

Problem Set

PROBLEM SET: Derivatives

Exercise 1.

Call option [4]

A stock's current price is \$160, and there are two possible prices that may occur next period: \$150 or \$175. The interest rate on risk-free investments is 6% per period.

1. Assume that a (European) call option exists on this stock having an exercise price of \$155.
 - (a) How could you form a portfolio based on the stock and the call so as to achieve a risk-free hedge?
 - (b) Compute the price of the call.
2. Answer the above two questions if the exercise price was \$180.

Exercise 2.

Explain the meanings of the following financial terms:

- a. Option
- b. Expiration date
- c. Strike price
- d. Call
- e. Put

Exercise 3.

Explain the difference between a long position in a put and a short position in a call.

Exercise 4.

You own a call option on Intuit stock with a strike price of \$40. The option will expire in exactly three months' time.

- a. If the stock is trading at \$55 in three months, what will be the payoff of the call?
- b. If the stock is trading at \$35 in three months, what will be the payoff of the call?
- c. Draw a payoff diagram showing the value of the call at expiration as a function of the stock price at expiration.

Exercise 5.

You own a put option on Ford stock with a strike price of \$10. The option will expire in exactly six months' time.

- a. If the stock is trading at \$8 in six months, what will be the payoff of the put?
- b. If the stock is trading at \$23 in six months, what will be the payoff of the put?
- c. Draw a payoff diagram showing the value of the put at expiration as a function of the stock price at expiration.

Exercise 6.

You own a share of Costco stock. You are worried that its price will fall and would like to insure yourself against this possibility. How can you purchase insurance against this possibility?

Exercise 7.

You are watching the option quotes for your favorite stock, when suddenly there is a news announcement. Explain what type of news would lead to the following effects:

- a. Call prices increase, and put prices fall.
- b. Call prices fall, and put prices increase.
- c. Both call and put prices increase.

Exercise 8.

Wesley Corp. stock is trading for \$25/share. Wesley has 20 million shares outstanding and a market debt-equity ratio of 0.5. Wesley's debt is zero-coupon debt with a 5-year maturity and a yield to maturity of 10%.

- a. Describe Wesley's equity as a call option. What is the maturity of the call option? What is the market value of the asset underlying this call option? What is the strike price of this call option?
- b. Describe Wesley's debt using a call option.

c. Describe Wesley's debt using a put option.

Exercise 9.

The current price of Estelle Corporation stock is \$25. In each of the next two years, this stock price will either go up by 20% or go down by 20%. The stock pays no dividends. The one-year risk-free interest rate is 6% and will remain constant. Using the Binomial Model, calculate the price of a one-year call option on Estelle stock with a strike price of \$25.

Exercise 10.

Roslin Robotics stock has a volatility of 30% and a current stock price of \$60 per share. Roslin pays no dividends. The risk-free interest is 5%. Determine the Black-Scholes value of a one-year, at-the-money call option on Roslin stock.

Exercise 11.

[1]

Which of the following statements is true?

- A) Call options are issued by corporations and bought by investors.
- B) Call options are issued by investors and bought by corporations.
- C) Call options are issued by investors and bought by investors.
- D) Put options are issued by corporations and bought by investors.
- E) Both B and D.

Exercise 12.

[3]

An out-of-the-money call option is one that

- A) has an exercise price below the current market price of the underlying security.
- B) should not be exercised.
- C) has an exercise price above the current market price of the underlying security.
- D) Both A and B.
- E) Both B and C.

Exercise 13.

[3]

A stock has both a call and a put option outstanding. The exercise price was set equal to the stock price. If the option were to expire now what would be the minimum value of the call and the put respectively?

- A) $(S_T - E); \geq 0$
- B) $0; (S_T - E)$
- C) $<0; >0$
- D) $0; 0$
- E) $(E - S_T); (S_T - E)$

Exercise 14.

[1]

A stock is selling for \$31. There is a call option on the stock with an exercise price of \$27. What is the approximate minimum value of the call option?

- A) \$ 0
- B) \$ 4
- C) \$27
- D) \$31
- E) Cannot determine without knowing the time to expiration.

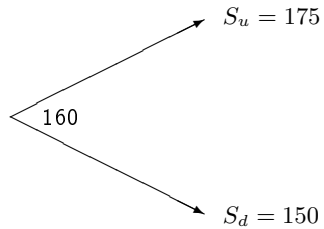
Solutions

PROBLEM SET: Derivatives

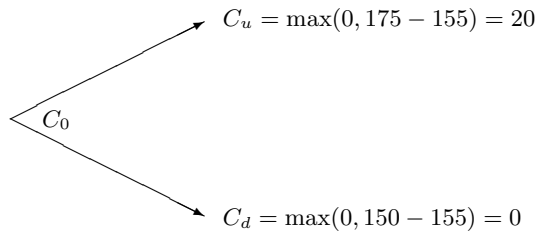
Solution to Exercise 1.

Call option [4]

1. We have the following payoff next period:



Call option with exercise price 155.



2. How to get a risk free hedge by buying m call options? Need payoff in each period to be equal

$$S_d + mC_d = S_u + mC_u$$
$$m = \frac{S_d - S_u}{C_u - C_d} = \frac{150 - 175}{20 - 0} = -1.25$$

Need to sell 1.25 options to create a risk free hedge.

3. To price the option, we find the parameters of the binomial option pricing model. Start by finding u and d :

$$S_u = uS_0 = u160 = 175$$

$$S_d = dS_0 = d160 = 150$$

Solve for u and d :

$$u = \frac{175}{160} = 1.09375$$

$$d = \frac{150}{160} = 0.9375$$

Then find the "risk-neutral" probabilities:

$$q = \frac{(1 + r_f) - d}{u - d} = \frac{1.06 - 0.9375}{1.09375 - 0.9375} = \frac{0.087}{0.127} = 0.784$$

Finding terminal payoffs

$$C_u = \max(S_u - K, 0) = \max(175 - 155, 0) = 20$$

$$C_d = \max(S_d - K, 0) = \max(150 - 155, 0) = 0$$

Then find price

$$C_0 = \frac{qC_u + (1 - q)C_d}{1 + r_f} = \frac{0.784 \cdot 20}{1.06} = 14.79$$

4. With an exercise price of 180, the call will never be exercised. It is worthless.

Solution to Exercise 2.

- a. Option: An option is a contract that gives one party the right, but not the obligation, to buy or sell an asset at some point in the future.
- b. Expiration date: The last date on which the holder still has the right to exercise the option. If the option is American, the right can be exercised until the exercise date; if it is European, the option can be exercised only on the exercise date.
- c. Strike price: the price at which the holder of the option has the right to buy or sell the asset.
- d. Call: An option that gives its holder the right to buy an asset.
- e. Put: An option that gives its holder the right to sell an asset.

Solution to Exercise 3.

When a party has a long position in a put, it has the right to sell the underlying asset at the strike price; when it has a short position in a call, it has the obligation to sell the underlying asset at the strike price if exercised. These are clearly different positions.

Solution to Exercise 4.

Long call option: value at expiration:

- a. \$15
- b. 0\$
- c. Draw graph

Solution to Exercise 5.

Long put value at expiration:

- a. \$2
- b. \$0
- c. Draw payoff diagram

Solution to Exercise 6.

To protect against a fall in the price of Costco, you can buy a put with Costco as the underlying asset. By doing this, over the life of the option you are guaranteed to get at least the strike price from selling the stock you already have.

Solution to Exercise 7.

- a. Good news about the stock, which raises its stock price
- b. Bad news, which lowers the stock's price
- c. News that increases the volatility of the stock

Solution to Exercise 8.

- a. Maturity = 5 years
Assets = E + D = \$25 per share × 20 million shares + .5(\$25 × 20) = \$500 + 250 = \$750 million
The market value of the asset underlying this call option is \$750.00 million.
The strike price is equal to the debt. Therefore,
Face Value of Debt = 0.50 × (\$25 per share × 20 million shares) × (1+0.1)⁵ = \$402.63 million
The strike price of this call option is \$402.63 million.
- b. Long the firm's assets and short the equity call option above
- c. Long risk-free debt and short a put option on Wesley's assets with a 5-yr maturity and \$402.63 million face value

Solution to Exercise 9.

In this case, the stock price either rises to $S_u = 25 \times 1.20 = 30$ or falls to $S_d = 25 \times 0.80 = 20$. The option payoff is therefore either $C_u = 5$ or $C_d = 0$. The replicating portfolio is $\Delta = (5 - 0)/(30 - 20) = 0.5$ and $B = (0 - 20 \times 0.5)/1.06 = -9.43$.
Therefore, $C = 0.5 \times 25 - 9.43 = \3.07 .

Solution to Exercise 10.

BS value = \$8.50

Solution to Exercise 11.

- [1]
- C

Solution to Exercise 12.

- [3]
- E

Solution to Exercise 13.

[3]

D

Solution to Exercise 14.

[1]

B Rationale: