LECTURE 8

An Introduction to Option Markets

EC3333 Financial Economics I

Learning Objectives

- Calculate potential profits resulting from various option trading strategies.
- Formulate portfolio management strategies to modify the risk-return profiles of the portfolio.
- Understand and apply the put-call parity relationship.

Options Overview

- Are **derivative securities** (a.k.a. derivatives for short) that get their value from the price of other securities
- Are also called contingent claims because their payoffs are contingent on the prices of other securities
- Powerful tools for hedging or speculation

Options Overview

- Options are traded both on organized exchanges and OTC
- Chicago Board Options Exchange (CBOE) began listing call options in 1973
- Standardization of the terms of listed option contracts increases market depth and lowers trading costs
- Over-the-counter (OTC) market
- An informal network of brokers and dealers who negotiate sales of securities (not a formal exchange)
- A market without a physical location in which dealers are connected by computers and telephones

Call Option

- A call option gives its holder the **right to buy** an asset:
  - At the exercise price (X) or strike price (K)
  - On or before the expiration date
- It's a right. Not an obligation
- So exercise the option only if it is profitable to do so
- **Exercise** the option to buy the underlying asset
  - **if market value > strike price**

Put Option

- A put option gives its holder the **right to sell** an asset:
  - At the exercise price (X) or strike price (K)
  - On or before the expiration date
- It's a right. Not an obligation
- So exercise the option only if it is profitable to do so
- **Exercise** the option to sell the underlying asset
  - **if market value < strike price**

The Option Contract

- The purchase price of the option is called the premium
- Option Writer: the seller of an option contract
- Sellers (writers) of options receive premium income
- If the option buyer (holder) exercises the option, the option writer must make (for call) or take (for put) delivery of the underlying asset

Market and Exercise Price Relationships

- **In the Money** – immediate exercise of the option produces a positive cash flow
  - Call: exercise price < current asset price
  - Put: exercise price > current asset price

- **Out of the Money** – immediate exercise of the option would not be profitable
  - Call: current asset price < exercise price
  - Put: current asset price > exercise price

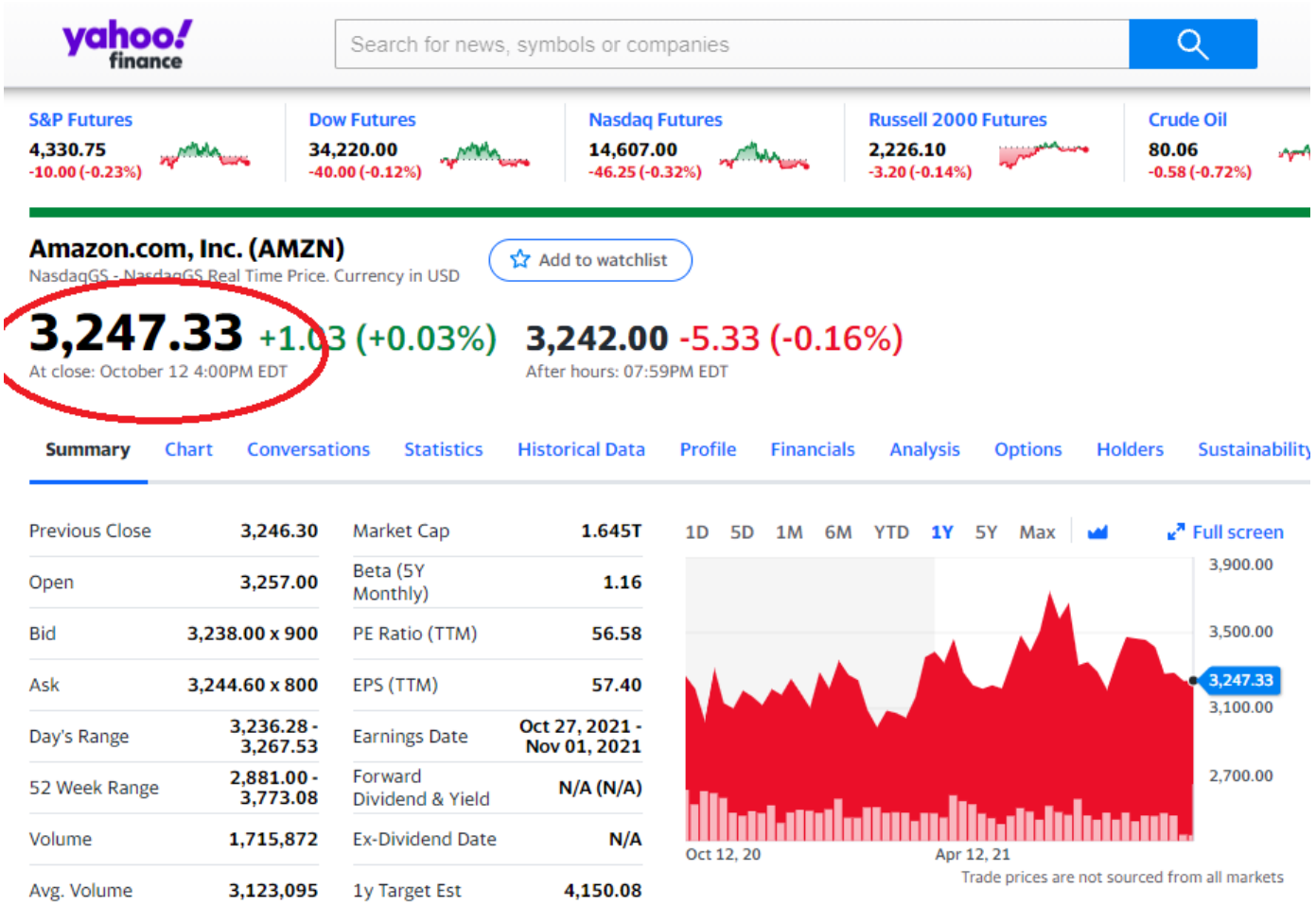
- **At the Money** - exercise price and current asset price are equal

Market and Exercise Price Relationships

- **Deep In-the-money**
  - Describes an option that is in-the-money and for which the strike price and the stock price are very far apart
- **Deep Out-of-the-money**
  - Describes an option that is out-of–the-money and for which the strike price and the stock price are very far apart

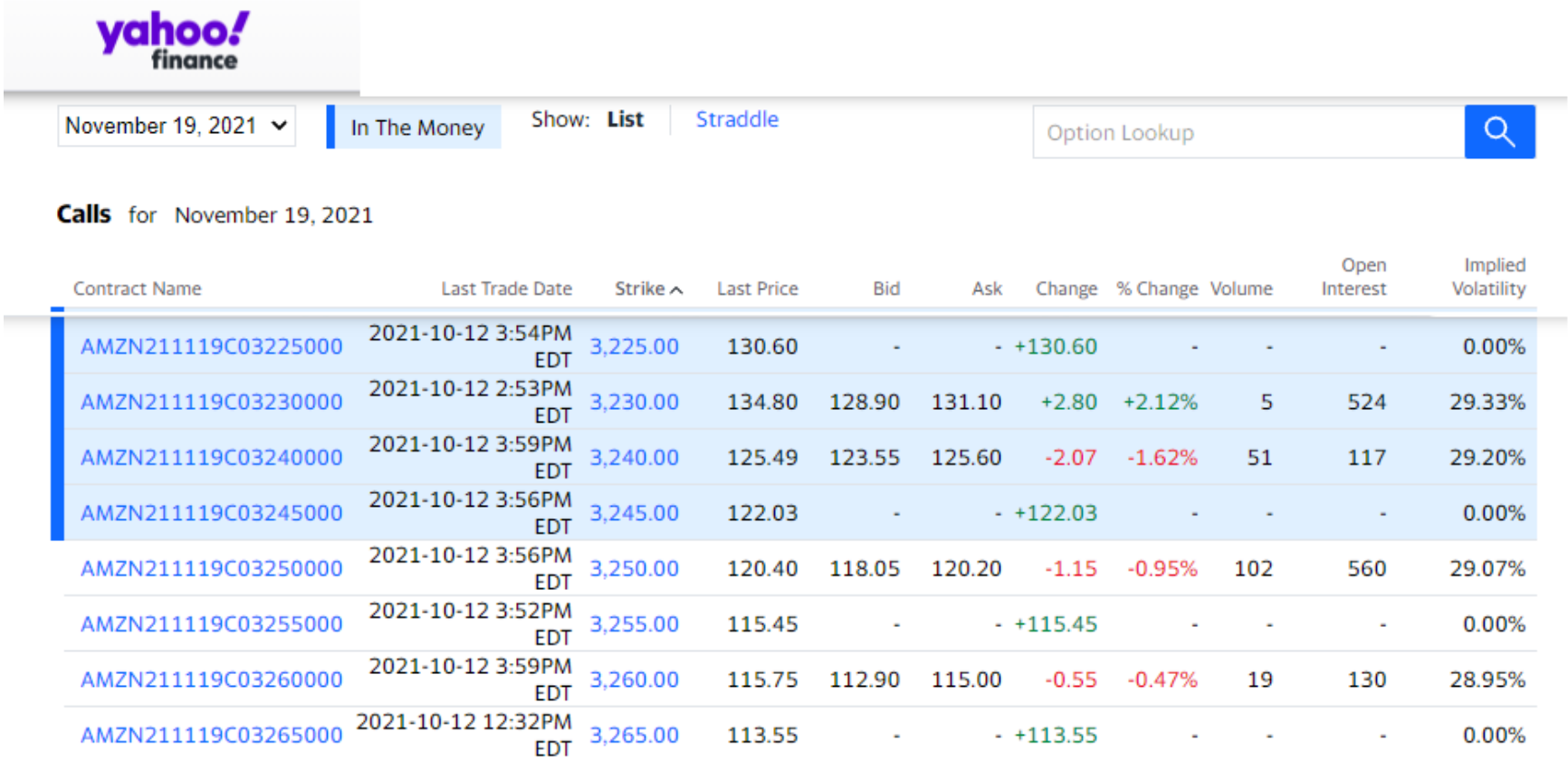
Price of stock options on Amazon

- Underlying stock price
- Source: https://finance.yahoo.com/quote/AMZN?p=AMZN



Price of stock options on Amazon

- Call options on Amazon
- Source: https://finance.yahoo.com/quote/AMZN?p=AMZN



yahoo! finance

November 19, 2021 | In The Money | Show: List | Straddle | Option Lookup

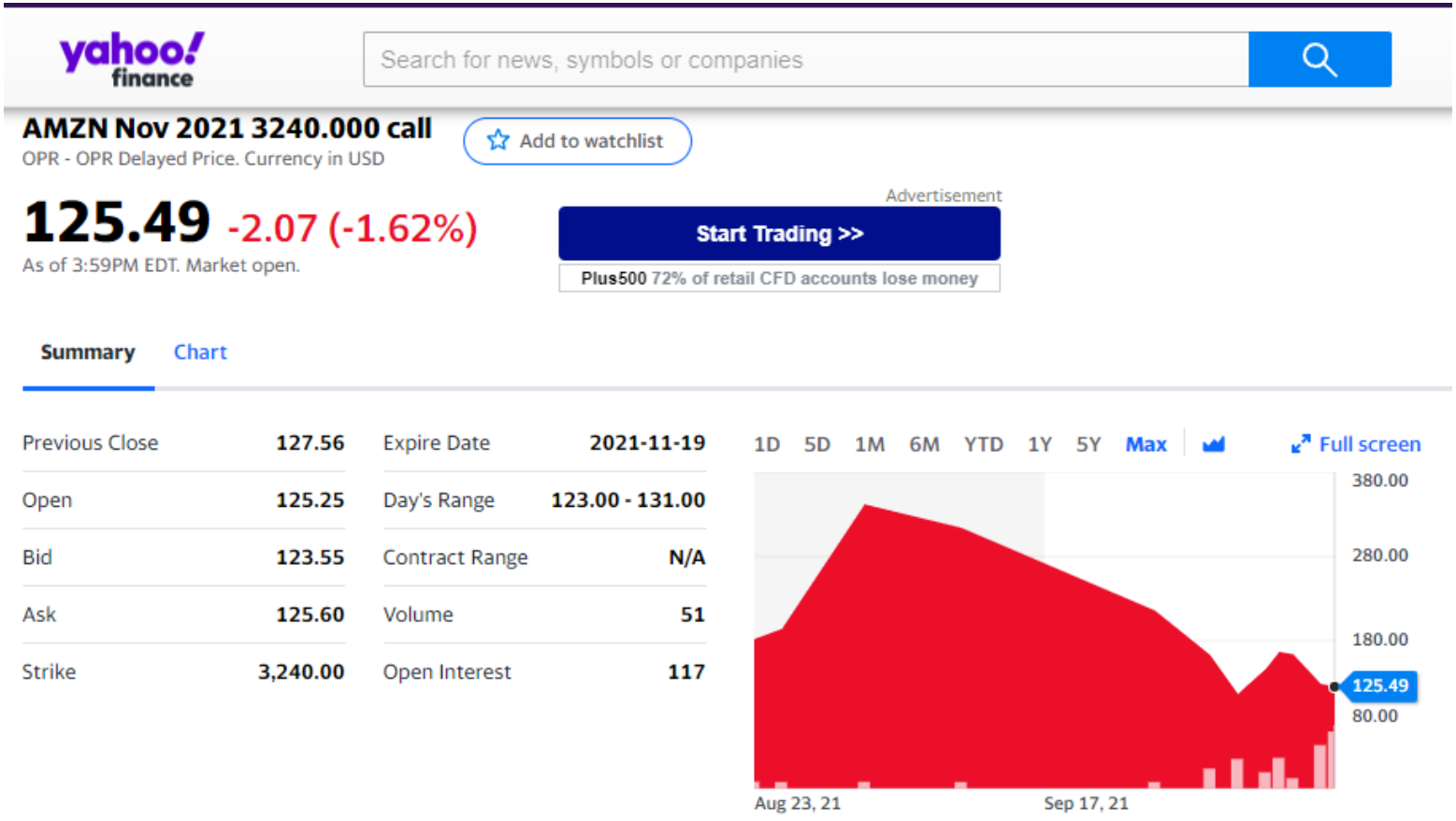
Calls for November 19, 2021

Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask	Change	% Change	Volume	Open Interest	Implied Volatility
AMZN211119C03225000	2021-10-12 3:54PM EDT	3,225.00	130.60	-	-	+130.60	-	-	-	0.00%
AMZN211119C03230000	2021-10-12 2:53PM EDT	3,230.00	134.80	128.90	131.10	+2.80	+2.12%	5	524	29.33%
AMZN211119C03240000	2021-10-12 3:59PM EDT	3,240.00	125.49	123.55	125.60	-2.07	-1.62%	51	117	29.20%
AMZN211119C03245000	2021-10-12 3:56PM EDT	3,245.00	122.03	-	-	+122.03	-	-	-	0.00%
AMZN211119C03250000	2021-10-12 3:56PM EDT	3,250.00	120.40	118.05	120.20	-1.15	-0.95%	102	560	29.07%
AMZN211119C03255000	2021-10-12 3:52PM EDT	3,255.00	115.45	-	-	+115.45	-	-	-	0.00%
AMZN211119C03260000	2021-10-12 3:59PM EDT	3,260.00	115.75	112.90	115.00	-0.55	-0.47%	19	130	28.95%
AMZN211119C03265000	2021-10-12 12:32PM EDT	3,265.00	113.55	-	-	+113.55	-	-	-	0.00%

Price of stock options on Amazon

- Call options on Amazon
- Source: https://finance.yahoo.com/quote/AMZN?p=AMZN

Open Interest = Number of option contracts that are still open (i.e. have not yet been exercised, or have not been closed out by an offsetting transaction, or have not expired)



Price of stock options on Amazon

- Call options on Amazon
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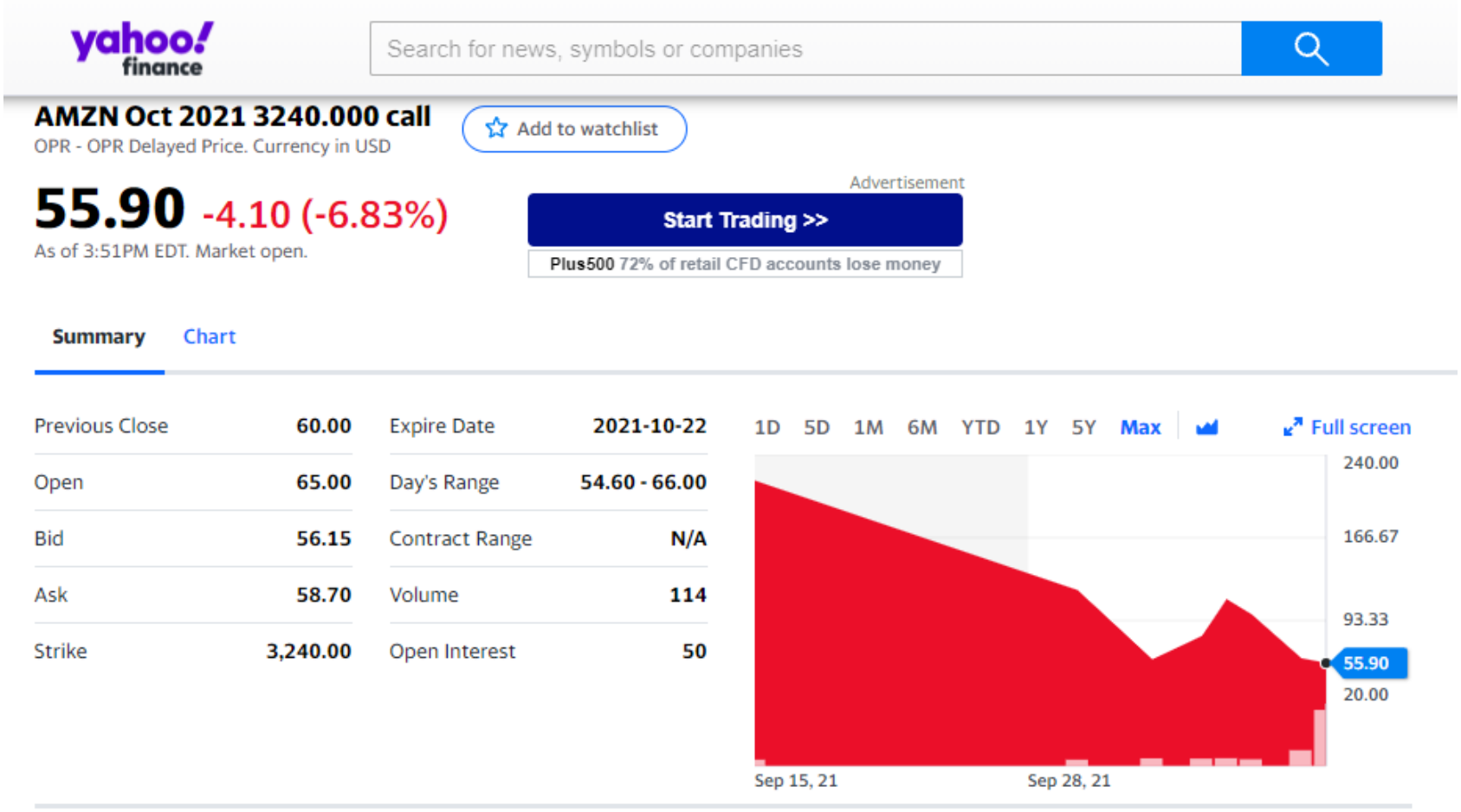


American vs. European Options

- American - the option can be exercised at any time before expiration or maturity

- European - the option can only be exercised on the expiration or maturity date

Accounting for Stock Split and Dividend Payout

- To account for stock split, the exercise price is reduced by a factor of the split, and the number of options held is increased by that factor
- A similar adjustment is made for stock dividends of more than 10%
- Cash dividends do not affect the terms of an option contract
  - Call option values are lower for high-dividend payout policies because they slow the stock price increase
  - Vice versa for put option
- Anticipated dividend payments are factored into the option price

Different Types of Options

- Stock Options
- Index Options
  - Options based on a stock market index such as the S&P 500 or NASDAQ100
- Futures Options
  - give holders the right to buy or sell a specified futures contract
- Foreign Currency Options
  - offer the right to buy or sell a quantity of one currency for a specified amount of another currency
- Interest Rate Options
  - Traded on Treasury notes and bonds, etc.

Values of Options at Expiration – Call Holder

- The value of the call option at expiration equals

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

- Where:
  - S_T is the value of the stock at expiration
  - X is the exercise price

- Call is exercised only if $S_T > X$

- Profit to Call Holder = Payoff – Premium

- If you **hold** a call option, you have a **long** call position

Figure 20.2
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

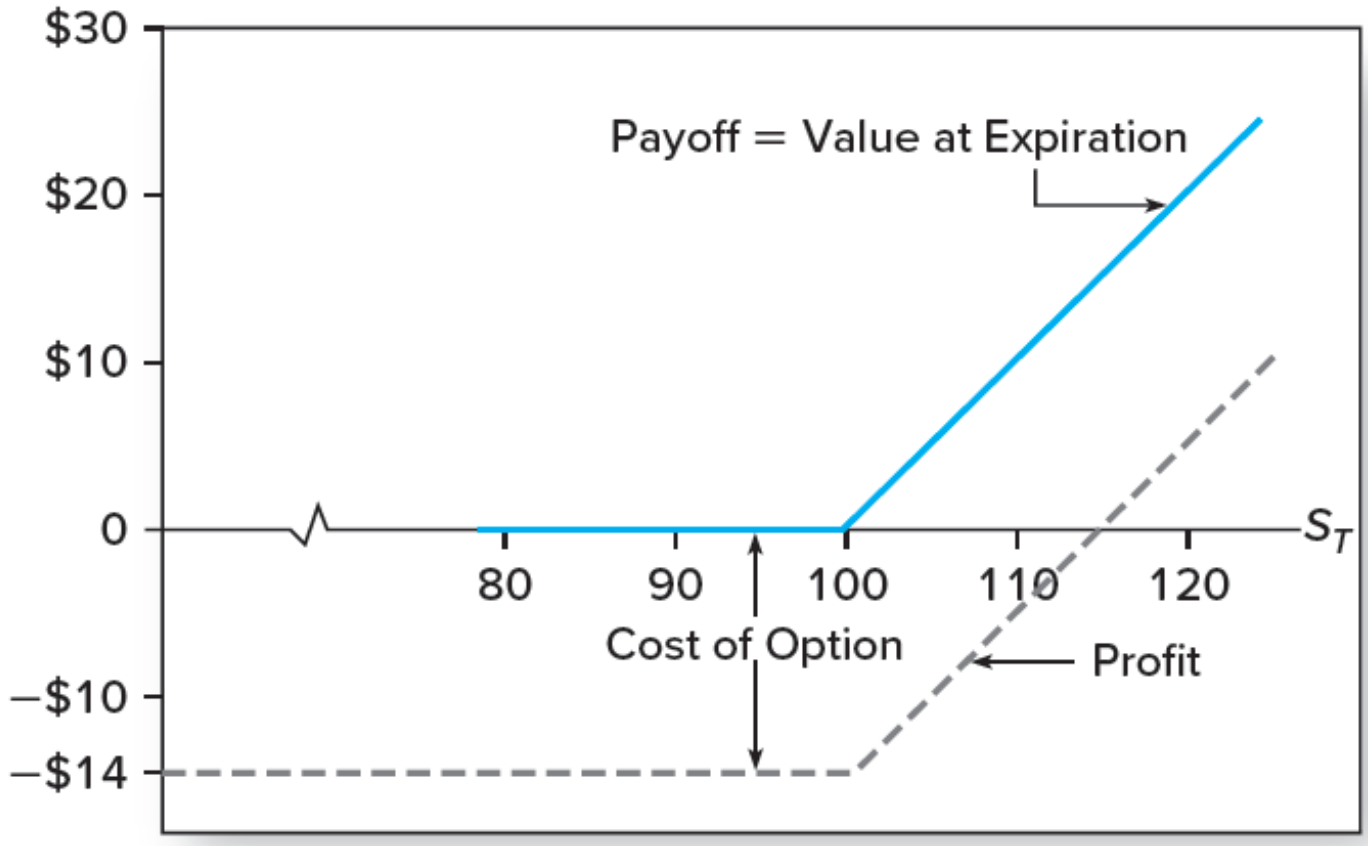


Figure 20.2 Payoff and profit to call option at expiration

Values of Options at Expiration – Call Writer

- Call writer incurs losses if the stock price is high, in which case the writer will receive a call and will be obligated to deliver a stock worth S_T for only X dollars

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

- Profit to Call Writer = Payoff + Premium

- If you are a **writer** of a call option, you have a **short** call position

Figure 20.3
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

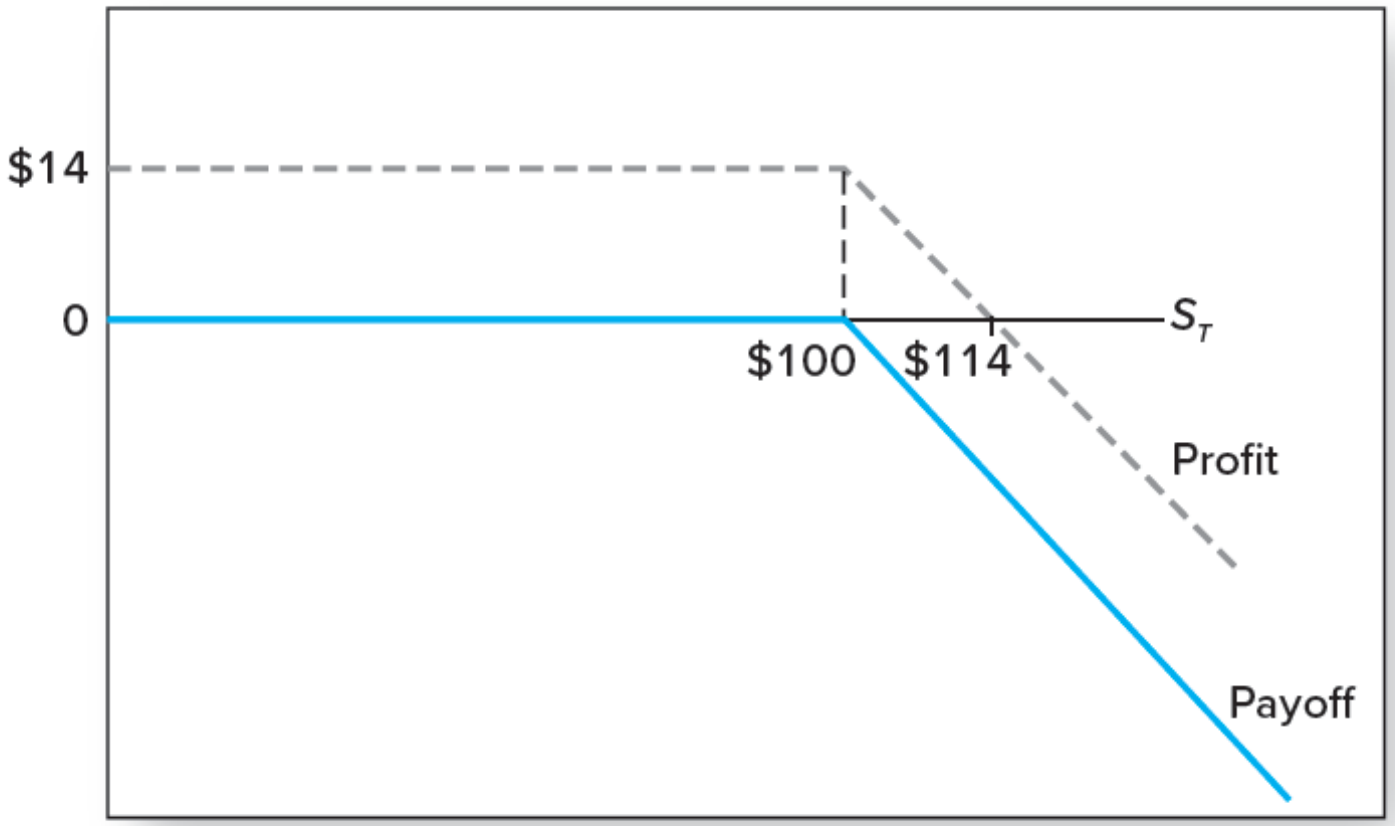


Figure 20.3 Payoff and profit to call writer at expiration

Values of Options at Expiration – Put Holder

- Holder will not exercise the option unless the asset is worth *less* than the exercise price

- Value of a put option at expiration

$$\text{Payoff to put holder} = \begin{cases} 0 & \text{if } S_T \geq X \\ X - S_T & \text{if } S_T < X \end{cases}$$

- Profit to Put Holder = Payoff – Premium

- If you **hold** a put option, you have a **long** put position

Figure 20.4
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

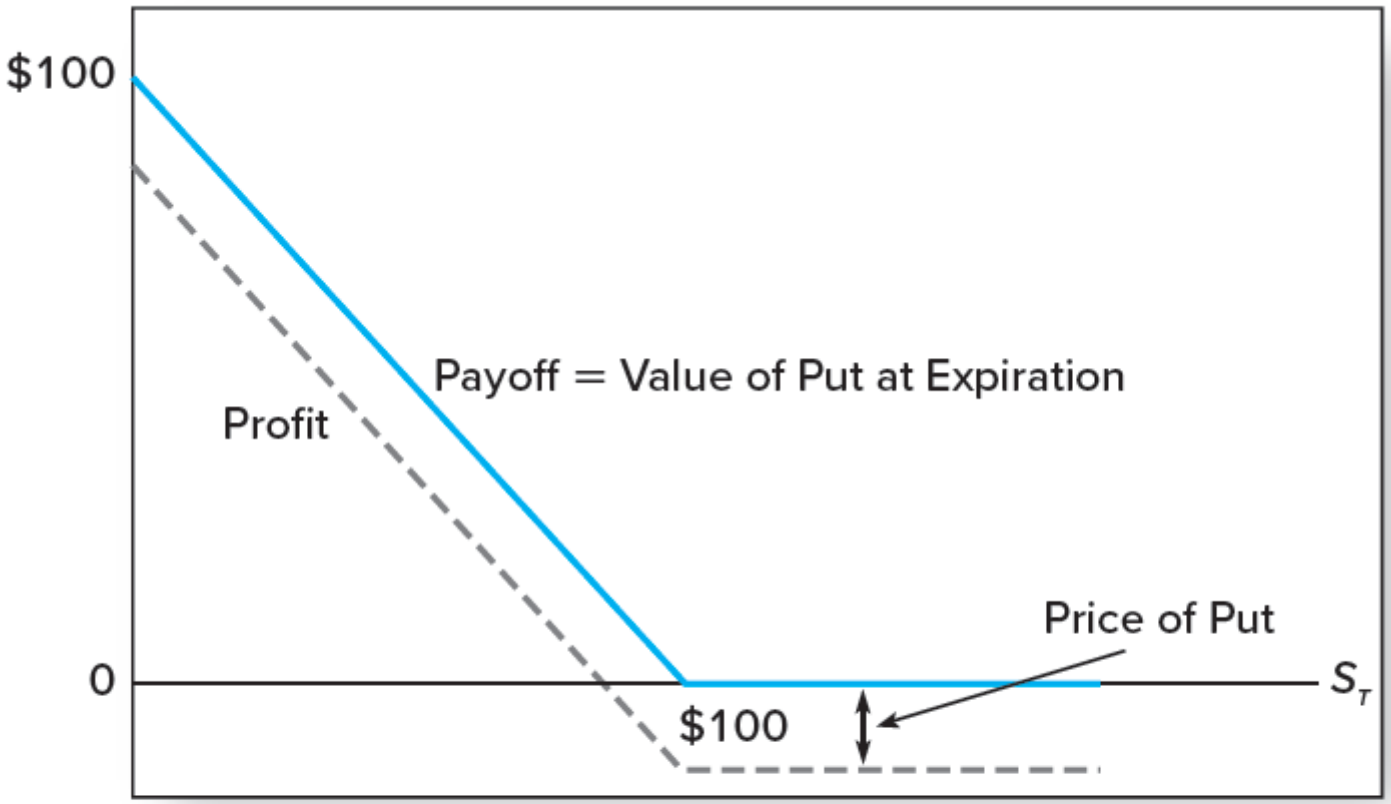


Figure 20.4 Payoff and profit to put option at expiration

Values of Options at Expiration – Put Writer

- Put writer incurs losses if the stock price is lower, in which case the writer will be obligated to buy a stock at price X dollars when it is worth only S_T.

$$\text{Payoff to put writer} = \begin{cases} 0 & \text{if } S_T \geq X \\ -(X - S_T) & \text{if } S_T < X \end{cases}$$

- Profit to Put Writer = Payoff + Premium

- If you are a **writer** of a put option, you have a **short** put position

Bullish vs. Bearish Strategy

- Bullish Strategy
  - Buying Calls
  - Writing Puts

- Bearish Strategy
  - Buying Puts
  - Writing Calls

Why would you purchase a call option rather than buy shares of stock directly?

- Example
  - Suppose you think that a stock, currently selling for $100, will appreciate
  - A 1-year maturity call option with exercise price $100 currently sells for $10, and the interest rate is 3%
  - You have $10,000 to invest
- Strategies
  A. Invest entirely in stock. Buy 100 shares, each selling for $100
  B. Invest entirely in at-the-money call options. Buy 1,000 calls, each selling for $10. (This would require 10 contracts, each for 100 shares.)
  C. Purchase 100 call options for $1,000. Invest your remaining $9,000 in 1-year T-bills, to earn 3% interest. (The bills will grow in value from $9,000 to $9,000 x 1.03 = $9,270.)

Why use options? Strategy payoffs

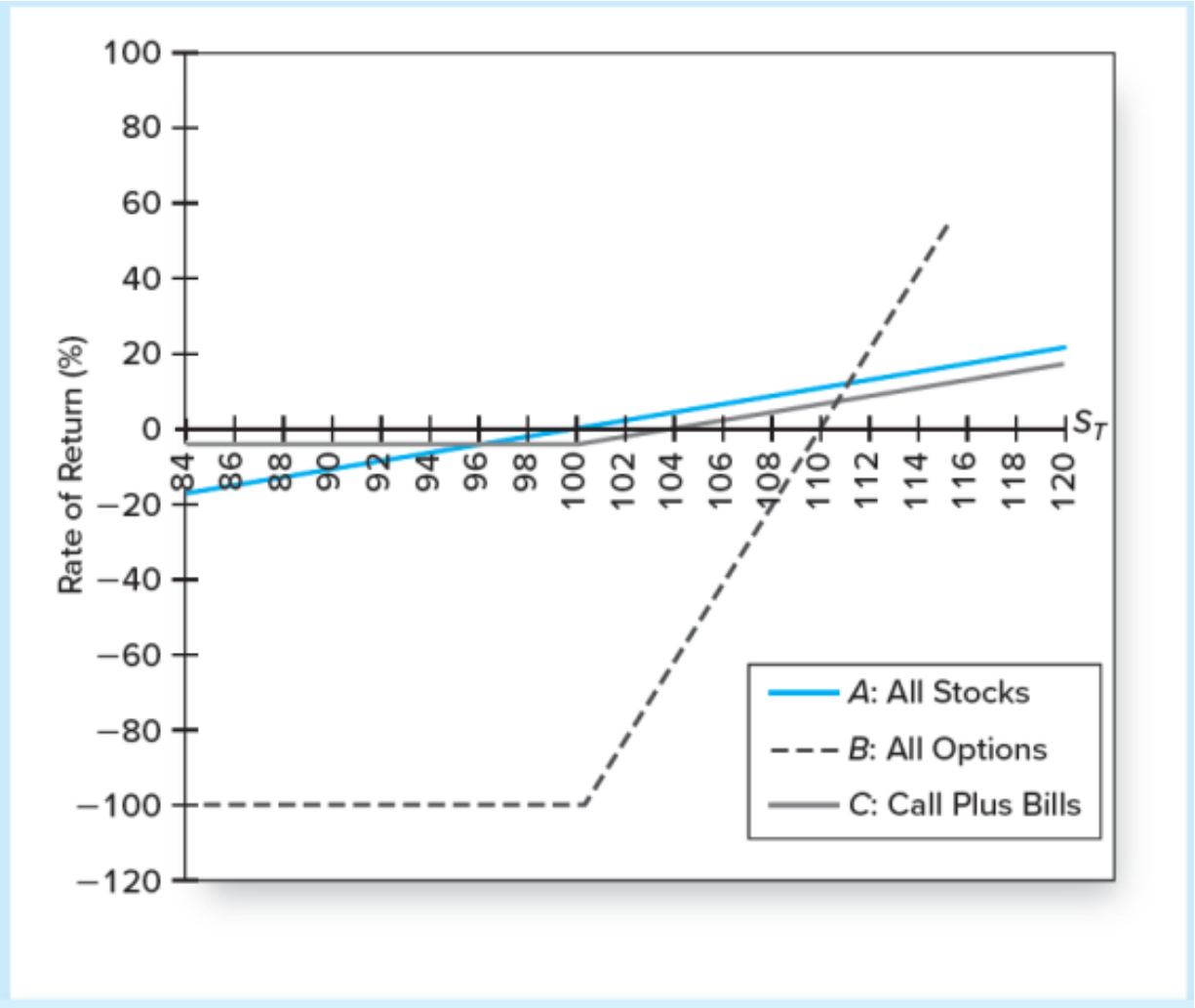
- Tables sourced from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e, page 668.

Portfolio	Stock Price					
	$95	$100	$105	$110	$115	$120
Portfolio *A*: All stock	$9,500	$10,000	$10,500	$11,000	$11,500	$12,000
Portfolio *B*: All options	0	0	5,000	10,000	15,000	20,000
Portfolio *C*: Call plus bills	9,270	9,270	9,770	10,270	10,770	11,270

Portfolio	Stock Price					
	$95	$100	$105	$110	$115	$120
Portfolio *A*: All stock	−5.0%	0.0%	5.0%	10.0%	15.0%	20.0%
Portfolio *B*: All options	−100.0	−100.0	−50.0	0.0	50.0	100.0
Portfolio *C*: Call plus bills	−7.3	−7.3	−2.3	2.7	7.7	12.7

Why use options?

Figure 20.5 Rate of returns to three strategies
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)



Implications on the various strategies

- An option **offers leverage**
  - E.g. for Portfolio B, values respond more than proportionately to changes in stock price.

- Options can be used **as an insurance.**
  - E.g. Portfolio C, T-bill-plus-option strategy
  - Value of portfolio C cannot be worth less than $9,270 at the end of the year
  - Trade-off: Some return potential is sacrificed to limit downside risk; hence Portfolio C underperforms A by 9.33% when share price rises

Protective Put

- Puts can be used as **insurance** against stock price declines
  - **E.g. Protective Put: Invest in stock and buy a put option on the stock**
  - Protective puts lock in a minimum portfolio value
  - The cost of the insurance is the put premium

- That is, options can be used for risk management, not just for speculation
  - Some return potential is sacrificed to limit downside risk
  - The absolute limitation on downside risk is a novel and attractive feature of this strategy

Table 20.1
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Table 20.1

Value of a protective put portfolio at option expiration

	$S_T \leq X$	$S_T > X$
Stock	S_T	S_T
+ Put	$X - S_T$	0
Total	X	S_T

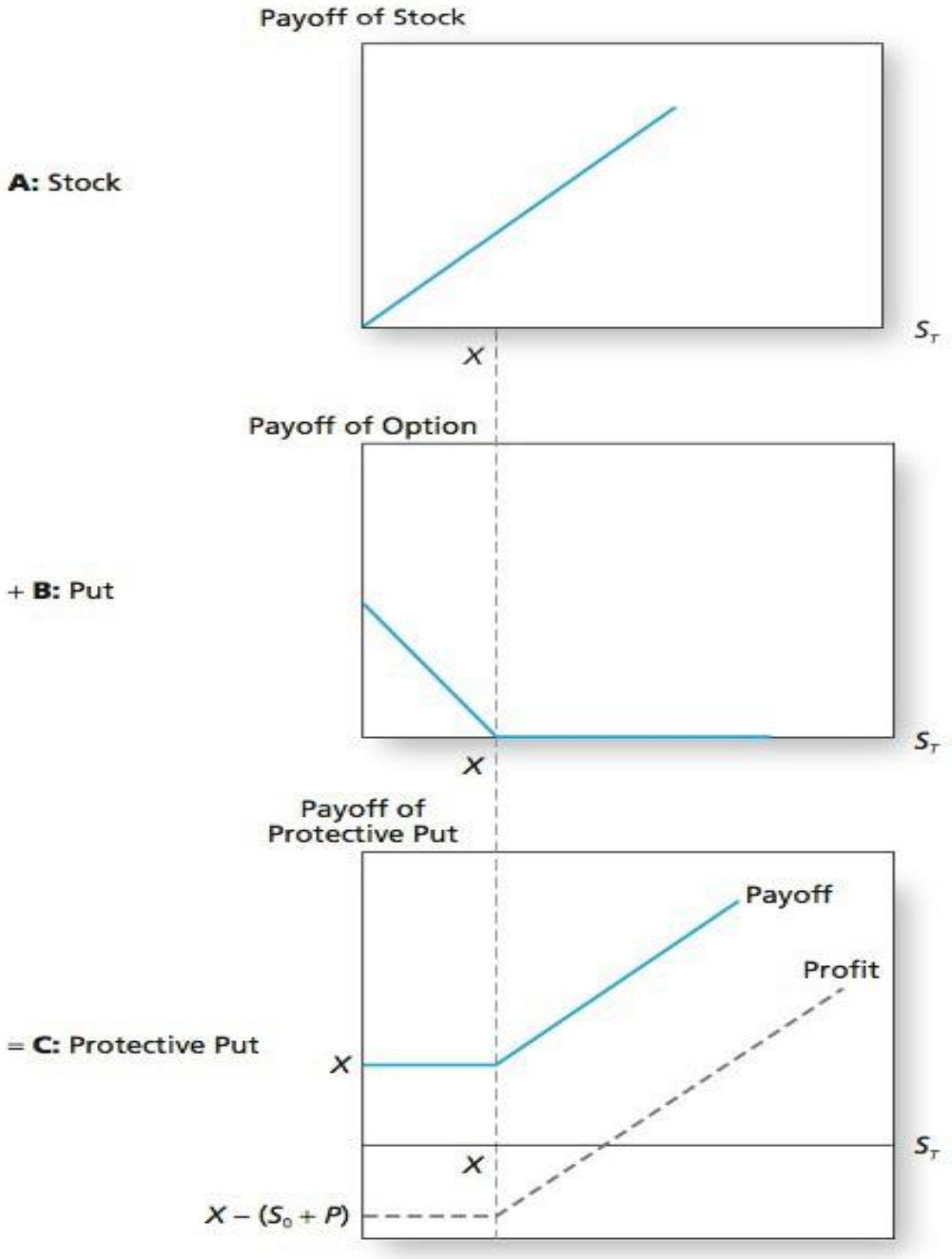


Figure 20.6 Value of a protective put position at expiration (from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Figure 20.7
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

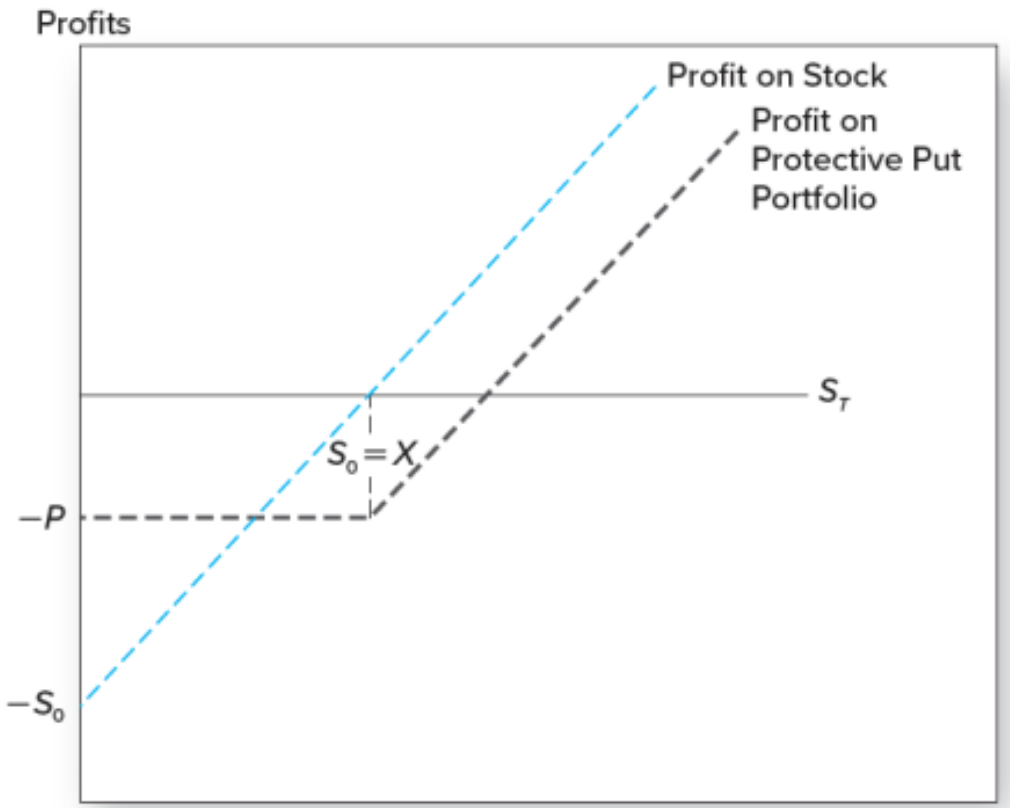


Figure 20.7 Protective put versus stock investment (at-the-money option)

Covered Calls

- The purchase of a **share of stock coupled with a sale of a call option on that stock**
- Payoff of a covered call position equals the stock value minus the value of the written call
- Trade-off: Investors forfeit potential capital gains, should the stock price rise above the exercise price

Value of a Covered Call Position at Option Expiration

Table 20.2
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Table 20.2

Value of a covered call position at option expiration

	$S_T \leq X$	$S_T > X$
Payoff of stock	S_T	S_T
+ Payoff of written call	-0	$-(S_T - X)$
Total	S_T	X

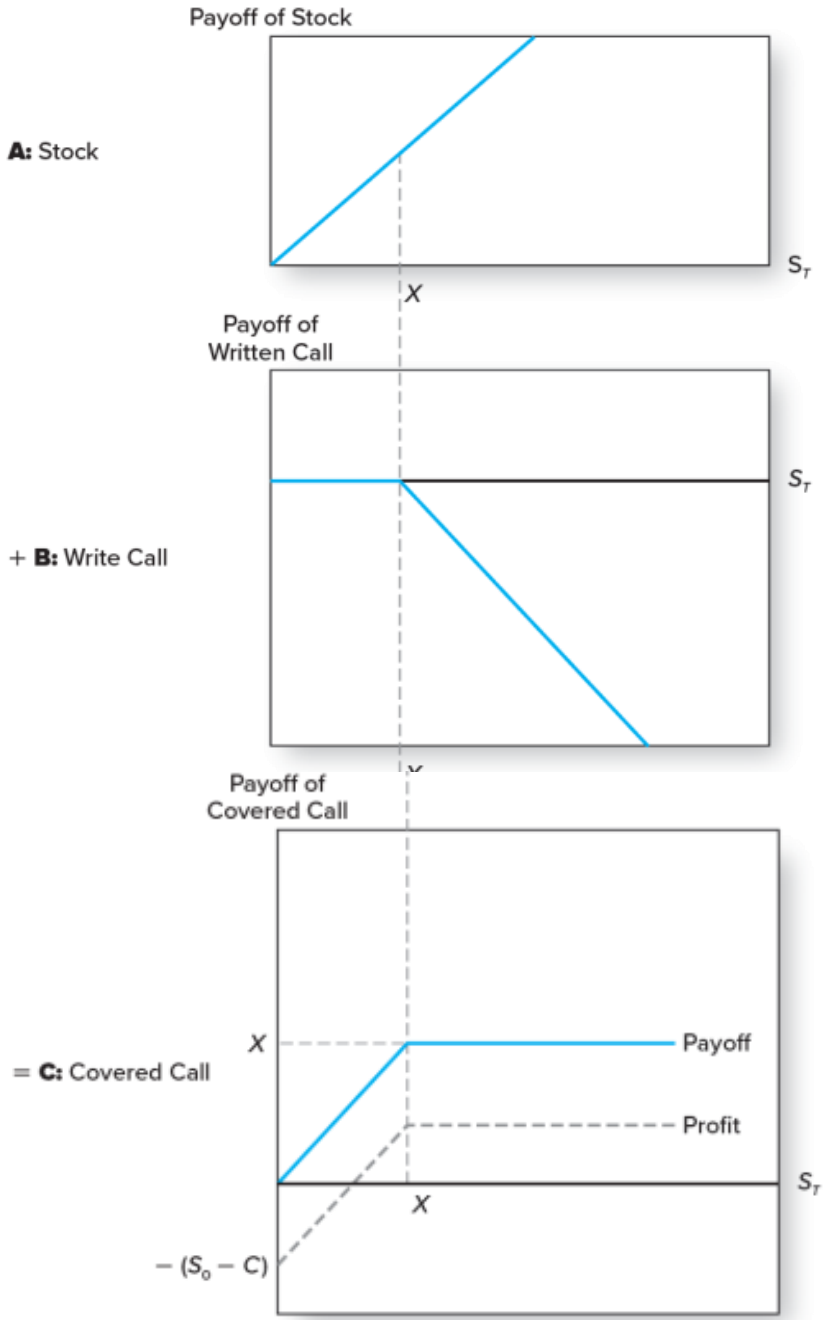


Figure 20.8 Value of a covered call position at expiration (from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Straddle

- A long straddle can be constructed by **buying both a call and a put on a stock**, each with the **same exercise price, X**, and the **same expiration date, T**
- Straddle positions are **bets on volatility**
- Initial cost of the straddle is the sum of the call and the put, P + C
- Final stock price must depart from X by this cost for the straddle to provide a profit

Value of a Straddle Position at Option Expiration

Table 20.3
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Table 20.3

Value of a straddle position at option expiration

	$S_T < X$	$S_T \geq X$
Payoff of call	0	$S_T - X$
+ Payoff of put	$X - S_T$	0
Total	$X - S_T$	$S_T - X$

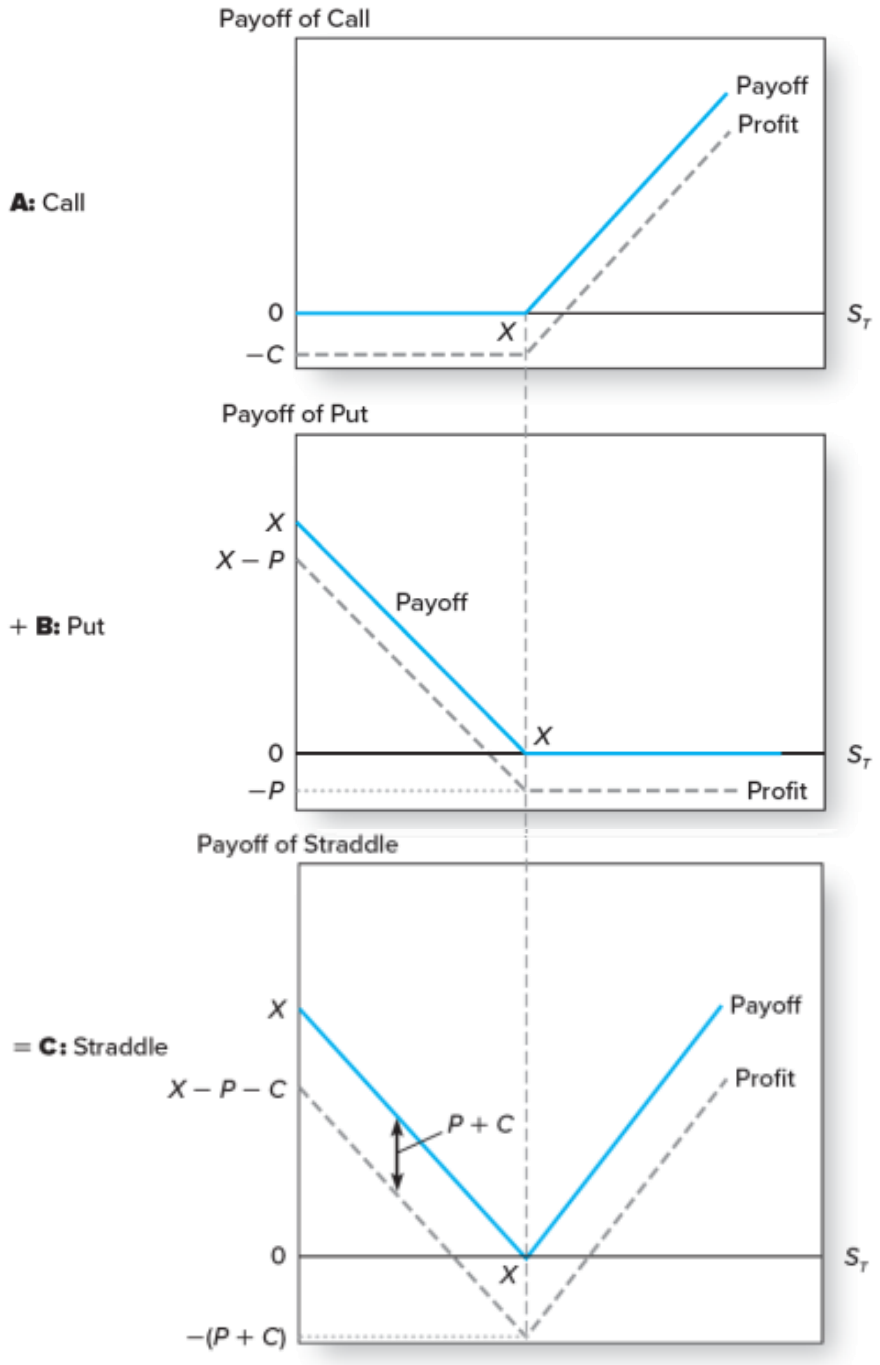


Figure 20.9 Value of a straddle at expiration (from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Spreads

- A spread is a combination of two or more call options (or two or more puts) on the **same stock** with **differing exercise prices (money spread) or times to maturity (time spread)**
- Motivation may be that the investor thinks one option is overpriced relative to another

Value of a Bullish Spread Position at Expiration

Table 20.4
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Table 20.4

Value of a bullish spread position at expiration

	$S_T \le X_1$	$X_1 < S_T \le X_2$	$S_T \ge X_2$
Payoff of purchased call, exercise price = X_1	0	$S_T - X_1$	$S_T - X_1$
+ Payoff of written call, exercise price = X_2	−0	−0	$-(S_T - X_2)$
Total	0	$S_T - X_1$	$X_2 - X_1$

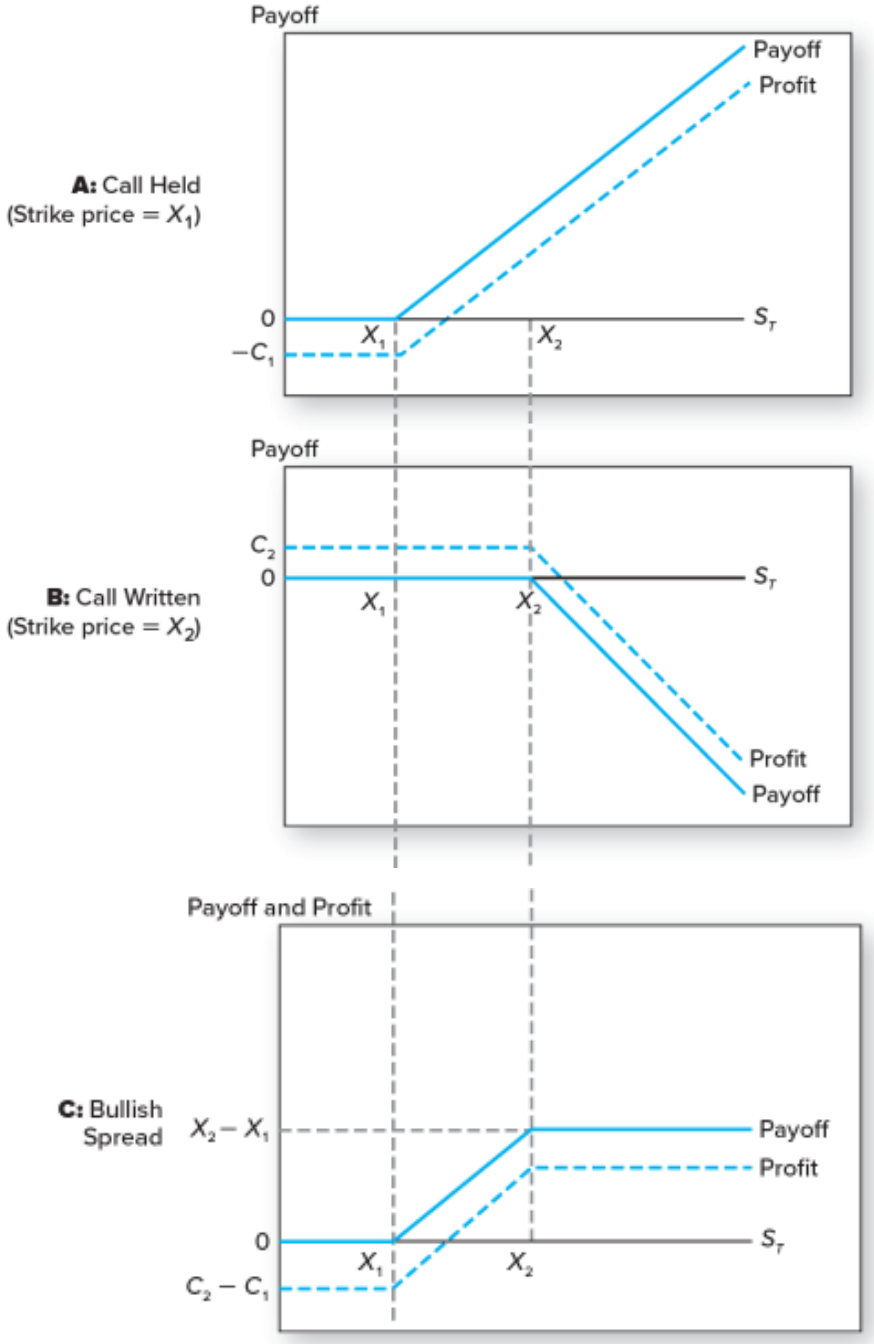


Figure 20.10 Value of a bullish spread position at Expiration
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Put-Call Parity

- A protective put portfolio provides a payoff with a guaranteed minimum value, but with unlimited upside potential
- Table 20.1
- Figure 20.6
- But a call-plus-bills portfolio can also provide similar payoff
- Buy a call option and buy zero-coupon Treasury bills with face value equal to the exercise price X of the call and with maturity date equal to the expiration date of the option

Value of a Call-plus-Bills Portfolio at Expiration

Source: adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e, page 678

	$S_T \leq X$	$S_T > X$
Value of call option	0	$S_T - X$
Value of riskless bond	X	X
TOTAL	X	S_T

Table 20.1

Value of a protective put portfolio at option expiration

	$S_T \leq X$	$S_T > X$
Stock	S_T	S_T
+ Put	$X - S_T$	0
Total	X	S_T

Put-Call Parity

- Since both portfolios provide the same exact payoffs, the call-plus-bond portfolio (on left) must cost the same as the stock-plus-put portfolio (on right):

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

- This equation, also known as the Put-call parity theorem depicts the relation between put and call prices
- Violation of parity implies the existence of arbitrage opportunities

Put-Call Parity - Disequilibrium Example with Arbitrage

Call Price = 17

Stock Price = 110

Risk Free = 5%

Put Price = 5

X = 105

Maturity = 1 yr

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

$$117 > 115$$

- Since the protective put is less expensive, acquire the low cost alternative and sell the high cost alternative

Put-Call Parity - Disequilibrium Example with Arbitrage

Table 20.5 Arbitrage strategy
(from adopted text, Bodie, Kane and Marcus, Investments, McGraw Hill, 12e)

Table 20.5

Arbitrage strategy

Position	Immediate Cash Flow	Cash Flow in 1 Year	
		$S_T < 105$	$S_T \geq 105$
Buy stock	−110	S_T	S_T
Borrow \$105/1.05 = \$100	+100	−105	−105
Sell call	+17	0	$-(S_T - 105)$
Buy put	−5	$105 - S_T$	0
Total	2	0	0