

## Options Markets: Introduction

Chapter 20

## Option Contracts

- **call option** = contract that gives the holder the right to *purchase* an asset at a specified price, on or before a certain date
- **put option** = contract that gives the holder the right to *sell* an asset at a specified price, on or before a certain date
- key feature: the holder is *not* required to exercise the option, but can *choose* to do so or not → the holder has to pay for this right
- the holder has a *long* position in the option, the seller of the option has the *short* position

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## Key Elements of Options

- **exercise (strike) price** = the price at which the asset is traded when the option is exercised
- **expiration date** = the last date the option can be exercised on
- **premium** = purchase price of option (paid when the option is purchased, regardless of whether the option is exercised or not)
- **writer** = person initially selling the option
- **American option** = the holder can exercise the option any time *on or before* the expiration date
- **European option** = the holder can exercise the option *only* on the expiration date

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## “Moneyness”

- **in the money** = the option is worth exercising
- **out the money** = the option is not worth exercising
- **at the money** = the holder is indifferent between exercising the option or not
- the moneyness of an option is given by the relationship between the exercise price and the current price of the stock and the type of option
- moneyness is not related to *positive* profits, but to whether the option is exercised or not

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## Underlying Assets

- stock options are the common options
- **index options** = options based on the value of an index → the execution is done by cash settlement
- **futures options** = the holder has the right to buy or sell a specified futures contract, with the price of the futures as exercise price
- **foreign currency options** = the holder can buy or sell a certain sum of foreign currency for a certain sum of domestic currency
- **interest rate options** = options based on debt securities

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## Call Options

- Value at expiration (payoff)
  - a call option will be executed only if the exercise price is lower than the ongoing price of the stock
  - hence, the value of the option at expiration is

$$\text{Payoff to call holder} = \begin{cases} S_T - X, & \text{if } S_T > X \\ 0, & \text{if } S_T \leq X \end{cases}$$

where  $S_T$  is the “current price” of the stock, and  $X$  is the exercise price

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## Call Options (cont.)

### ■ Moneyness

- a call option is
  - *in the money* – if the exercise price is below the current price
  - *out the money* – if the exercise price is above the current price
  - *at the money* – if the exercise price is equal to the current price

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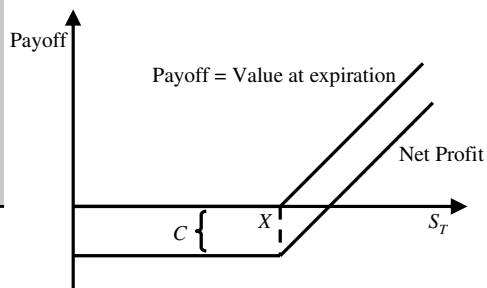
## Call Options (cont.)

### ■ Profits

- for the holder of the call option, the net profit is  
Profit = Value at expiration – Premium ( $C$ )
- notice that the holder might not get positive profit even if the option is exercised
- for the writer of the call option, the value at expiration and net profit are exactly the opposite those of the holder  
Profit of writer = – Profit of holder
- writing a *naked call* (i.e., a call option without an offsetting position in the stock) exposes the investor to unlimited losses if stock price rises

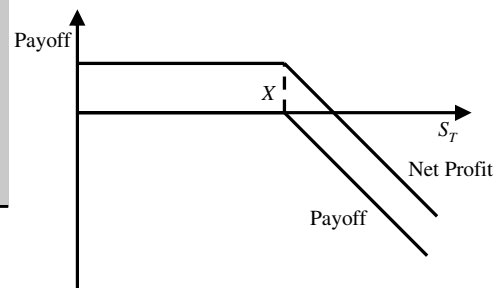
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## Call Options – Holder



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## Call Options – Writer



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## Call Options – Example

- strike price:  $X = \$100$
- premium: \$15

| Value of stock ( $S_T$ ) | Payoff | Profit for holder | Profit for writer |
|--------------------------|--------|-------------------|-------------------|
| \$90                     | \$0    | –\$15             | \$15              |
| \$100                    | \$0    | –\$15             | \$15              |
| \$110                    | \$10   | –\$5              | \$5               |
| \$120                    | \$20   | \$5               | –\$5              |

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## Put Options

### ■ Value at expiration (payoff)

- a put option will be executed only if the exercise price is higher than the ongoing price of the stock
- hence, the value of the option at expiration is

$$\text{Payoff to put holder} = \begin{cases} 0, & \text{if } S_T > X \\ X - S_T, & \text{if } S_T \leq X \end{cases}$$

where  $S_T$  is the “current price” of the stock, and  $X$  is the exercise price

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## Put Options (cont.)

- **Moneyness**
  - a put option is
    - *in the money* – if the exercise price is above the current price
    - *out the money* – if the exercise price is below the current price
    - *at the money* – if the exercise price is equal to the current price

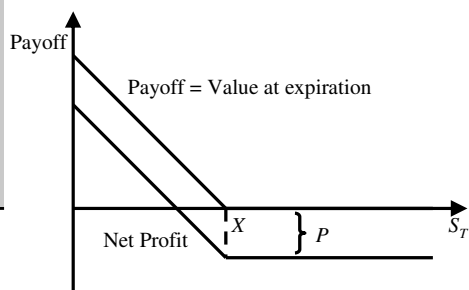
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## Put Options (cont.)

- **Profits**
  - for the holder of the put option, the net profit is  
Profit = Value at expiration – Premium ( $P$ )
  - for the writer of the put option, the value at expiration and net profit are exactly the opposite those of the holder  
Profit of writer = – Profit of holder
  - writing a *naked put* (i.e., a put option without an offsetting short position in the stock) exposes the investor to losses if the stock price falls

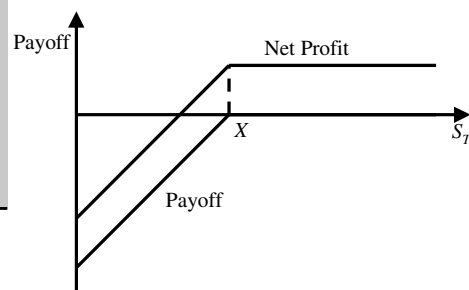
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## Put Options – Holder



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## Put Options – Writer



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## Put Options – Example

- strike price:  $X = \$100$
- premium: \$15

| Value of stock ( $S_T$ ) | Payoff | Profit for holder | Profit for writer |
|--------------------------|--------|-------------------|-------------------|
| \$80                     | \$20   | \$5               | –\$5              |
| \$90                     | \$10   | –\$5              | \$5               |
| \$100                    | \$0    | –\$15             | \$15              |
| \$110                    | \$0    | –\$15             | \$15              |

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## Investments in Options

- purchasing call options or writing put options are *bullish* strategies (i.e., provide profits when stock prices increase)
- writing call options or purchasing put options are *bearish* strategies (i.e., provide profits when stock prices fall)
- as opposed to stock investments, investments in options provide better hedging opportunities
- also, remember that quotations and information about options are given *per share*, but an option contract is usually written for 100 shares

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## Option Strategies

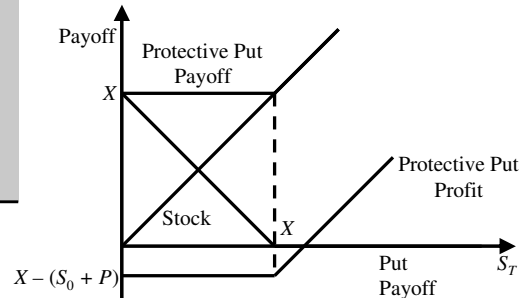
### Protective Put

- buy a stock and a put option on the stock at the same time
- used to limit loss to a certain level (portfolio insurance) → used for *risk management*
- value of protective put at expiration:

|                 | $S_T \leq X$ | $S_T > X$ |
|-----------------|--------------|-----------|
| Payoff of stock | $S_T$        | $S_T$     |
| Payoff of put   | $X - S_T$    | 0         |
| Total payoff    | $X$          | $S_T$     |

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## Protective Put – Profit of Holder



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## Option Strategies (cont.)

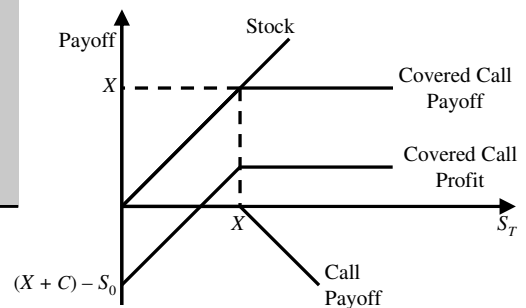
### Covered Call

- buy a stock and sell a call option on the stock at the same time
- used for downside protection, at the expense of giving up gain potential
- value of protective put at expiration:

|                 | $S_T \leq X$ | $S_T > X$    |
|-----------------|--------------|--------------|
| Payoff of stock | $S_T$        | $S_T$        |
| Payoff of call  | 0            | $-(S_T - X)$ |
| Total payoff    | $S_T$        | $X$          |

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## Covered Call – Profit of Holder



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## Option Strategies (cont.)

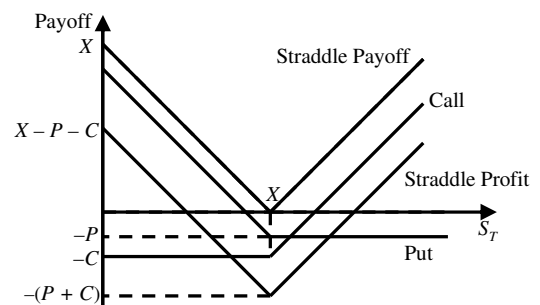
### Straddle

- buy a call and a put option on the same stock, with same exercise price and same expiration date
- used if price is believed to change, but direction of change is unknown (bet on volatility)
- value of straddle at expiration:

|                | $S_T \leq X$ | $S_T > X$ |
|----------------|--------------|-----------|
| Payoff of call | 0            | $S_T - X$ |
| Payoff of put  | $-(S_T - X)$ | 0         |
| Total payoff   | $X - S_T$    | $S_T - X$ |

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## Straddle – Profit of Holder



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## Option Strategies (cont.)

- Spreads
  - combinations of two or more call options (or put options) on the same stock, with different exercise prices or expiration dates
  - *money spread* = difference between options is exercise price
  - *time spread* = difference between options is expiration date

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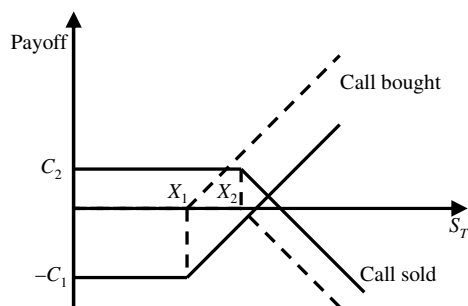
## Example of Spread

- money spread: buy a call option with exercise price  $X_1$  and sell a call option with exercise price  $X_2 > X_1$
- bullish spread - payoff is either increased or unaffected by stock price increases
- value of spread at maturity:

|                     | $S_T \leq X_1$ | $X_1 < S_T \leq X_2$ | $S_T > X_2$    |
|---------------------|----------------|----------------------|----------------|
| Payoff of call 1    | 0              | $S_T - X_1$          | $S_T - X_1$    |
| Payoff of call 2    | 0              | 0                    | $-(S_T - X_2)$ |
| <b>Total payoff</b> | 0              | $S_T - X_1$          | $X_2 - X_1$    |

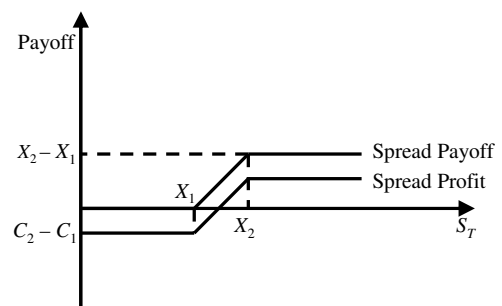
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## Spread – Calls Profits and Payoffs



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## Spread – Profit of Holder



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## Option Strategies (cont.)

- Collar
  - options strategy that brackets the value of an existing portfolio between two bounds
  - used if a target wealth is set, and losses need to be limited
  - a lower bound can be placed by buying a put option → need to pay a premium → to recover the money paid for premium, write a call option (with higher exercise price)
  - the protection against downside risk is obtained by giving up the gain potential from price increases

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## Example of Collar

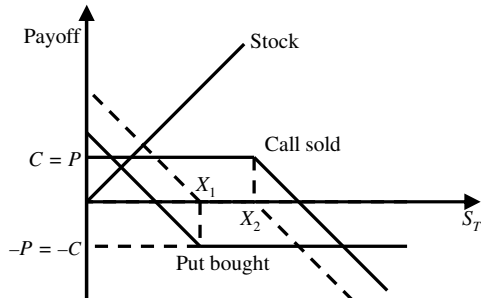
- you already hold stock, so buy a put option on the same stock with exercise price  $X_1$  and sell a call option with exercise price  $X_2 > X_1$
- value of collar at maturity:

|                     | $S_T \leq X_1$ | $X_1 < S_T \leq X_2$ | $S_T > X_2$    |
|---------------------|----------------|----------------------|----------------|
| Payoff of stock     | $S_T$          | $S_T$                | $S_T$          |
| Payoff of put       | $X_1 - S_T$    | 0                    | 0              |
| Payoff of call      | 0              | 0                    | $-(S_T - X_2)$ |
| <b>Total payoff</b> | $X_1$          | $S_T$                | $X_2$          |

- notice that the payoff and the profit of the holder are equal, since the premiums cancel out

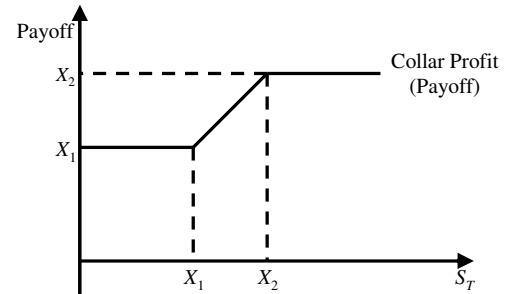
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## Collar – Calls Profits and Payoffs



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## Collar – Profit of Holder



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## Put-Call Parity Relationship

- an alternative strategy that provides the same type of protection as a protective put is a call with same expiration date and strike price  $X$  and a riskless bond with face value equal to  $X$
- value of investment at maturity:

|                | $S_T \leq X$ | $S_T > X$ |
|----------------|--------------|-----------|
| Payoff of call | 0            | $S_T - X$ |
| Payoff of bond | $X$          | $X$       |
| Total payoff   | $X$          | $S_T$     |

- this is exactly the same payoff pattern as the protective put

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## Put-Call Parity Relationship (cont.)

- arbitrage argument: if two investments always have the same value, they should have the same price
- the price of the protective put is the sum of put premium and stock price at time 0
- the price of the call + bond investment is the sum of the call premium and the present discounted value of the bond (i.e., of  $X$ )
- hence,

$$C + \frac{X}{(1+r_f)^T} = S_0 + P$$

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## Put-Call Parity Relationship (cont.)

- this relationship is called the *put-call parity theorem*
- notice that it applies only to European options, because they are exercised only at maturity
- it can be generalized to include dividends paid on the underlying stock:
 
$$P = C - S_0 + PV(X) + PV(\text{Dividends})$$
- if it fails – arbitrage opportunity (create the other investment and profit from the price difference)

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## Exotic Options

- Asian options* = payoff depends on average price of underlying asset during some portion of the life of the option
- barrier options* = payoff depends not only on price at expiration, but also on whether the price has crossed through some barrier
- lookback options* = payoffs depend in part on the min or max price during the life of the option
- currency-translated options* = asset or exercise prices denominated in foreign currency
- binary options* = payoffs depends on whether the price satisfies a certain condition or not

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