FIN 2704/2704X

Week 12 Slides

Introduction to Option

Learning objectives

- Understand what derivatives are
- Understand what options are
- Understand option terminology

Derivative Securities – Overview

- A **Derivative Instrument** is one for which the ultimate **payoff** to the investor **depends directly on the value of another security or commodity**. Types of derivatives:
  - Options: Calls & Puts
  - Forwards & Futures
  - Extended Derivatives: Swap contract / Convertible Securities / Other Embedded Derivatives (Call feature of a bond)

- Derivatives can be used both for *risk-management* as well as *speculation* via their large leverage ratio potential.
  - An example of risk-management: an airline can use an energy derivative to manage the risk of changes in the price of fuel.

Derivative Securities

The **underlying assets** can include agricultural commodities, energy and petroleum, metals, currencies, common stocks and stock indexes, bonds, and even some other derivatives (e.g., an option on futures).

- Agricultural commodities: corn, soybeans, wheat, (live) cattle, pork, lumber, dairy, even orange juice.
- Energy products: crude oil, refined oil, natural gas, electricity.
- Metals: steel, copper, silver, gold, platinum.
- Currencies: Euro, Chinese Yuan, Japan Yen, of course, S$.
- Stock, bonds, and indices: S&P 500, Dow Jones, Nasdaq-100, Global indexes.
- E.g. of options: Stock Options, Index Options, Futures Options, Foreign Currency Options, Interest Rate Options.

Global Derivatives Markets: Exchange-Traded vs. OTC

- **Exchange-traded derivatives** are standardized contracts (e.g., exchange traded options trade in multiples of 100 options) traded on regulated exchanges that provide clearing and regulatory safeguards to investors.
- **OTC (Over-the-counter)** derivatives are customized contracts provided directly by dealers to end-users or other dealers.

Main Options Exchanges in the U.S.: International Securities Exchange and Chicago Board Options Exchange (makes trading easy, creates liquid secondary market)

Visit http://www.bis.org/statistics/derstats.htm for derivative statistics

Options

- **CALL option** is a security that gives its holder
  - the *right* (but not the obligation)
  - to *purchase*
  - a given *asset* (e.g., a stock)
  - for a predetermined *price* (referred to as exercise or strike price)
  - on *a given date*, or *anytime before a given date*
- **European Options** - can be exercised only at the expiration date.
- **American Options** - can be exercised any time before expiration.
- **PUT option**, in contrast to a call option, gives its holder the right to sell an asset on a given date at a predetermined price.

Options

- Options are "side bets" between investors - investors trade options on common stock among themselves, and these option trades *do not involve the firms* on whose shares the trades or "bets" are based.

- So if an investor ***sells* a call option (also referred to as *"writes"* a call option)**, then he promises to *provide* the *holder/buyer* of the call with shares of the underlying firm, if asked to do so by the option buyer on the date of maturity.

- Similarly, the ***seller*** or ***writer* of a put option** has the obligation to *buy* (if the put option *holder/buyer* wants to exercise the option)

Options Terminology

- Buy/hold – Long position
- Sell/write – Short position
- Call – holder has the right to buy
- Put – holder has the right to sell
- Key Elements
  - *Exercise* Price also called *Strike* Price
  - ***Premium*** of the Option also called *Price* of the Option contract
  - *Maturity* of the Option also referred to as *Expiration* of the Option

<u>There are four possible option positions:</u>

- **Call Option: buyer <u>or</u> seller**
- **Put Option: buyer <u>or</u> seller**

Options Notations

S - Price of underlying asset generally

S_0 - Price of underlying asset today

S_T - Price of underlying asset at option's expiration date

X - Exercise or Strike Price of the option (also referred to as E)

T - Option expiration date

r - Interest rate (the risk-free rate)

C_0 - The price of a call option today

C_T - The value of a call option at the option's expiration date

P_0 - The price of a put option today

P_T - The value of a put option at the option's expiration date

Options Payoff at Maturity

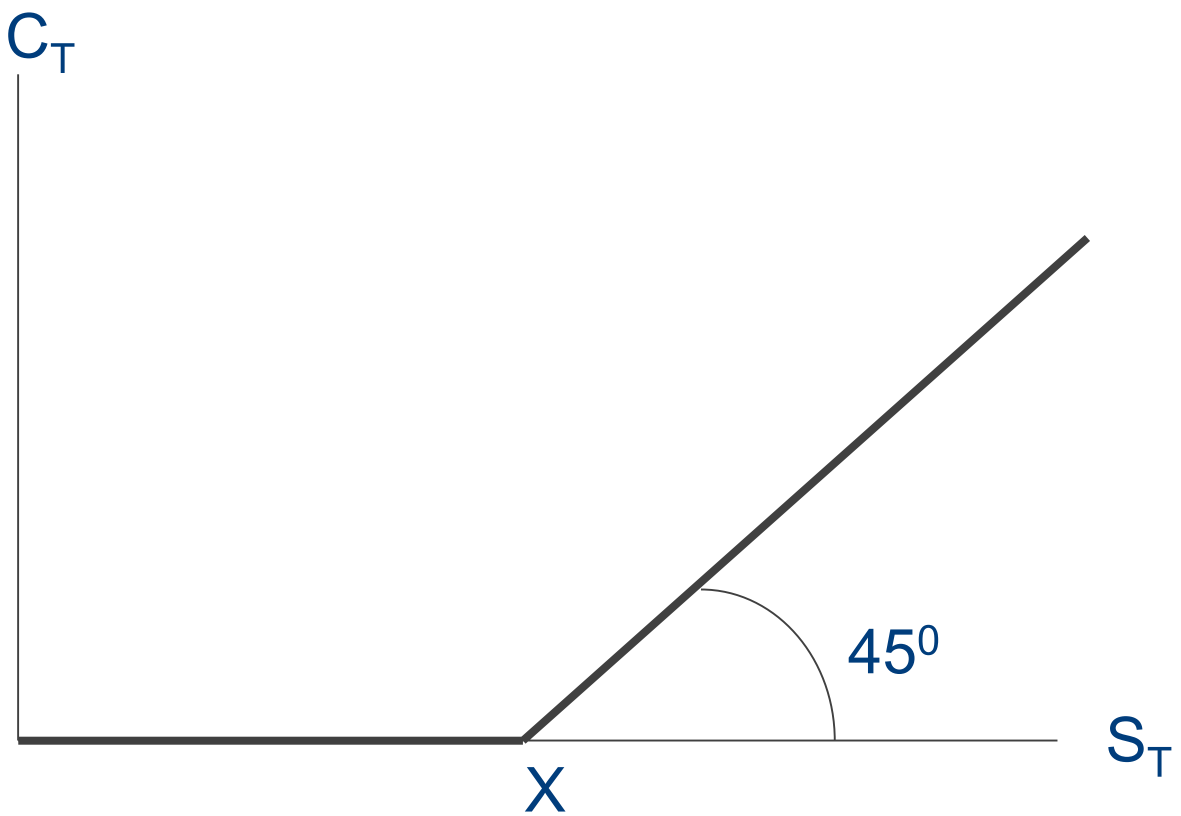
- Since the owner of a call option has the *right* but not the obligation to *buy* the asset for *X* dollars (strike price), they will do so only if the asset's market price *exceeds* X dollars.

- If $X < S_T$, we can buy the stock by exercising the option at a price that is lower than the price prevailing in the market. Thus, we should exercise the option. The value of the option in this case, **equals the difference between the value of the stock at the day of exercise (i.e. the market price) and the price paid for the stock (by exercising):** $C_T = S_T - X$

- If $X > S_T$ we can buy the stock in the market at a price lower than the price required by exercising the option. Thus, we should let the option expire and not exercise it. The value of the option is then **ZERO**.

$\Rightarrow$ *Payoff of Call at Maturity*: $C_T = Max\{S_T - X, 0\}$

Call Value *at Maturity Date* as Function of Stock Price



The 45-degree line shows that once the market price of the stock rises above the exercise price, the call holder gains dollar for dollar in their payoff if the stock price goes up and loses dollar for dollar if it falls.

Options Payoff Description

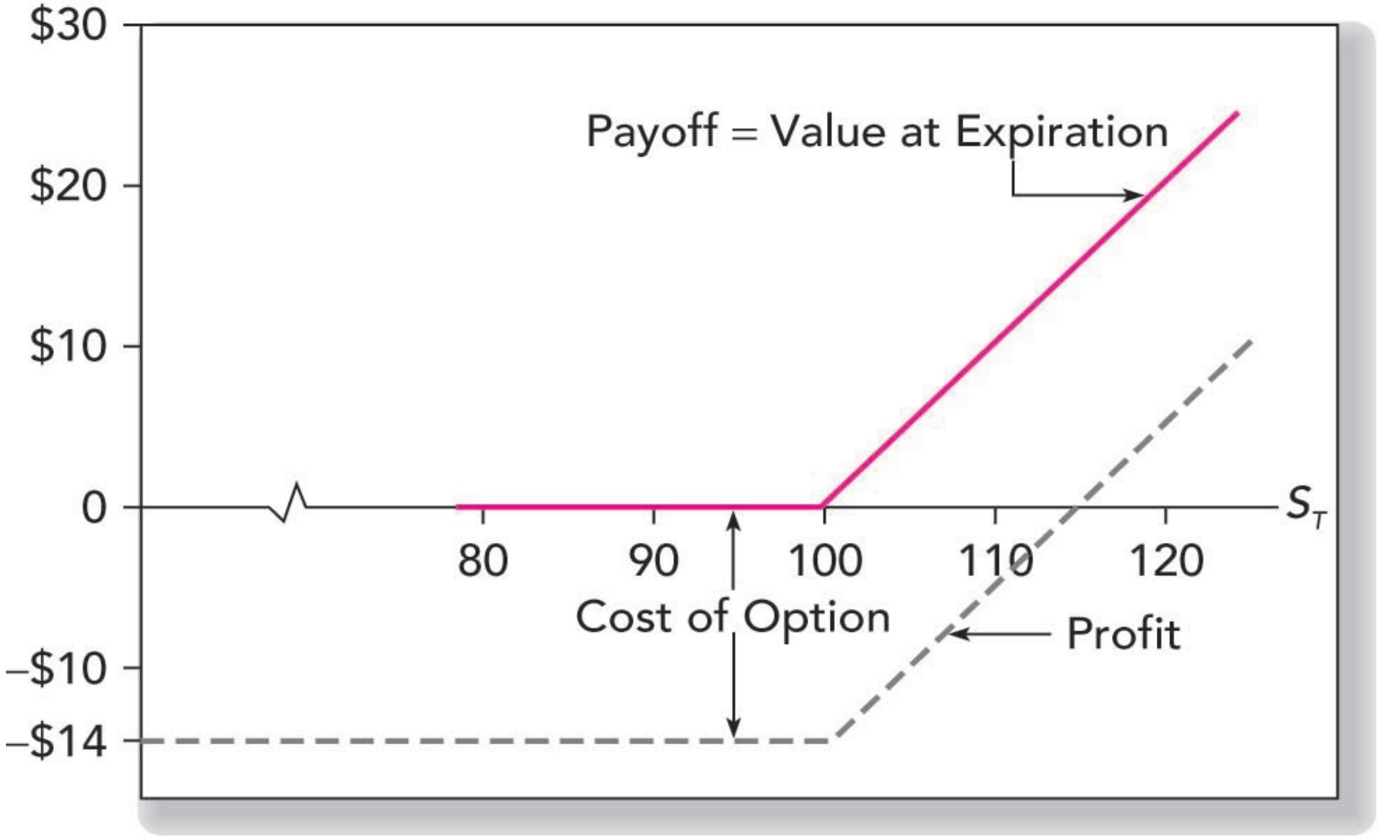
- **"In the Money"** Option – Refers to the situation when, if the date of expiration *would have been* today, the option holder *would have exercised* their option, meaning S > X for call options (and vice versa for put options, i.e., X > S).

- **"At the Money"** Option - Refers to the situation when, if the date of expiration *would have been* today, the holder would have been indifferent to exercising their option, meaning S = X.

- **"Out of the Money"** Option - Refers to the situation when, if the date of expiration *would have been* today, the holder would have given up the right to exercise the option, meaning S < X for call options (and vice versa for put options, i.e., X < S)

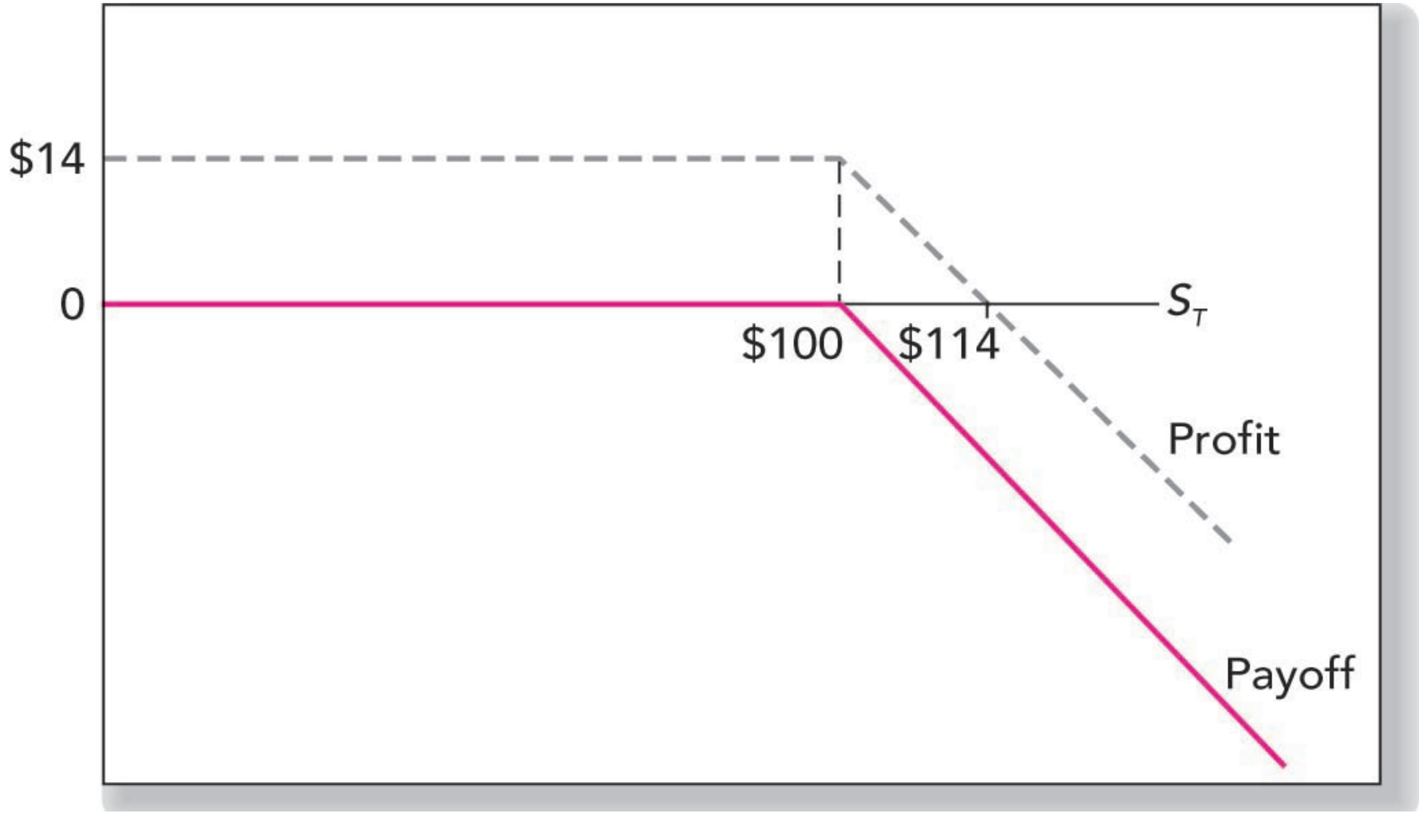
Payoff and Profit of CALL Options AT EXPIRATION

- In this example, the call option's original cost is $14 ($14 is the call "premium"). The exercise price X = $100.



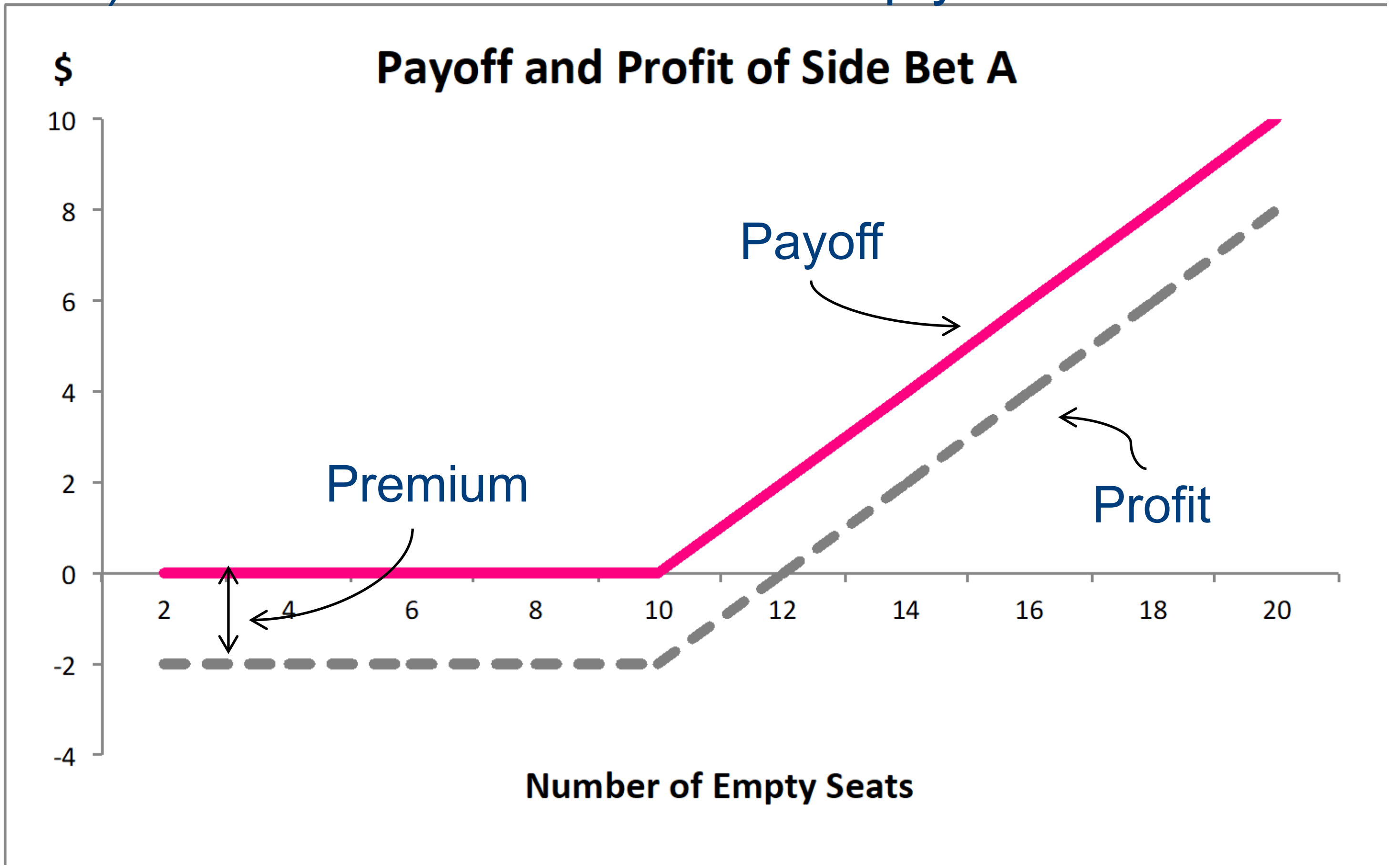
Payoff and Profit to CALL **Writers** AT EXPIRATION

- In this example, the call option's original cost is \$14 (\$14 is the call "premium"). The exercise price X = \$100.



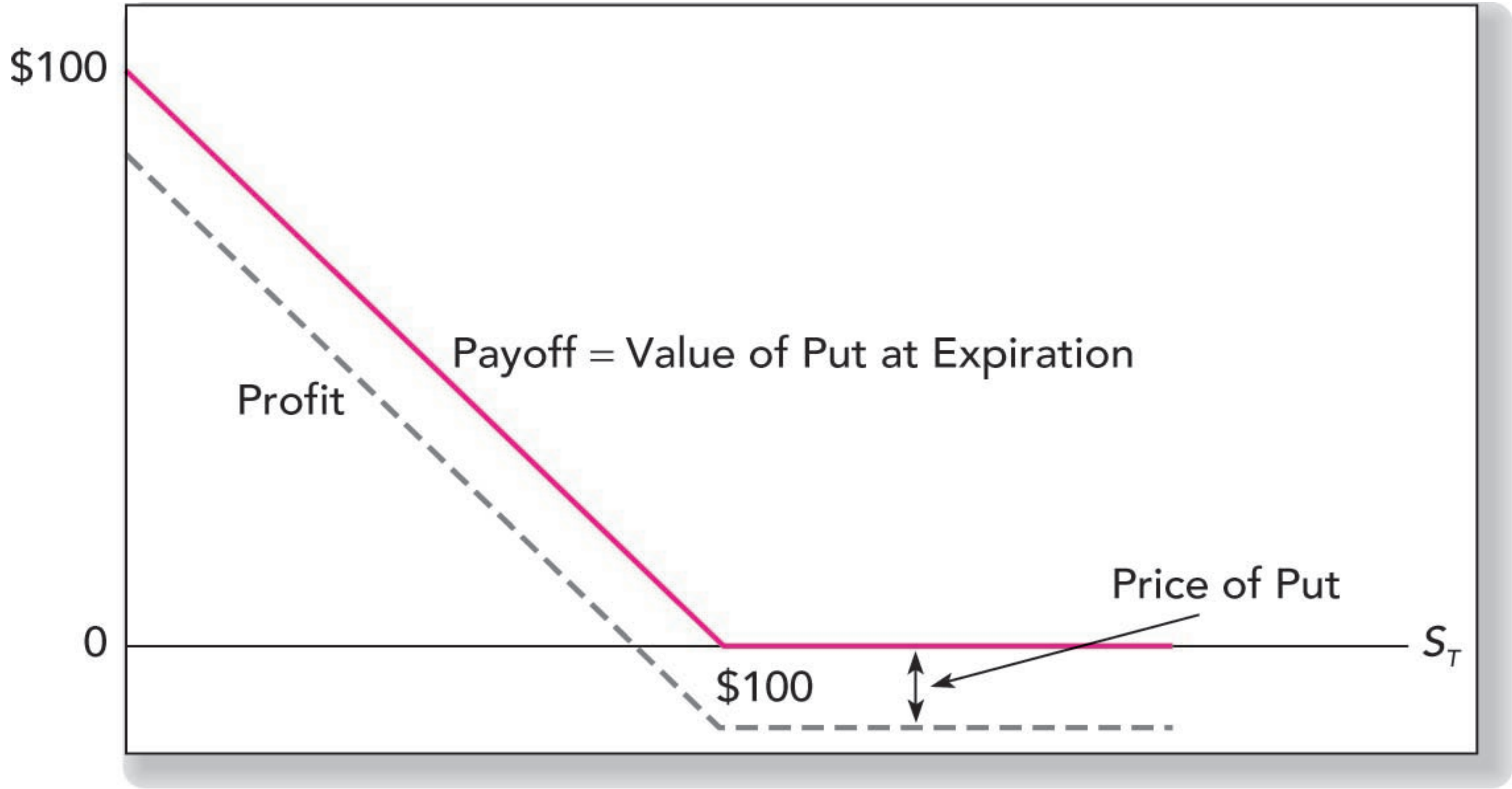
Example Bet A:
Payoff and Profit to **HOLDER** AT EXPIRATION

- In Side Bet A, the call option's original cost is $2 ($2 is the call "premium"). The exercise level X = 10 empty seats.



Payoff and Profit of PUT Option AT EXPIRATION

- In this example, the put option's original cost is $14 ($14 is the put "premium"). The exercise price X = $100.



Put Options: Payoffs and Profits at Expiration

Payoffs to Put **Holder**

if $S_T \geq X$ — 0

if $S_T < X$ — $(X - S_T)$

Profit to Put **Holder**

Payoff – Premium

Payoffs to Put **Writer**

0 — if $S_T \geq X$

$-(X - S_T)$ — if $S_T < X$

Profits to Put **Writer**

Payoff + Premium

Example: 3 Different Investment Strategies

▸ Stock, All Call Options, & Call Options + T-Bills

You have **$10,000** to invest. You can invest in three different ways. The stock is selling for $100/share. Call Options with a strike price of $100 are selling for $10 each. The risk-free rate is 3%.

Investment	Strategy	Investment	
(i) Equity only	Buy stock @ $100	100 shares	$10,000
(ii) Options only	Buy calls @ $10	1000 options	$10,000
(iii) T-Bills/Calls	Buy calls @ $10 Buy T-bills @ 3% Yield	100 options	$1,000 $9,000

Example: 3 Different Investment Strategies

▸ Stock, All Call Options & Call Options + T-Bills

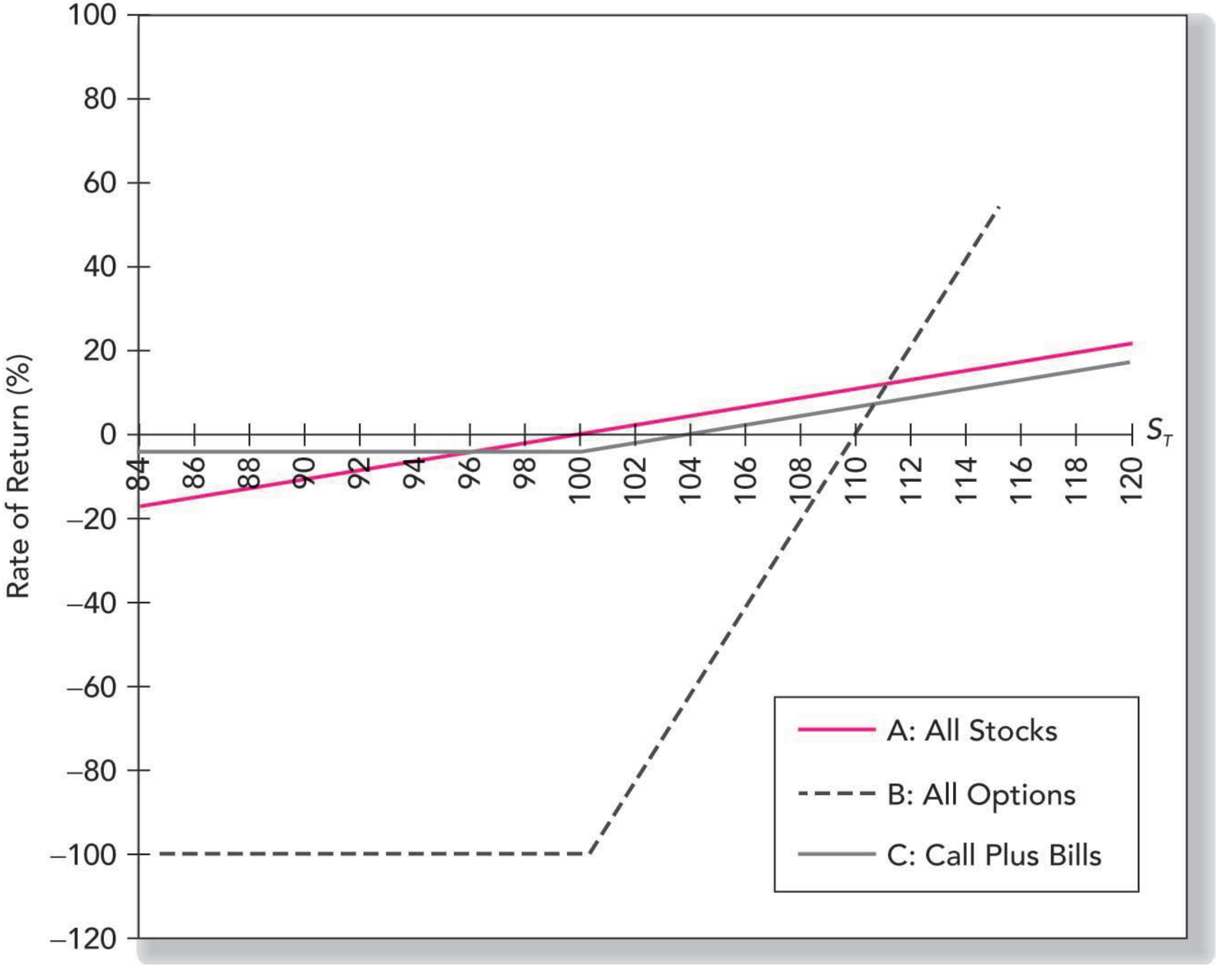
Investment VALUE Under 3 Scenarios of Stock Price at Expiration (S_T)					
	(i) $70	(ii) $95	(iii) $105	(iv) $115	(v) $130
All Stock	$7000	$9,500	$10,500	$11,500	$13,000
All Call Options	$0	$0	$5,000	$15,000	$30,000
T-Bills/Calls	$9,270	$9,270	$9,770	$10,770	$12,270

Example: 3 Different Investment Strategies

▸ Stock, All Call Options & Call Options + T-Bills

Investment RETURN Under 3 Scenarios of Stock Price at Expiration (S_T)					
	(i) \$70	(ii) \$95	(iii) \$105	(iv) \$115	(v) \$130
All Stock	-30.0%	-5.0%	5.0%	15%	30%
All Call Options	-100%	-100%	-50%	50%	200%
T-Bills/Calls	-7.3%	-7.3%	-2.3%	7.7%	22.7%

Example: Rate of Return to Three Strategies



As the graph highlights, the "all options" strategy is essentially a leveraged investment.

There is a disproportionately higher increase in return for a small increase in price in the underlying asset.

In the Headlines

List of Top 10 trading losses on Wikipedia

Trader Name	Loss in $Billions	Institution	Market	Year
Bruno Iksil	$9.0	JP Morgan Chase	Credit Default Swaps	2012
Howie Hubler	$9.0	Morgan Stanley	Credit Default Swaps	2008
Jerome Kerviel	$7.2	Societe Generale	European Index Futures	2008
Brian Hunter	$6.5	Amaranth Advisors	Gas Futures	2006
John Meriwether	$4.6	Long Term Capital Management	Interest Rate & Equity Derivatives	1998

https://en.wikipedia.org/wiki/List_of_trading_losses

In the Headlines

List of Top 10 trading losses on Wikipedia

Trader Name	Loss in $Billions	Institution	Market	Year
Bill Ackman	$4.1	Pershing Square	Valeant Pharmaceuticals	2015-2017
Yasuo Hamanaka	$2.6	Sumitomo Corporation	Copper Futures	1996
Isac Zagury, Rafael Sotero	$2.5	Aracruz	Foreign Exchange Options	2008
Robert Citron	$1.7	Orange County	Leveraged Bond Investments	1994
Heinz Schimmelbusch	$1.6	Metallgesell-schaft	Oil Futures	1993

https://en.wikipedia.org/wiki/List_of_trading_losses

Summary

- Derivatives
- Options
  - Types
  - Terminology
  - Payoffs

Put Call Parity

Learning objectives

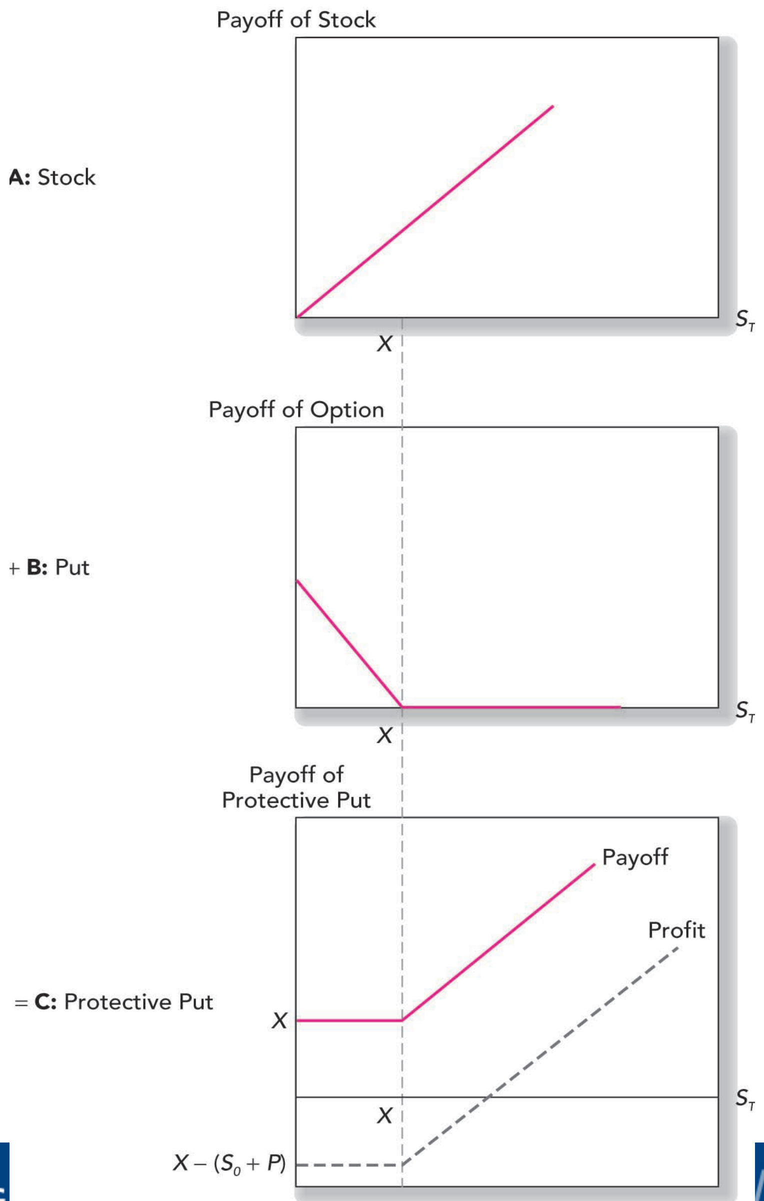
Understand put call parity

Options

Any set of payoffs contingent on the value of some underlying asset, can be constructed with a mix of simple options on that asset.

By adding and subtracting various combinations of calls and puts (at various exercise prices), we can create a variety of financial instruments with an endless range of payoff positions.

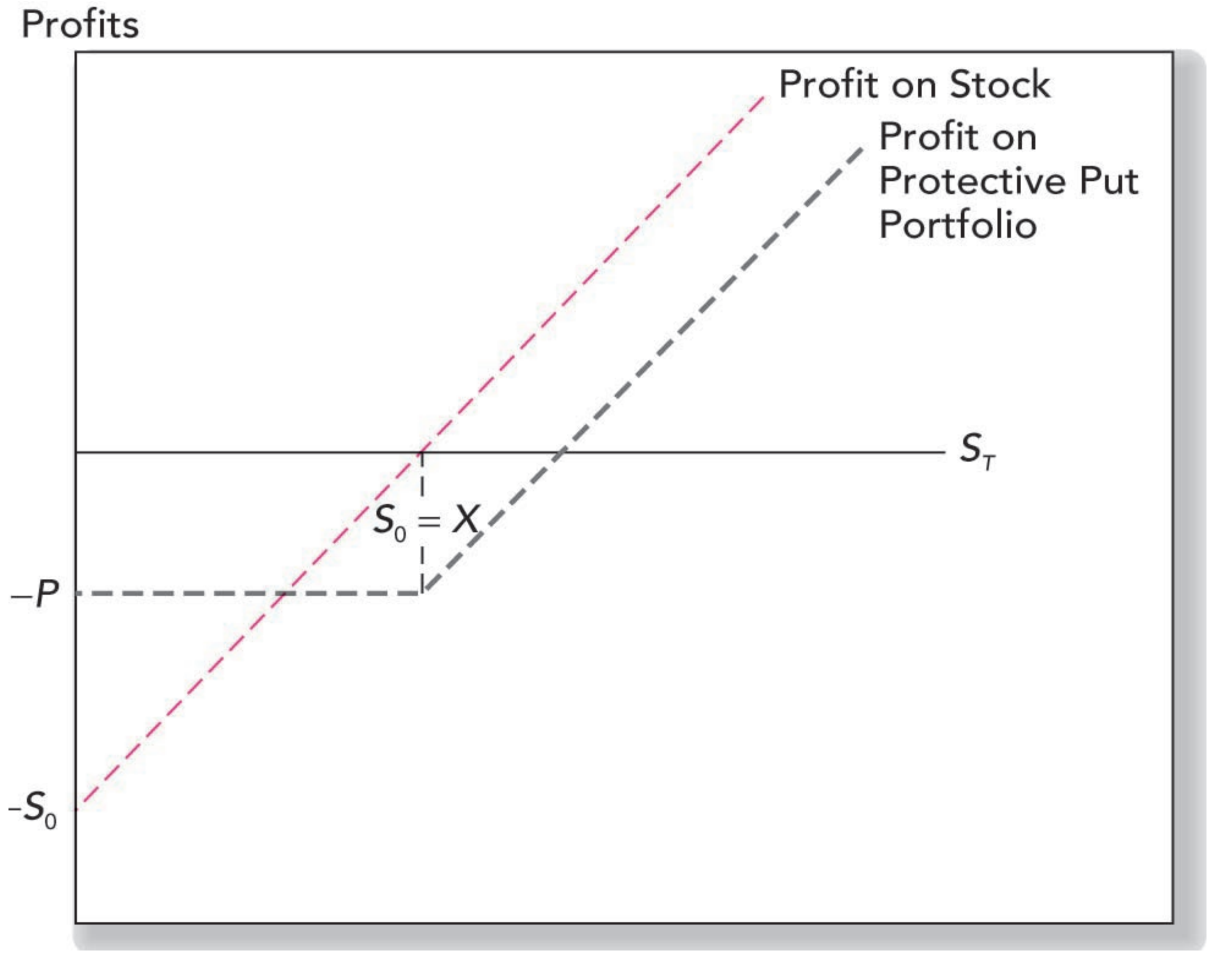
Value of a Protective Put Position at Option Expiration



Buy a Stock **&**
Buy a Put option
on the Stock

Profits: Protective Put *vs.* Stock Investment

Assumption: X is set to be equal to S_0



Put Call Parity

Not Examinable

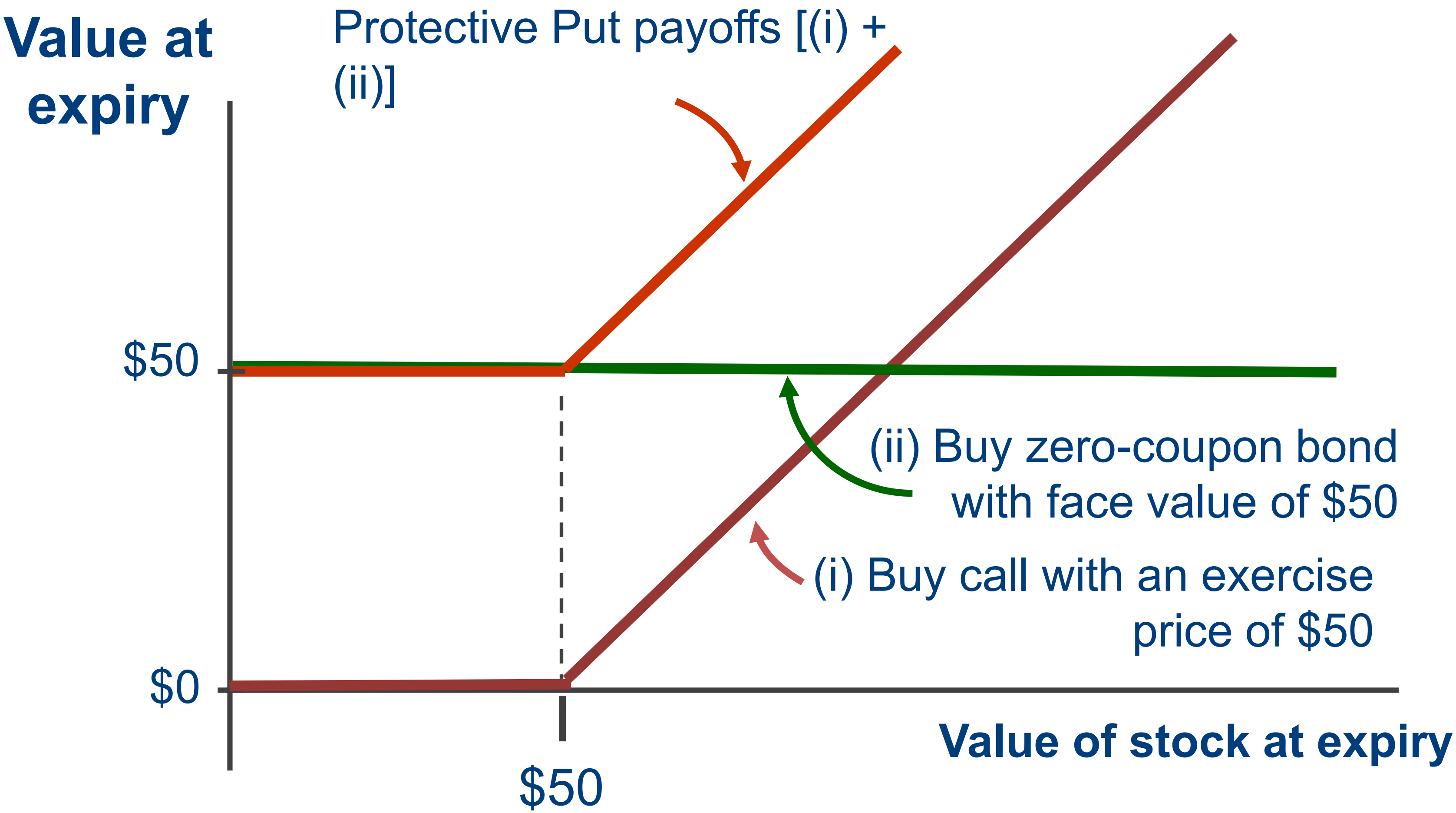
- Investment 1: Protective put (stock position and a put option on that position)
- Investment 2: Buy a call option on the same stock and Treasury bills with face value equal to the exercise price
- These ***two payoffs are identical***
- Therefore, ***they must cost the same***

$$S_0 + P = C + X / (1 + r_f)^T$$

If the prices are not equal, arbitrage will be possible.

Not Examinable

Protective Put Strategy vs Buy a Call and Buy a Zero-Coupon Bond: *Payoffs* at Expiry



Not Examinable

Comparing the Strategies for Put Call Parity

	Value at Expiration	
	$S < X$	$S \geq X$
Stock + Put	X	S
Call + PV(X)	X	S

- **Stock + Put**
  - If $S < X$, exercise put and receive X $(X – S + S)$
  - If $S \geq X$, let put expire and have S
- **Call + PV(X)**
  - PV(X) will be worth X at expiration of the option
  - If $S < X$, let call expire and have investment, X
  - If $S \geq X$, exercise call using the investment and have S $(S – X + X)$

Not Examinable

Put-Call Parity Again

Cost of 1st Strategy = Cost of 2nd Strategy

Price of Underlying Stock	+	Price of Put	=	Price of Call	+	PV of Exercise Price

$$S + P = C + PV(X)$$

zero-coupon bond with face value = X

$$\rightarrow P = C + PV(X) - S$$

Summary

Any sets of payoffs can be created by combining options, underlying assets, and risk-free bonds.

If the combined value is the same at the end, under all situations, then the cost today must be the same.

E.g., Put call parity

Option Value

Learning objectives

Basic understanding of option valuation

Option Values

- **Intrinsic value** – payoff that could be made ***if*** the option were to be immediately exercised.
    - CALL: Stock Price – Exercise Price
    - PUT: Exercise Price – Stock Price

  But in each case, Intrinsic Value must be ZERO or greater

- **Time Value of an Option** (not similar to the time value of money)
    - The difference between the *option price* and the *intrinsic value*
    - Most of the time value is coming from the volatility of the underlying asset's price

Call Option Value Bounds

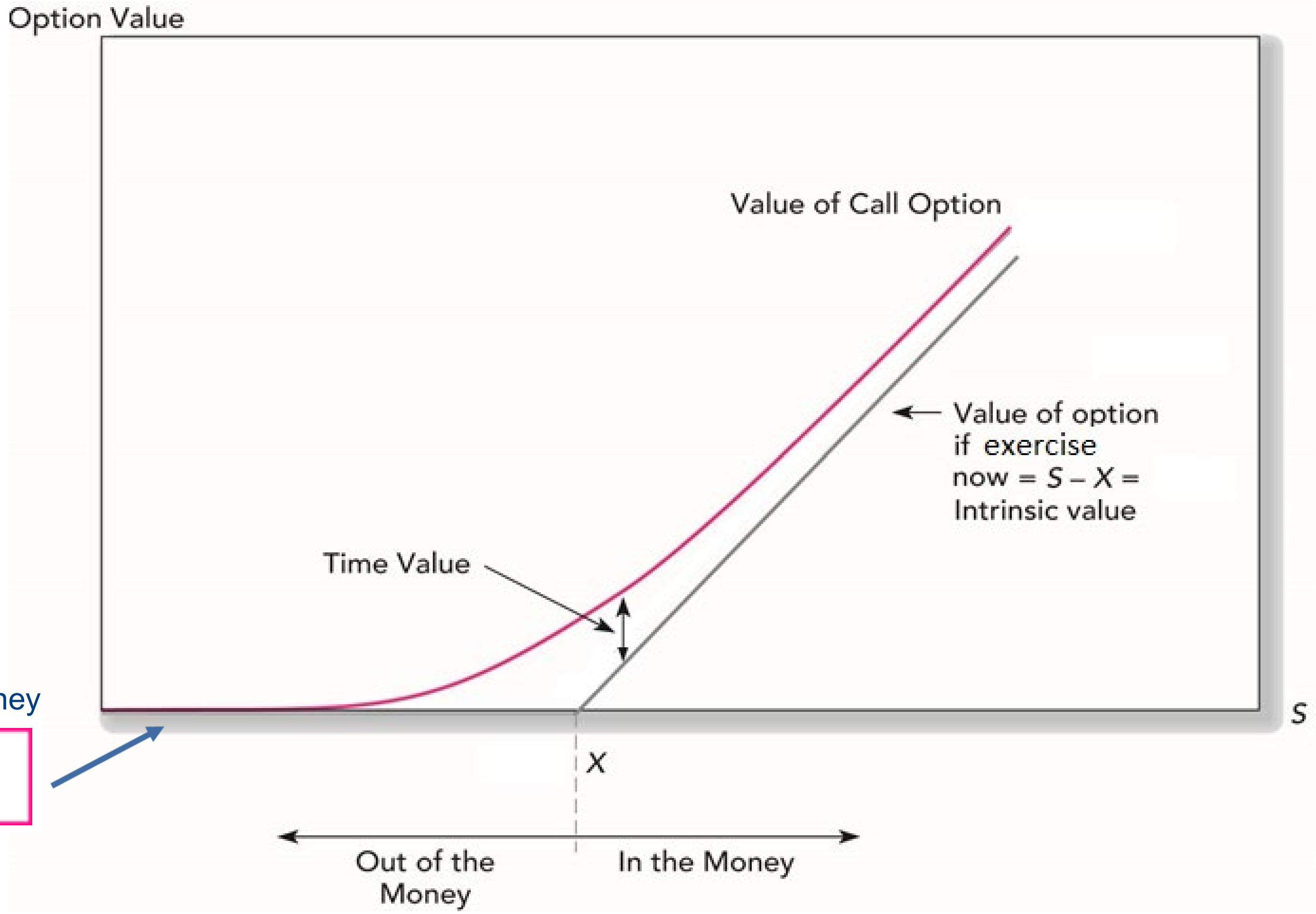
- **Upper bound**
  - Call price must be less than or equal to the stock price.
- **Lower bound**
  - Call price must be greater than or equal to the "intrinsic value" ("stock price minus the exercise price" or zero, whichever is greater).
- The value of a call option *C* must fall within

  $$\max(S - X, 0) \le C \le S$$

- If either of these bounds are violated, there is an arbitrage opportunity.

Call Option Value BEFORE Expiration

Highlighted in Pink
(Intrinsic Value in Black)



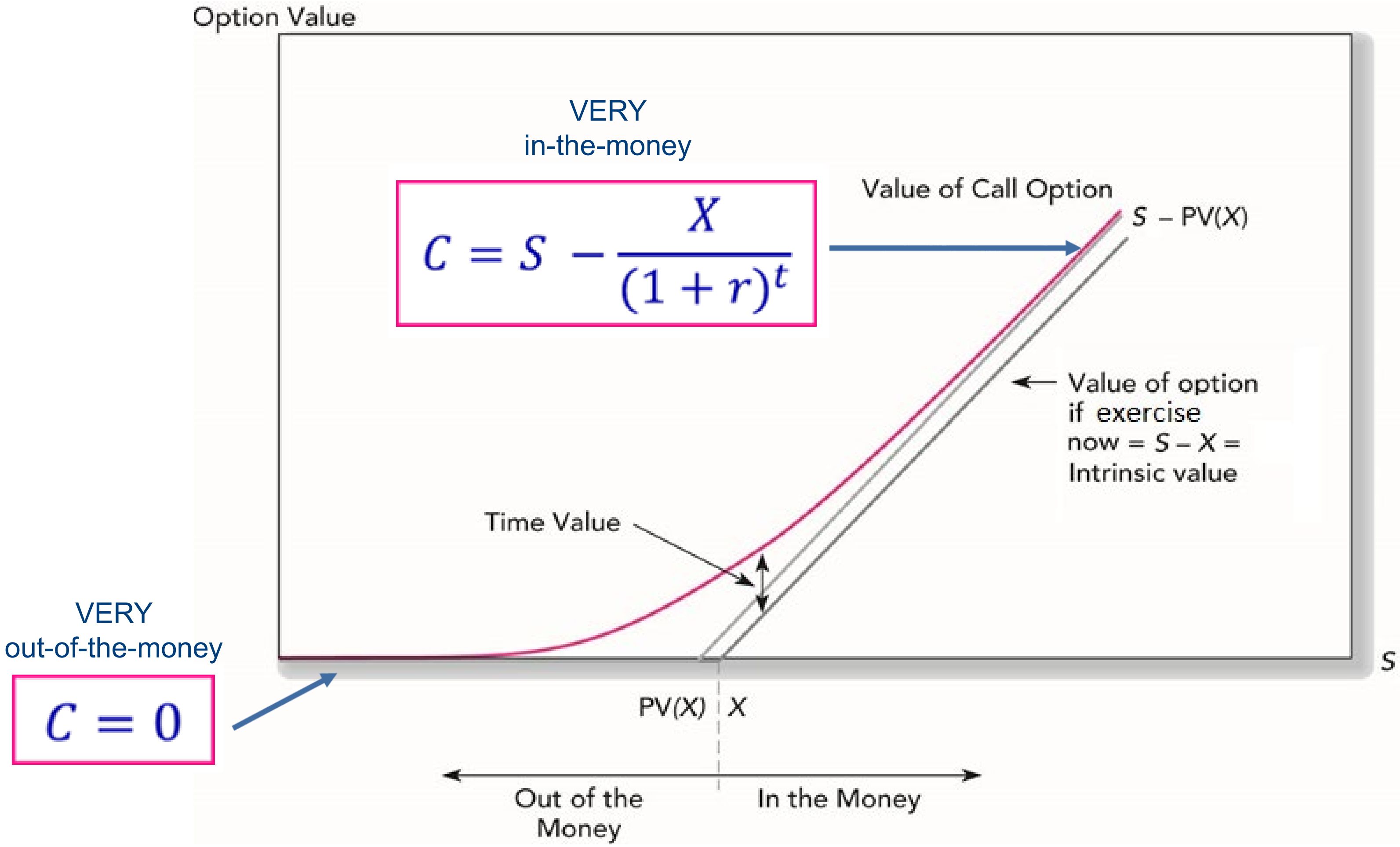
VERY out-of-the-money

$\boxed{C = 0}$

Call Option Value BEFORE Expiration

Highlighted in Pink

(Intrinsic Value in Black)



Call Option Value BEFORE Expiration

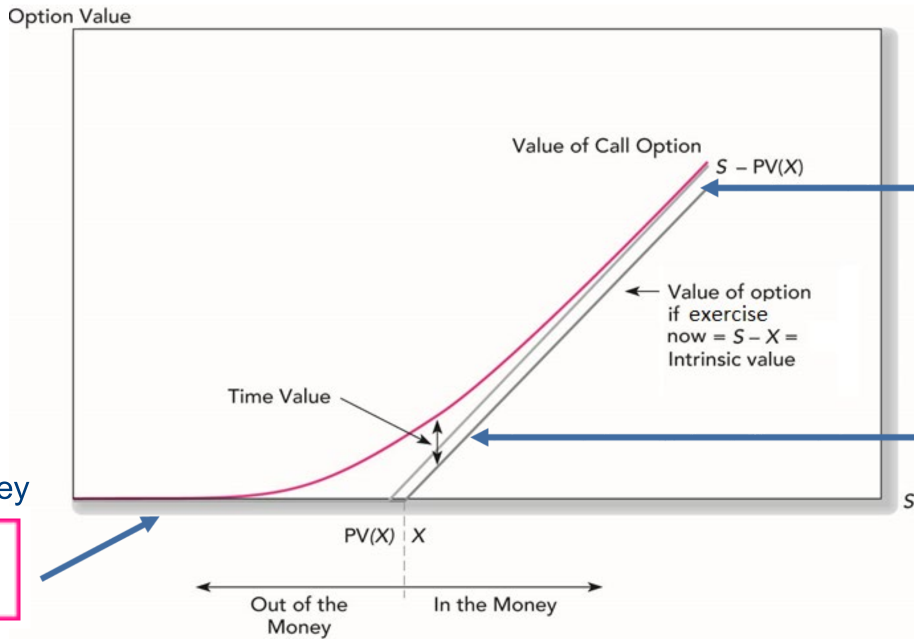
Highlighted in Pink

(Intrinsic Value in Black)

At the **two extreme ends,** when a call is VERY in-the-money or VERY out-of-the-money (such that it will definitely be exercised or definitely not be exercised at maturity), we can price the call BEFORE expiration.

VERY
in-the-money

$$C = S - \frac{X}{(1+r)^t}$$



VERY
out-of-the-money

$$C = 0$$

But in the area in between these extremes, we will need an options pricing model to help us factor in the 'time value' into the price of the call before expiration.

For a put, **at the two extreme ends,** when a put is VERY in-the-money that it will definitely be exercised at maturity, its value is $P = \frac{X}{(1+r)^t} - S$, and when VERY out-of-the-money $P = 0$.

CALL Options Valuation

- The value of a CALL option ***increases as stock price increases,*** (holding the exercise price constant).
- The value of a CALL option ***increases with both the rate of interest and the time to maturity***. The option's price is paid today but the exercise price isn't paid until the option is exercised, thus the longer the option maturity and the higher interest rates, the more valuable the delay in payment of the exercise price.
- The value of a CALL option ***increases both with the volatility of the share price and the time to maturity***. Option holders gain from volatility because their payoffs are not symmetric. If the stock price falls below the exercise price, the call option will have zero value, but for every \$ the stock price rises above the exercise price, the call will be worth an extra \$.

Option Value Determinants

	Call	Put
1. Stock price	+	–
2. Exercise price	–	+
3. Interest rate	+	–
4. Volatility in the stock price	+	+
5. Expiration date	+	+

Options Example

- Consider the Firm Gini Inc. Below are quotes for call options on its stock, as of September 2020 when its closing stock price was $60:

Expiration	Strike Price	Calls Vol.	Last
Apr-21	$55	809	$6.70
Apr-21	$60	790	$3.85
Apr-21	$65	801	$1.95
Jul-21	$55	600	$7.80
Jul-21	$60	610	$5.15
Jul-21	$65	590	$3.15

- Thus a call option on the firm's stock which matures in April 2021 and allows its owner to purchase a share of Gini stock for $65, sells for $1.95.

Options Valuation

What we know about option valuation so far:

- One thing that should be clear by now is that we ***cannot*** *use the* ***traditional*** *discounted cash flow method (DCF) to value options*.
- This is because **traditional DCF** requires us to
  a) estimate expected future cash flows and
  b) discount those cash flows at the opportunity cost of capital (reflecting the riskiness of the cash flows)
- An option's expected cash flows and relevant risk measures change every time the underlying stock's price changes.
  - **The underlying stock price changes constantly**.

Summary

- Basic option valuation concepts
- Determinants of option value

APPENDIX I:
Valuing an Option via an Option Equivalent

Non-Examinable

Valuing an Option via an Option Equivalent

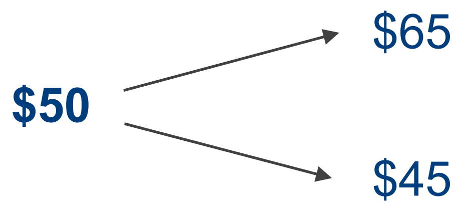
*We can value an option by setting up an **option equivalent** – by combining common stock investment and borrowing.*

- <u>HOW</u> do we do this?
- First of all, the value of an option *<u>prior to expiration</u>* inherits some of the properties of its <u>payoff upon expiration</u>.
- Thus to price the option we can do the following:
  - First, calculate the option's payoff upon expiration
  - Second, find a portfolio (via investment in <u>common stock</u> and <u>borrowing</u>) that *replicates the option payoff* and that ***<u>can be priced</u>*** independently
  - Third, the price of this replicating portfolio will also be the value of the option in an arbitrage-free equilibrium.

Valuing an Option via an Option Equivalent

We will illustrate using a simple **binomial** example.

- A firm's stock is presently selling for \$50. At the exercise date, one year from now, the price of the stock may increase to \$65 or may drop to \$45.
- The one-year risk-free rate is 12.5%.



- Consider a CALL option to buy a share of ABC at the end of the year for \$57 (exercise price).
- The possible terminal option values are:
  - C_H = Max {65 - 57, 0} = \$8.
  - C_L = Max {45 - 57, 0} = \$0.

Valuing an Option via an Option Equivalent

Is there **a portfolio** invested in the **stock** and the **risk-free asset** that **replicates these payoffs?**

The replicating portfolio contains:

- Δ = the number of *shares in the original stock*. Also called the ***hedge ratio or option delta***
- ***B*** = the amount that is *borrowed* at the risk-free rate.

We need to solve the following two simultaneous equations:

Δ * \$65 + *B* * (1 + 12.5%) = 8 ← Payoff in the H state

Δ * \$45 + *B* * (1 + 12.5%) = 0 ← Payoff in the L state

Note: Recall that the risk-free rate is 12.5% and the exercise date is one year from now

We solve for B and Δ.

Valuing an Option via an Option Equivalent

We need to solve the following two simultaneous equations:

$\Delta * \$65 + B * (1 + 12.5\%) = 8$ ← Payoff in the H state

$\Delta * \$45 + B * (1 + 12.5\%) = 0$ ← Payoff in the L state

Subtracting one equation from the other we get:

$\Delta * (\$65 - \$45) = (8 - 0)$

$\boldsymbol{\Delta = \underline{0.4}}$

Solving for *B* using the second equation:

$0.4 * \$45 + B * (1 + 12.5\%) = 0$

$\boldsymbol{B = -0.4 * \$45/1.125 = \underline{-\$16}}$

Valuing an Option via an Option Equivalent

Δ = **0.4**; B = **–$16**

- Thus, to replicate the option's payoff one needs to
  - ✓ ***Buy* 0.4** shares for 0.4 * $50 (the price of 1 share) = $20
  - ✓ ***Borrow* $16** to partially finance the purchase
- Net cost of the portfolio that replicates the option's payoff is **$4**.
  - In an (arbitrage-free) equilibrium, this must be the value of the option
- **Implication:** A call option is like a leveraged portfolio in which the purchase of a stock is partially financed with a risk-free loan

Valuing an Option via an Option Equivalent

Note that we could equivalently find the hedge ratio as follows:

$$\Delta = \textbf{\textit{Delta}} = \frac{\text{spread of possible option values}}{\text{spread of possible stock prices}} = \frac{\$8 - \$0}{\$65 - \$45} = 0.4$$

Delta and the Hedge Ratio

- The above practice of the construction of a riskless hedge is called *delta hedging*.
- The Δ (**delta**) of a call option is between 0 and 1.
  - Recall from the example:

$$\Delta = \frac{\text{Swing in value of call}}{\text{Swing of value of underlying stock}} = \frac{\$8-0}{\$65-\$45} = \frac{\$8}{\$20} = \frac{2}{5} = 0.4$$

- The delta of a put option is between -1 and 0.
- ***A call option that is very deep in the money will have a delta of 1***. The value of a call that is assumed to end in the money will move dollar for dollar in the same direction as the price of the underlying asset.

Delta

- ***Determining the Amount of Borrowing***:
  - PV of the lower possible stock price at maturity * Delta
  - From previous example: ($45/1.125 * (0.4)) = **$16**

- ***Determining the Value of a Call***
  - ***VALUE OF A CALL = STOCK PRICE * DELTA – AMOUNT BORROWED***
  - From example: $50 * (0.4) − $16 = $20 − $16 = **$4**

APPENDIX II:
The Black-Scholes Model

Non-Examinable

The Black–Scholes Model

- The ***B&S model is based on the replication method previously discussed***.
- It is founded on the following assumptions:
  - Can buy or sell the stock at all times (no restriction on short sales).
  - No transaction costs.
  - Unlimited borrowing and lending at the riskless rate.
  - Prices evolve smoothly.
  - Constant risk-free rate and volatility.
  - Stock price is log-normally distributed (follows a log-normal random walk).
  - Stocks do not pay dividends.

Value of Call Option* = *C* = *B&S* formula function of *[S, X, σ, r, T]

The Black–Scholes Formula

$$C \quad = \quad S * N(d_1) \quad - \quad \underbrace{X e^{-r\,T}}_{\text{PV (Exercise Price)}} * N(d_2)$$

Value of call option = [current share price * delta] – [bank loan]

Where:

$$d_1 = \frac{\ln\left(S / X \cdot e^{-rT}\right) + \frac{1}{2}\sigma^2 T}{\sigma\sqrt{T}} \quad \text{and} \quad d_2 = d_1 - \sigma\sqrt{T}$$

- ***ln* ( )** is the natural logarithm function,
- ***N* (d)** denotes the standard normal distribution function probability that a random draw from a normal distribution will be less than d.
- **T** is the number of periods to exercise date
- **σ** is the standard deviation per period of the stock's logarithmic return (continuously compounded).
- **r** the risk-free interest rate (continuously compounded)

Simplified Analogy to the Simple Binomial Model

$$C_0 = S \times \mathrm{N}(d_1) - \underbrace{Xe^{-rT} \times \mathrm{N}(d_2)}$$

Value of a call = Stock price × Delta − Amount borrowed

Black-Scholes Formula – Online

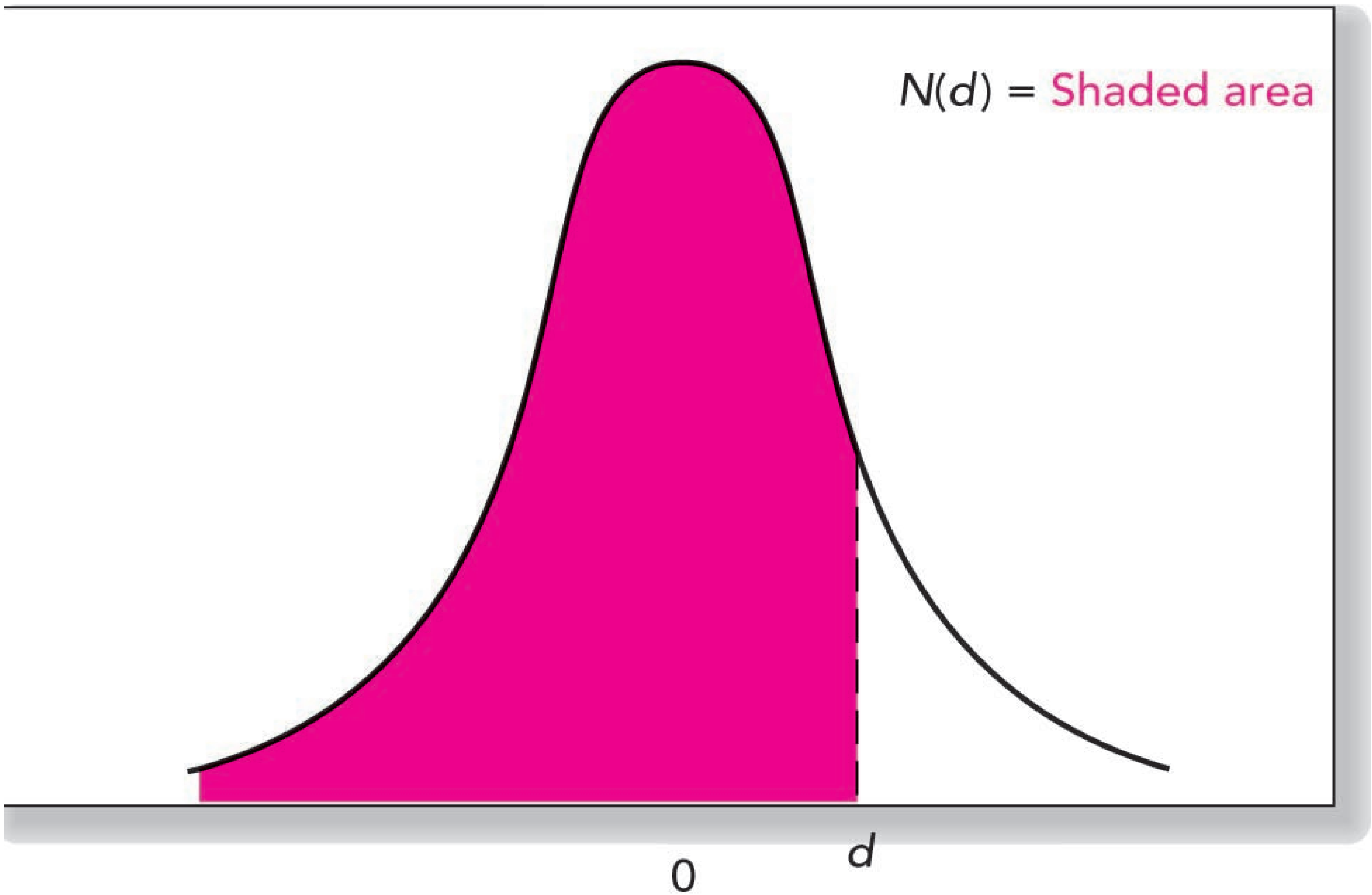
- A number of ready-made tools are available to enable you to compute option prices.
- One option price tool available on the web is at:

http://www.option-price.com/index.php

Inputs: Current Stock Price **S** (in $); Option Exercise Price **X** (in $); **r** is the annual risk-free interest rate to maturity of the option (in %); Annual Standard Deviation **σ** (in %); Time to Option Expiration **T** (note here the input is in days). [Includes input for dividend yield (in %) if dividends issued].

Output: Call Price **C**

Standard Normal Curve



Call Option Example

$S_o = 100$ $\quad X = 95$

$r = 0.10$ $\quad T = 0.25$ (quarter)

$\sigma = 0.50$

$$d_1 = \frac{\ln(S/X) + [T^* (r + (\sigma^2/2))]}{\sigma * T^{1/2}}$$

$$d_1 = \frac{\ln(100/95) + [0.25 * (0.10 + (0.5^2/2))]}{0.5 * 0.25^{1/2}}$$

$$= 0.43$$

$$d_2 = 0.43 - 0.5*0.25^{1/2} = 0.18$$

Probabilities from Normal Distribution

From Cumulative Normal Distribution Tables

d	N(d)	
.42	.6628	
.43	.6664	Interpolation
.44	.6700	

N (.43) = .6664

d	N(d)
.16	.5636
.18	.5714
.20	.5793

N (.18) = .5714

Call Option Value

$C_o = S_o * N(d_1) - Xe^{-rT} * N(d_2)$

$C_o = 100*0.6664 - 95\ e^{-\ 0.10*0.25}*0.5714$

$C_o = 13.70$

<u>Implied Volatility</u>

Using Black-Scholes and the actual price of the option, one can solve for implied volatility.

Put Value Using Black-Scholes

$P = Xe^{-rT}\,[1-N(d_2)] - S_0\,[1-N(d_1)]$

Using the sample call data:

$S = 100 \qquad r = 0.10$

$X = 95 \qquad \sigma = 0.5 \qquad T = 0.25$

$P = 95e^{-10x0.25}(1-0.5714) – 100(1-0.6664) = 6.35$

Put Value: Using Put-Call Parity

$P = C + PV(X) - S_o$

$= C + Xe^{-rT} - S_o$

<u>Using the example data:</u>

$C = 13.70$ $X = 95$ $S = 100$

$r = 0.10$ $T = 0.25$

$P = 13.70 + 95e^{-0.10*0.25} - 100$

$P = 6.35$

Employee Stock Options (ESOs)

- Employee Stock Options (ESOs) allow employees to purchase company stock at a fixed price.
- They are granted primarily for two basic reasons:
  - Align employee interests with owner interests
  - Feasible form of compensation for cash-strapped companies

- **ESO Features** differ from company to company, but some common ones are
  - Typical expiration of 10 years
  - Cannot be sold or transferred unless the employee dies, then options transfer to the estate
  - Vesting (waiting) period during which they cannot be exercised
  - Employee loses the options if he leaves the company

APPENDIX III: Options and Corporate Finance

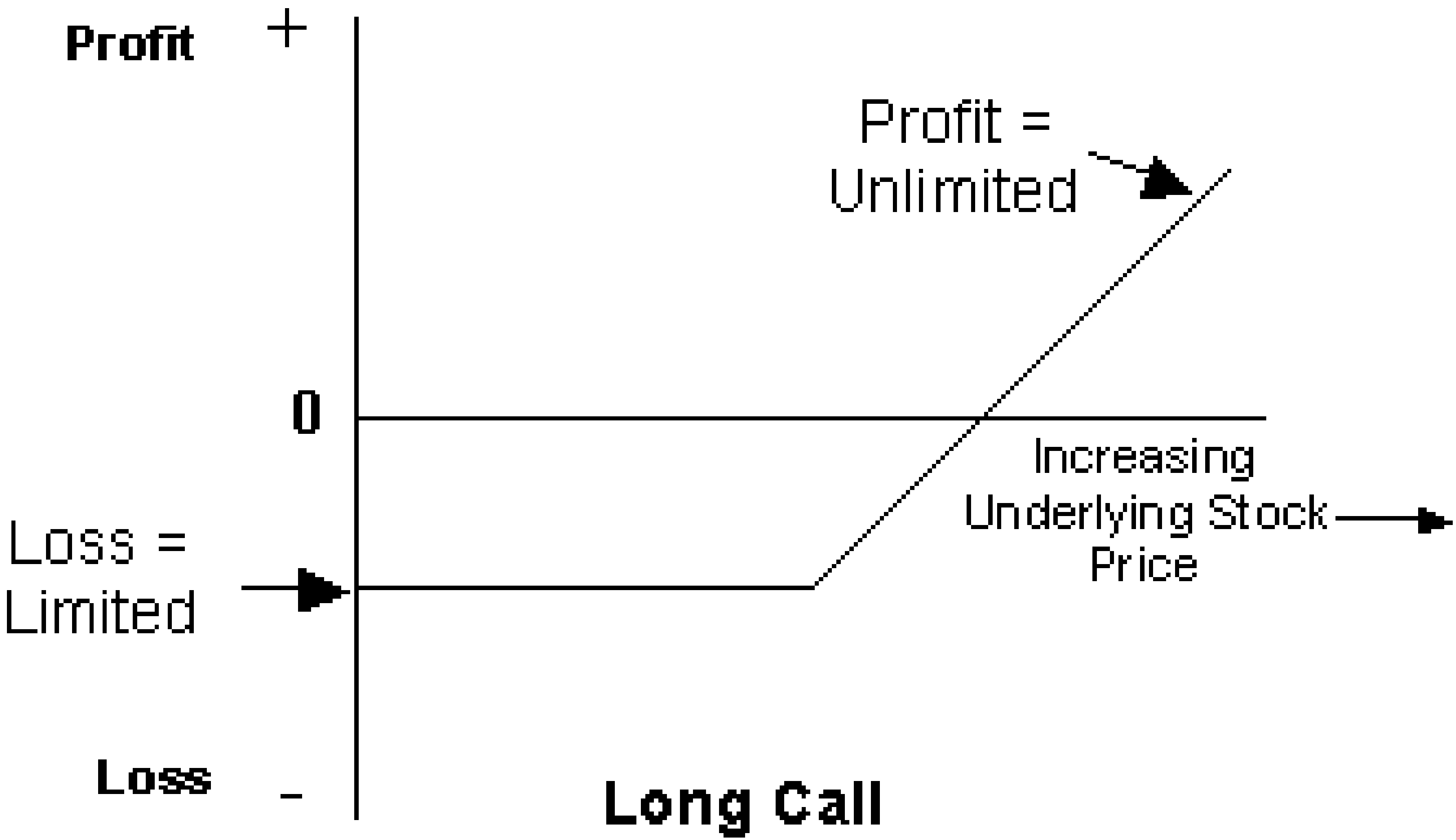
Non-Examinable

Options and Corporate Finance

Equity is a Call Option

- The stockholders have a call on the firm with the strike price equal to the face value of the firm's debt.
- If the firm's assets are worth more than the debt, the option is in-the-money
  - Stockholders will exercise the option by paying off the debt
- If the firm's assets are worth less than the debt, the option expires unexercised
  - The company will default on its debt

Equity as a Call Option



Options and Capital Budgeting

A. The Investment Timing Decision

- The ***option to wait*** is valuable when the economy or market is expected to be better in the future
- The option to wait may actually turn a bad project into a good project
- Waiting a year or two may allow the firm to capture higher cash flows

Options and Capital Budgeting

B. Managerial Options – whether to modify a project after implementation

- ***Option to expand***: make project bigger if successful
- ***Option to abandon:*** shutdown project if things don’t go as planned
- ***Option to suspend or contract***: downsize when market is weaker than expected

Options and Corporate Securities

A. Warrants

- Issued by the firm: gives the holder the right, but not the obligation, to purchase the common stock directly from the company at a fixed price for a given period
- Sweeteners or equity kickers: warrants are sometimes issued together with privately placed bonds, public issues of bonds, and new stock issues

Options and Corporate Securities

B. Convertible Bonds

- Bond that may be converted into a fixed number of shares on or before the maturity date
- The conversion option is essentially a call option on the company's stock with the strike price equal to the bond price

Options and Corporate Securities

C. Callable bonds, Put bonds

- ***Callable bonds:*** the firm may retire the bonds early at a specified call price
- ***Putable bonds***: the bondholder may put bonds back to the issuer at specified intervals before maturity

Options and Corporate Securities

D. Insurance and Loan guarantees

– These can be viewed as combination of the underlying asset plus a put option. If the asset declines in value, the put holder (insured) exercises the option and "sells" the underlying asset to the put writer (insurer).