

Chapter 21: Options and Corporate Finance

- 21.1 a. An option is a contract which gives its owner the right to buy or sell an underlying asset at a fixed price on or before a given date.
- b. Exercise is the act of buying or selling the underlying asset under the terms of the option contract.
- c. The strike price is the fixed price at which the option holder can buy or sell the underlying asset. The strike price is also called the exercise price.
- d. The expiration date is the maturity date of the option. It is the last date on which an American option can be exercised. It is the only date on which a European option can be exercised.
- e. A call is an option contract, which gives its owner the right to buy an underlying asset at a fixed price on or before a given date.
- f. A put is an option contract, which gives its owner the right to sell an underlying asset at a fixed price on or before a given date.

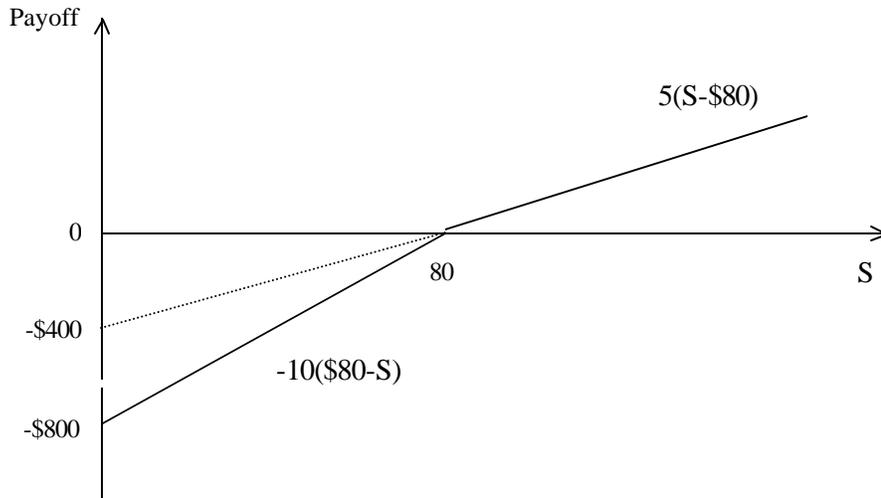
21.2 American options can be exercised on any date up to and including the exercise date. A European option can be exercised only on the expiration date.

21.3 The lower bound of the value of the put is $\text{Max}\{E - S, 0\} = \$40 - \$35 = \5 . Since the option is selling for \$4.5, the best strategy is (1) buy more put options at \$4.5 and (2) exercise them to get arbitrage.

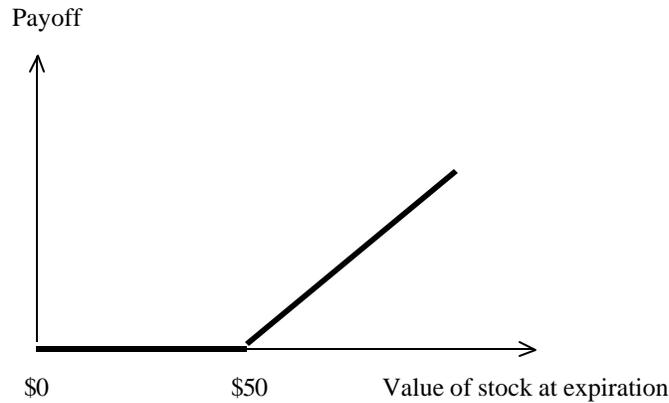
- 21.4 a. It can be exercised on any date up to and including the expiration date.
- b. It can be exercised only on February 18 of next year.
- c. The option is not worthless.

21.5 Payoff

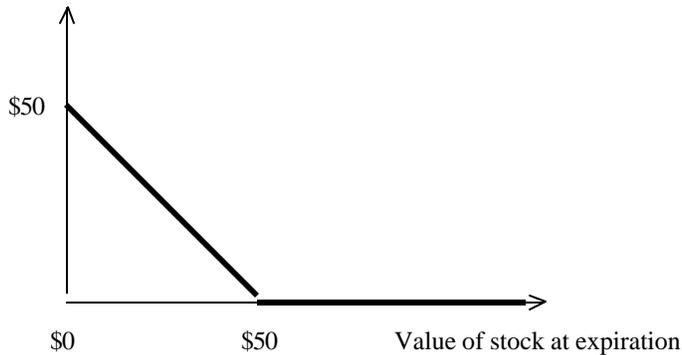
	$S < \$80$	$S = \$80$	$S > \$80$
Short 10 puts	$-10(\$80 - S)$	\$0	0
Long 5 calls	\$0	\$0	$5(S - \$80)$
Total payoff	$-10(\$80 - S)$	\$0	$5(S - \$80)$



- 21.6 a. Payoff = $\$55 - \$50 = \$5$
 b. Payoff = $\max \{ \$45 - \$50, \$0 \} = \0
 c.



- 21.7 a. Payoff = $\$0$
 b. Payoff = $\$50 - \$45 = \$5$
 c.

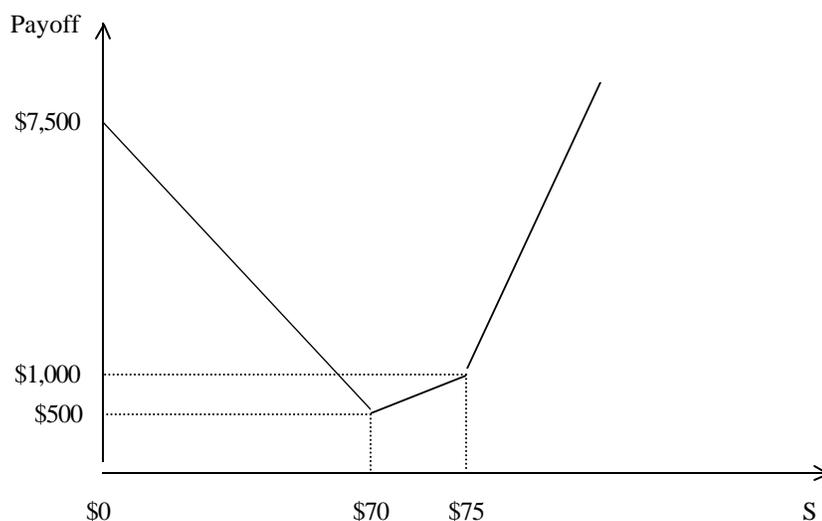


- 21.8 a.

	$S = \$65$	$S = \$72$	$S = \$80$
Long 2 calls	\$0	$200(\$72 - \$70) = \$400$	$200(\$80 - \$70) = \$2,000$
Long 1 put	$100(\$75 - \$65) = \$1,000$	$100(\$75 - \$72) = \$300$	\$0
Total payoff	\$1,000	\$700	\$2,000

- b.

	$S < \$70$	$\$70 < S < \75	$S \geq \$75$
Long 2 calls	\$0	$200(S - \$70)$	$200(S - \$70)$
Long 1 put	$100(\$75 - S)$	$100(\$75 - S)$	\$0
Total payoff	$100(\$75 - S)$	$100(S - \$65)$	$200(S - \$70)$



- 21.9 a. You would exercise the call option contract by paying the strike price of \$100/share and receiving stock worth \$130 / share. The total profit from the contract is $(\$130 - 100) \times 100 = \$3,000$.
- b. If the stock price is lower than the strike price, the option will be expired unexercised.

21.10 Assume the options will expire in one year, apply the put-call parity formula.

$$S + P - C = PV(E)$$

$$S = -\$2 + \$8 + \$40 / 1.1$$

$$= \$42.36$$

- 21.11 a. To eliminate the risk of the put, sell a call and buy stock. Buying stock makes stock available to you in the event that its price falls. If the price falls below the exercise price, the put will be exercised against you. The call provides additional income if the price of the stock rises above the exercise price. The combination, buy stock, buy a put and sell a call, ensures that the net payoff is the same whether the stock price rises to \$172 or falls to \$138.

b. Payoffs at expiration

	S = \$172	S = \$138
Buy stock	\$172	\$138
Buy put	expires	give up stock worth \$138, receive \$160
Sell call	give up stock worth \$172, receive \$160	
Net payoff	\$160	\$160

- 21.12 a. You should buy the call and exercise it immediately.
- b. Profit = $(\$60 - \$50) - \$8 = \2
- c. The lower bound on the price of American calls is
[Stock price - Exercise price].
- d. Upper bound = stock price because no one would be willing to pay more than the stock price for the right to receive the stock.

21.13 Factors determining the value of an American call:

1. Strike price: The value of an American call must be at least the difference between the stock price and the exercise price $[S - E]$. For a given stock price, a higher exercise price will reduce the value of the call.
2. Expiration date: The time to expiration of a call affects the price of the option. Compare two calls, which are identical except for the time to expiration. The longer term option has all the rights and benefits of the shorter term option, plus more. It has all of those benefits and rights for a longer period of time. Thus, as the time to expiration increases, the value of the call increases.
3. Stock price: The value of an American call must be at least the difference between the stock price and the exercise price $[S - E]$. For a given exercise price, a higher stock price will increase the value of the call.
4. Variability of the price of the underlying asset: The higher the variability of the price of the underlying asset is, the higher is the probability that the call will be in the money at the expiration date. Thus, higher variability of the asset's price will enhance the option's value.
5. Interest rate: If you buy a call, you do not have to pay the strike price until the expiration date. The delay in the payment has value. As interest rates rise, the delayed payment has more value. To convince yourself, consider what else you can do with the strike price until the expiration date (your opportunity cost). You can put that money in an account and earn interest on the amount until the expiration date. If the interest rate increases, you will earn more interest.

21.14 Factors determining the value of an American put:

1. Strike price: The value of an American put must be at least the difference between the exercise price and the stock price $[E - S]$. For a given stock price, a higher exercise price will increase the value of the put.
2. Expiration date: The time to expiration of a put affects the price of the option. Compare two puts which are identical except for the time to expiration. The longer term option has all the rights and benefits of the shorter term option, plus more. It has all of those benefits and rights for a longer period of time. Thus, as the time to expiration increases, the value of the put increases.
3. Stock price: The value of an American put must be at least the difference between the exercise price and the stock price $[E - S]$. For a given exercise price, a higher stock price will reduce the value of the put.
4. Variability of the price of the underlying asset: The higher the variability of the price of the underlying asset is, the higher is the probability that the put will be in the money at the expiration date. Thus, higher variability of the asset's price will enhance the option's value.

5. Interest rate: If you buy a put, you have the right to sell the stock for a fixed price in the future. The present value of the delayed receipt decreases as the interest rate rises. Thus, if the interest rate rises, the value of the put will fall.
- 21.15 a. An increase in the risk of the stock implies an increase in the volatility of the stock price. As the volatility of the stock price rises, the value of a call increases. Call holders gain only if the stock price is greater than the exercise price. Call holders do not lose if the stock price is less than the exercise price. The volatility increases the probability that the call will be in the money.
- b. An increase in the risk of the stock implies an increase in the volatility of the stock price. As the volatility of the stock price rises, the value of a put increases. Put holders gain only if the stock price is less than the exercise price. Put holders do not lose if the stock price is greater than the exercise price. The volatility increases the probability that the put will be in the money.
- 21.16 Value the call by examining the value of the investment combination, which duplicates the payoffs of the call. The investment strategy, which duplicates the payoffs of the call, is buy stock and borrow money.

Payoffs of buying a call:	$S_T = \$120$	$S_T = \$95$
Call (A contract covers 100 shares) Payoff	100 (\$120 - \$112) = \$800	Expires = \$0
Payoffs of the strategy:		
Buy 32 shares of the stock	$32 \times \$120$ = \$3,840	$32 \times \$95$ = \$3,040
Borrow \$3,012.26*	-\$3,040	-\$3,040
Net payoff	\$800	\$0

* The net payoffs of the duplicating strategy must be the same as the payoffs of the call. To have the payoff be \$800 when the stock price is \$120, the repayment of the loan and its interest must be \$3,040. If the annual interest rate is 10%, then the interest rate applicable for the five week life of the call is $(1.10)^{5/52} - 1 = 0.00921$. Thus, the amount which you must borrow to be sure you repay \$3,040 is \$3,012.26 [= \$3,040 / 1.00921].

To prevent arbitrage, the value of the call must be equal to the value of setting up this strategy. The cost today of purchasing 32 shares of stock is $32 \times \$96 = \$3,072$. In addition you will borrow \$3,012.26. The borrowing generates a cash inflow. The cost of establishing this strategy is $\$3,072 - \$3,012.26 = \$59.74$. \$59.74 is the cost of setting up a strategy, which duplicates the contract. Since the contract covers 100 shares, each call is worth $\$0.5974$ [= $\$59.74 / 100$].

21.17

Payoff at expiration	$S = \$25$	$S = \$35$
1. Call	\$0	$\$3 \times 100 = \300

2. Stock (N shares)	25 N	\$35N
Borrow (\$25N/1.05)	-25 N	-\$25N
Net payoff	<u>\$0</u>	<u>\$10N</u>

Duplicating amount = $\$25 N / 1.05$

where $\$10 N = \300

$N = 30$ shares

Borrow $\$25 \times 30$ shares / 1.05 = \$714.29.

Thus, buying one call contract

= (1) buy 30 shares of stock	\$900
(2) borrow \$714.29	<u>-\$714.29</u>
	\$185.71

Call option value = \$185.71

Call price per share = \$1.857

From put-call parity,

$$\begin{aligned}
 P &= C + PV(E) - S \\
 &= \$1.857 + \$32 / 1.05 - \$30 \\
 &= \$2.333
 \end{aligned}$$

21.18

Payoff at expiration	$S_T = \$40$	$S_T = \$60$
1. Call	\$0	100 (\$60 - \$50) = \$1,000
2. Buy N shares	\$40N	\$60N
Borrow	<u>-\$40N</u>	<u>-\$40N</u>
Net payoff	\$0	\$20N

To equate, $\$20N = \$1,000$

$N = 50$ shares

Thus, borrowing amount = $\$40 \times 50 / 1.09 = \$1,834.86$

Call value = Value of 50 shares + Borrowing \$1,834.86

$$= 50 \times \$55 - \$1,834.86$$

$$= \$915.14$$

Each call is worth \$9.1514.