follows: 2-months = 5.01%; 7-months = 4.99%; 10-months = 4.87%; What cash flow can you expect today as you buy the call contracts? Note: use a “+” to represent an inflow and a “-“ to represent an outflow.

\[
P V(K) = \frac{7.50}{(1.0487)^{10/12}}
\]

\[
d_1 = \frac{\ln \left( \frac{6.70}{PV(K)} \right) + 0.62 \sqrt{\frac{10}{12}}}{0.62 \sqrt{\frac{10}{12}}};
\]

\[
d_2 = d_1 - 0.62 \sqrt{\frac{10}{12}}
\]

\[
C = 6.70 \times N(d_1) - PV(K) \times N(d_2)
\]

N(d_1) and N(d_2) = cumulative normal distribution of d_1 and d_2. In Excel: =normsdist(d).

CF = -C x 2 x 100

3. Assume that DoPunt Inc.’s stock, which has a market value of $9,000,000, has a beta of 1.15. Assume also that DoPunt’s zero-coupon debt that matures 7-years from today for $25,000,000 has a market value of $11,300,000. Finally, assume that the risk-free rate is 4%. Calculate the beta of DoPunt’s assets (or unlevered equity) and its debt?

Note: Be sure to state which variables you will need to solve for.

\[
A = 9 + 11.3 = 20.3
\]

\[
P V(K) = \frac{25}{(1.04)^7}
\]

\[
d_1 = \frac{\ln \left( \frac{20.3}{PV(K)} \right) + \sqrt{7}}{\sqrt{7}}
\]

\[
d_2 = d_1 - \sqrt{7}
\]

\[
E = 9 = 20.3 \times N(d_1) - PV(K) \times N(d_2)\text{ where } N() = \text{cumulative normal distribution of } d_1 \text{ and } d_2
\]

=> solve for \(\sigma\) that makes this hold

\[
\Delta = N(d_1)
\]

\[
\beta_U = \frac{1.15}{\Delta \left(1 + \frac{11.3}{9}\right)}
\]

\[
\beta_D = (1 - \Delta) \frac{20.3}{11.3} \beta_U
\]
4. Hewitt Packing (HP) has a current market price of $25 per share. In each of the next two years, HP’s stock price will either increase by $5 per share or decrease by $3 per share. Calculate the value today of a put with a strike price of $30 if the risk-free rate is 2% and is not expected to change.

\[ S = 25; \ S_u = 25 + 5 = 30; \ S_d = 25 - 3 = 22 \]
\[ S_{uu} = 25 + 5 + 5 = 35; \ S_{ud} = S_{du} = 25 + 5 - 3 = 25 - 3 + 5 = 27; \ S_{dd} = 25 - 3 - 3 = 19 \]
\[ P_{uu} = \max(30 - 35, 0) = 0; \ P_{ud} = P_{du} = \max(30 - 27, 0) = 3; \ P_{dd} = \max(30 - 19, 0) = 11 \]

\[ \Delta_u = \frac{P_{uu} - P_{ud} \varnothing}{S_{uu} - S_{ud}} = \frac{0 - 3}{35 - 27} \]
\[ B_u = \frac{P_{uu} - S_{ud} \varnothing}{1 + r_f} = \frac{3 - 27 \varnothing}{1.02} \]
\[ P_u = S_u \Delta_u + B_u = 30 \Delta_u + B_u \]
\[ \Delta_d = \frac{P_{ud} - P_{dd} \varnothing}{S_{ud} - S_{dd}} = \frac{3 - 11}{27 - 19} \]
\[ B_d = \frac{P_{dd} - S_{dd} \varnothing}{1 + r_f} = \frac{11 - 19 \varnothing}{1.02} \]
\[ P_d = S_d \Delta_d + B_d = 22 \Delta_d + B_d \]
\[ \Delta = \frac{P_u - P_d \varnothing}{S_u - S_d} = \frac{P_u - P_d}{30 - 22} \]
\[ B = \frac{P_d - S_d \varnothing}{1 + r_f} = \frac{P_d - 22 \varnothing}{1.02} \]
\[ P = 5 \Delta + B = 25 \Delta + B \]
Chapter 21 Problems

5. FewBucks Coffee Company’s current stock price is $21 per share. In each of the next two years, FewBucks will go up by $3 per share or down by $2 per share. The risk-free rate is currently 3% per year and is not expected to change. Using the binomial option pricing model, calculate the value of a put with a strike price of $20 that expires 2 years from today.

\[ S_u = 21 + 3 = 24, \quad S_d = 21 - 2 = 19 \quad S_{uu} = 21 + 3 + 3 = 27, \quad S_{ud} = S_{du} = 21 + 3 - 2 = 22, \quad S_{dd} = 21 - 2 - 2 = 17 \]

\[ P_{uu} = 0, \quad P_{ud} = P_{du} = 0, \quad P_{dd} = 20 - 17 = 3 \]

\[ P_u = 0 \text{ since only possible payoff = 0} \]

\[ P_d: \]
\[ \Delta_d = \frac{0 - 3}{22 - 17} \]
\[ B_d = \frac{3 - 17\Delta_d}{1.03} \]
\[ P_d = C_d = 19\Delta + B_d \]

\[ P: \]
\[ \Delta = \frac{0 - P_d}{24 - 19} \]
\[ B = \frac{P_d - 19\Delta}{1.03} \]
\[ P = C = 21\Delta + B \]
Multiple-Choice

1. Golden Socks Inc’s stock price currently equals $16 per share and is expected to equal either $12 or $20 per share a year from today. Calculate B you would use in determining the value of a put with a $15 strike price if the risk-free rate is 2% and \( \Delta \) equals – 0.375.

a. 9.31
B. 7.35
c. 4.41
d. 12.25
e. – 1.47

2. OOPS Inc. has a current stock price of $22 and its shares may rise to $26 per share one year from today. Its shares may also drop in value. You have short-sold $9.3204 of risk-free bonds earning a rate of 3% and purchased 0.6 shares. A call with what strike price will provide the same payoff as your portfolio one year from today?

a. $28
B. $20
c. $26
d. $6
e. there is not enough information

3. Assume that you want to calculate the beta of a put with a strike price of $20 that matures 40 days from today. Assume that the stock currently trades for $21 and has a beta of 0.7. Using the Black-Scholes option pricing model, you have determined that \( d_1 \) equals 0.554 and that \( d_2 \) equals 0.448. You have also determined that \( N(d_1) \) equals 0.7102 and that \( N(d_2) \) equals 0.6730. Finally, you have calculated the present value of the strike price as 19.914. Which of the following will calculate the beta of the option?

\[
\begin{align*}
a. & \quad \left( \frac{-(1-.554) \times 20}{-(1-.554) \times 20 + 19.914 \times (1-.448)} \right) \times .7 \\
b. & \quad \left( \frac{-(1-.7102) \times 20}{-(1-.7102) \times 20 + 19.914 \times (1-.6730)} \right) \times .7 \\
c. & \quad \left( \frac{-(1-.554) \times 21}{-(1-.554) \times 21 + 19.914 \times (1-.448)} \right) \times .7 \\
D. & \quad \left( \frac{-(1-.7102) \times 21}{-(1-.7102) \times 21 + 19.914 \times (1-.6730)} \right) \times .7 \\
e. & \quad \left( \frac{-(1-.7102) \times 21}{-(1-.7102) \times 21 + 19.914} \right) \times .7 \\
\end{align*}
\]

4. Assume you are planning to value a put on Microsoft that expires in 3 months using the Black-Scholes Option Pricing Model. What rate should you use to calculate the present value of K if you plan to exercise the put in 2 months?

A. the return on a 3-month Treasury
b. the return on a 2-month Treasury
c. the return on a 1-month Treasury bill
d. the return on a 1-year Treasury bill
e. the required return (using the CAPM) on Microsoft stock
5. CitiDivide Inc’s stock price currently equals $8 per share and is expected to equal either $5 or $12 per share a year from today. Calculate $\Delta$ you would use in determining the value of a put with a $10 strike price that expires one year from today if the risk-free interest rate is 4%.

   a. – 0.2857  
   b. – 0.4286  
   C. – 0.7143  
   d. – 0.5714  
   e. none of the above

6. Assume that you have calculated the value of Chrysis Motors’ stock as equaling $50 million by viewing the stock as a call on Chrysis’ assets. In your calculations, you used the following data: the debt matures for $330 million in 7 years and has a current market value of $150 million; the risk-free rate on a 7-year Treasury is 2%; the calculated values for $d_1$ is 0.0803 and for $d_2$ is – 0.8548. Calculate the beta of Chrysis’ debt if the beta on its assets is 0.52.

   a. 0.56  
   b. 0.69  
   C. 0.32  
   d. 0.64  
   e. 0.28

7. Assume that in valuing a two-period option using the binomial option pricing model you have determined that at time $t = 0$, $\Delta$ equals 0.6743 and that B equals -10.4558. If at $t = 1$, the stock price rises from its current $21 to $27, then $\Delta$ will equal 1 and B will equal -19.5122. If the risk-free rate of interest is 2.5%, how will you need to change your borrowing at $t = 1$?

   a. short-sell risk-free bonds worth $19.03  
   b. short-sell risk-free bonds worth $9.06  
   C. short-sell risk-free bonds worth $8.80  
   d. buy and return all bonds that have sold short  
   e. sort-sell bonds worth $8.58