



BACHELOR of ECONOMICS
International Program

Thammasat University | Thailand

FN 312

Investments



Options

Outline

- What are options
- Option markets
- Profit/loss of option
- Option trading strategies
- Put call parity
- Option-like securities

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What are options

- A European call option contract provides its holder with the right (but not the obligation) to buy an asset for a specified price (exercise price or strike price) on a specified expiration day

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10530	85	Mar	*	...	722	060
10530	95	Mar	262	1220	796	165
10530	95	Apr	71	1460	684	430
10530	100	Mar	133	830	2043	275
10530	105	Mar	1435	470	2483	440
10530	105	Apr	2593	870	412	740
10530	110	Mar	1532	285	586	730
10530	110	Apr	1010	580	46	11
10530	115	Mar	958	120	36	11
10530	115	Apr	408	420	55	1320
10530	120	Mar	2511	055	14	16
10530	120	Jul	487	560	1	1840

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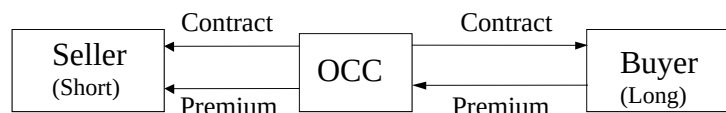
What are options

- A European put option contract provides its holder with the right (but not the obligation) to sell an asset for a specified price (exercise price or strike price) on a specified expiration day
- Purchase price is called the premium

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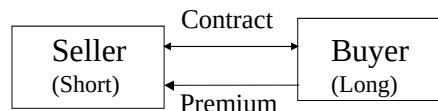
Option markets

- Exchange-traded options



Standardized contracts that are less flexible, but more liquid market;
Easy to reverse position; No counter party risk

- OTC (Over The Counter) options



Customized contracts; Illiquid market; Costly to reverse position;
Counter party risk

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Option markets

- Standardized options first traded at the CBOE in 1973
- Now, options are traded on many exchanges
- For examples of exchange traded options see <http://www.cboe.com>
- Exchange traded options expires on the third Friday of the expiration month

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Notation

C_t : Price of Call Option at time t .

P_t : Price of Put Option at time t .

S_t : Price of Stock (or other asset) at t .

X : Exercise Price of Option.

t
(current time)

T
(Expiration Date)

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Payoff/Profit of a Call

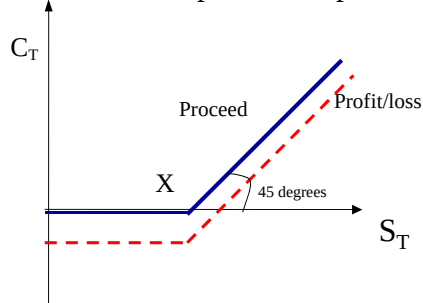
What is the payoff of a call at expiration, C_T ?

Proceed = $S_T - X$ if $S_T > X$

0 if $S_T \leq X$

Buy a call (long); profit loss = $\max(S_T - X, 0) - \text{premium}$

Break even when stock price = $X + \text{premium}$

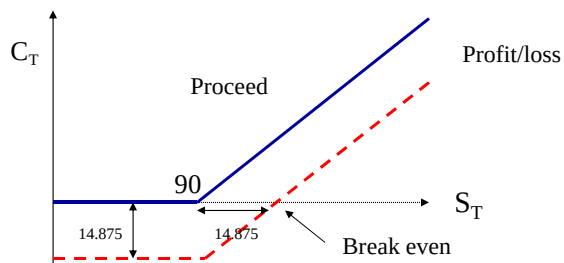


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Payoff/Profit of a Call

Long a January call option on

IBM: $X=90$ price = 14.875 (BKM Figure 20.2)



Exercise when stock price > 90

Proceed = $\max(S_T - 90, 0)$; Profit/loss = $\max(S_T - 90, 0) - 14.875$

Break even when stock price = $90 + 14.875 = 104.875$

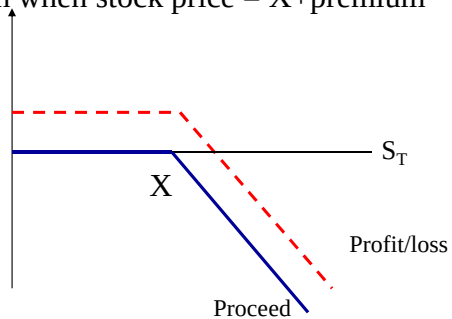
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Payoff/Profit of a Call cont.

Write (short) a call; proceed = $-\max(S_T - 90, 0)$

Profit/loss = proceed + premium

Break even when stock price = $X + \text{premium}$



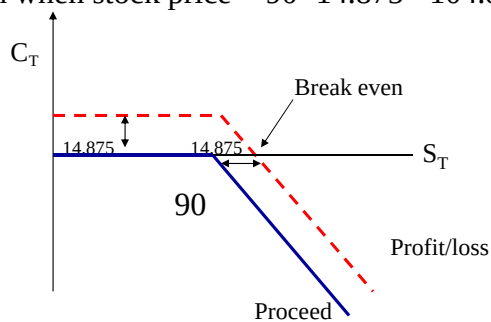
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Payoff/Profit of a Call cont.

Short a January call option on IBM: $X = 90$ price = 14.875

Profit loss = proceed + premium = $-\max(S_T - 90, 0) + 14.875$

Break even when stock price = $90 + 14.875 = 104.875$



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Concept check

What is the profit/loss of an investor who buys a one month call option of a stock XYZ with a strike price of 50 at the premium of \$5 when the stock price at maturity is 52?

- G) -3
- Y) 3
- R) -5

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Payoff/Profit of a Put

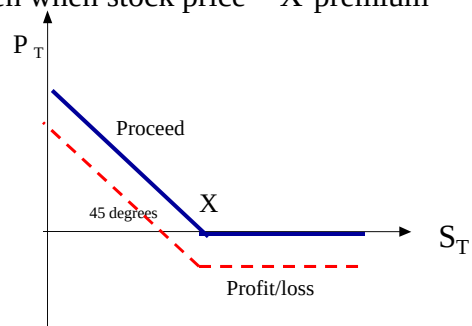
Payoff/proceed to a put holder at expiration

$$P_T = 0 \quad \text{if } S_T > X$$

$$X - S_T \quad \text{if } S_T \leq X$$

Buy a put: profit/loss = $\max(X - S_T, 0) - \text{premium}$

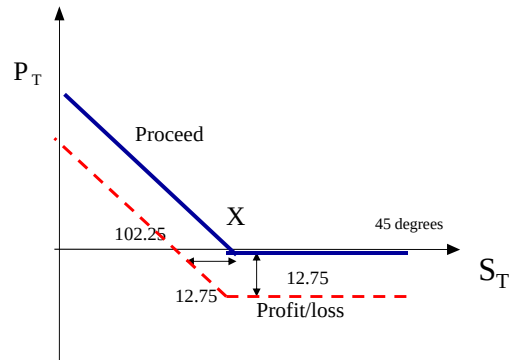
Break even when stock price = $X - \text{premium}$



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Payoff/Profit of a Put

Long a February put option on IBM: $X=115$ price =12.75



Exercise when stock price < 115

Proceed = $\max(115 - S_T, 0)$; Profit/loss = $\max(115 - S_T, 0) - 12.75$

Break even when stock price = $115 - 12.75 = 102.25$

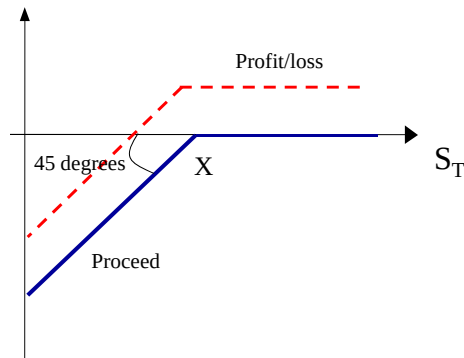
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Payoff/Profit of a Put

Write (short) a put: Proceed = $-\max(X - S_T, 0)$

Profit/loss = proceed + premium

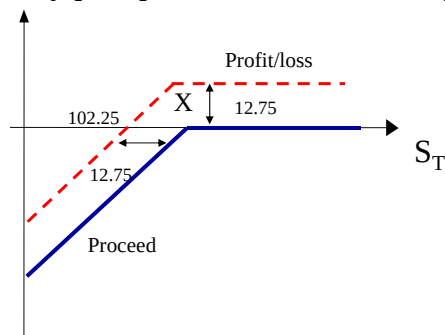
Break even when stock price = $X - \text{premium}$



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Payoff/Profit of a Put

Short a February put option on IBM: $X = 115$ price = 12.75



Proceed = $-\max(115 - S_T, 0)$; Profit/loss = $-\max(115 - S_T, 0) + 12.75$

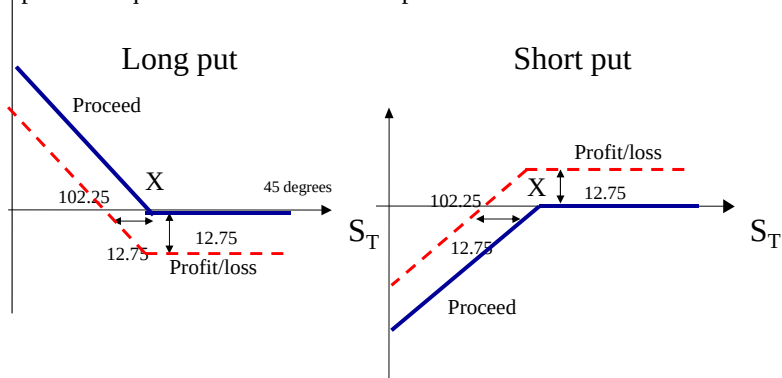
Break even when stock price = $115 - 12.75 = 102.25$

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Payoff/Profit

Short and long positions are mirror images of each other along the horizontal axis

Long and short derivatives is a zero sum game; the gain to the long position equals the loss to the short position and vice versa



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ATM, OTM, and ITM

- An option is said to be in-the-money (ITM) when its immediate exercise would generate a positive cash-flow for its holder

ITM call $S_T > X$

- The option is said to be out-of-the-money (OTM) when its immediate exercise would generate negative cash flow (CF)

OTM call $S_T < X$

- A put or call option is said to be at-the-money (ATM) when the exercise price equals the asset price

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Concept check



When is a put option in the money and when is it out of the money?

G) ITM put $S_T < X$, OTM put $S_T > X$

Y) ITM put $S_T > X$, OTM put $S_T < X$

R) ITM put $S_T = X$, OTM put $S_T = X$

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Option strategies: option versus stock investment

A: Use \$10K to buy 100 shares of ABC at 100

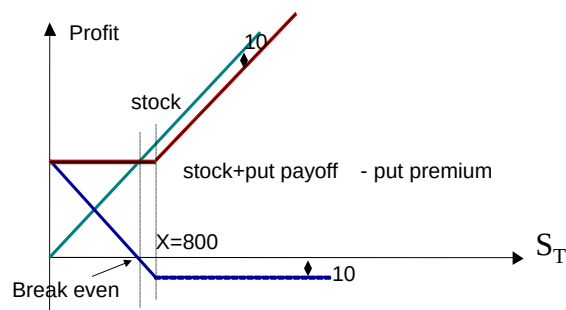
B: Use \$10K to buy 1000 ABC call option at \$10, $X=100$

	ABC stock Prices				
Portfolio	100	105	110	115	120
<u>All stocks</u>					
Value	10000	10500	11000	11500	12000
Return	0	5%	10%	15%	20%
<u>All options</u>					
Value	0	5000	10000	15000	20000
Return	-100%	-50%	0%	50%	100%

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Basic Options Strategies

- Protective put: hold asset and buy a put for portfolio insurance

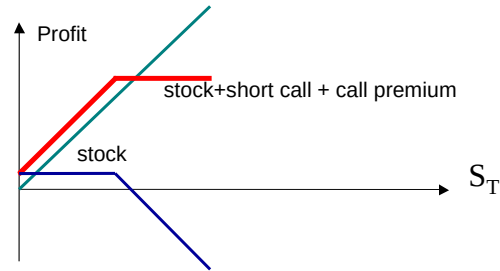


- Hold market index (S&P500). Buy option on the index with $X=800$. Let each option contract be 1 time the index. The premium = \$10. Break even = 790.

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Basic Options Strategies

- Covered call: hold the asset and write a call. Give up some upside potential for income from call premium

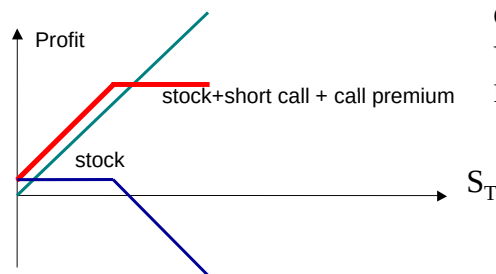


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Concept check

- You are a portfolio manager that holds a diversified market portfolio. You do not think the stock market is going to increase much in the near future (1 month). You want to add income to your portfolio by selling call options on the index. The strike price is 1000 and the premium=\$50. What is the break even index level beyond which you are better off not selling calls?



G) 1000

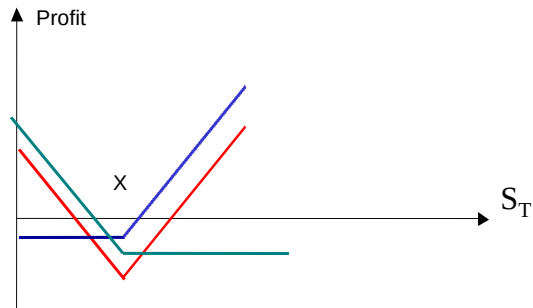
Y) 950

R) 1050

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Basic Options Strategies

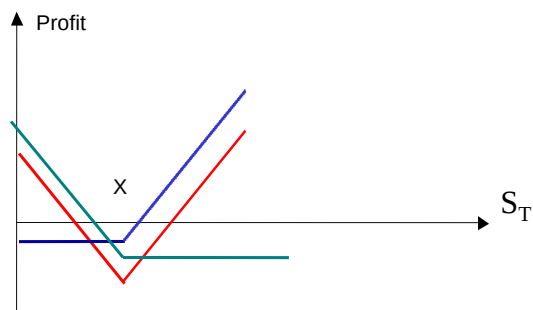
- Straddle: Buy call and put at the same strike price



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Basic Options Strategies

- Straddle: Buy call and put at the same strike price

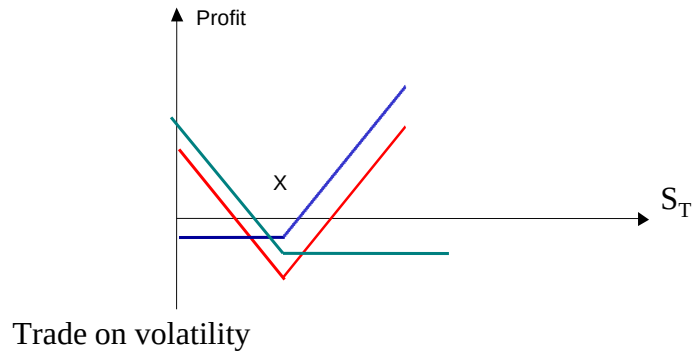


What is the view on the market?

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Basic Options Strategies

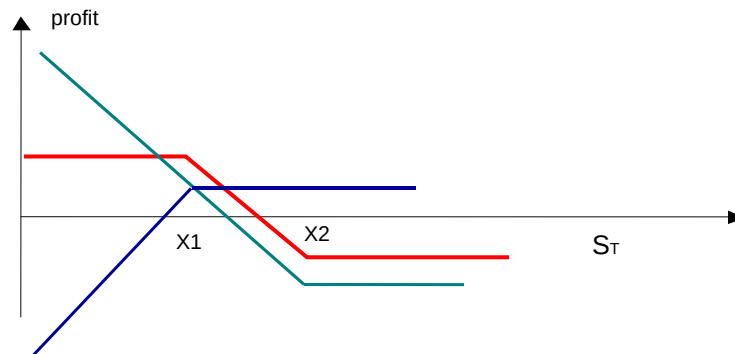
- Straddle: Buy call and put at the same strike price



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Basic Options Strategies: Bear spread

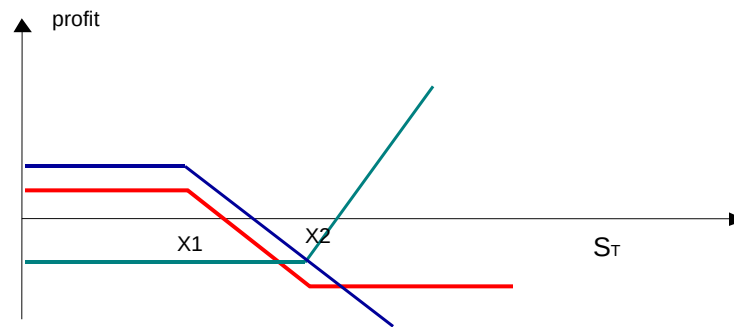
- Spreads: buy and sell puts on different strike price
- A bear spread can be constructed from 1) Shorting put at X_1 and long put at X_2 for $X_1 < X_2$.



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Basic Options Strategies: Bear spread

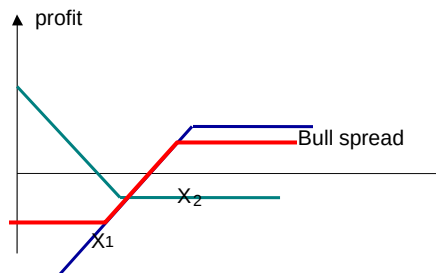
- Spreads: buy and sell puts on different strike price
- A bear spread can be constructed from 2) Shorting call at X_1 and long call at X_2 for $X_1 < X_2$.



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Basic Options Strategies: bull spread

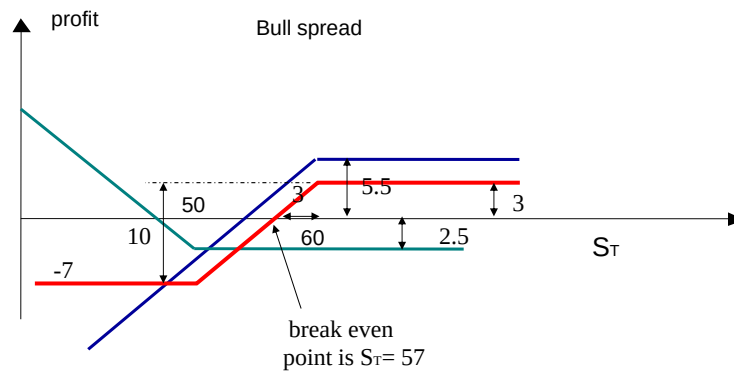
- A bull spread can be constructed from 1) Shorting put at X_2 and long put at X_1 ; $X_1 < X_2$ or 2) Shorting call at X_2 and long call at X_1 ; $X_1 < X_2$



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Basic Options Strategies: Bull spread

- Example: buy a put with $X = \$50$ at $\$2.5$ and sell a put with $X = \$60$ at $\$5.5$.



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Basic Options Strategies

- Example: buy a put with $X = \$50$ at $\$2.5$ and sell a put with $X = \$60$ at $\$5.5$.

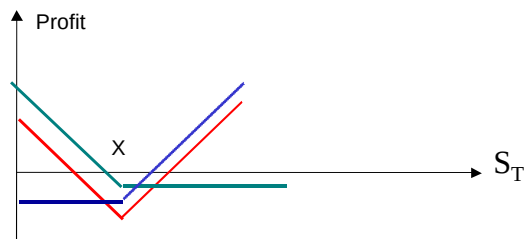
	$S_T < 50$	$50 < S_T < 60$	$S_T > 60$
• Buy put	$50 - S_T$	0	0
• Sell put	$-(60 - S_T)$	$-(60 - S_T)$	0
• Premiums	3	3	3
• Profit	-7	$-57 + S_T$	3
• What is the break even point?	$-57 + S_T = 0 \rightarrow S_T = 57$		

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Concept check

- Buy a call at $X=\$70$ for \$7 buy a put at $X=\$70$ for \$5. Maximum loss from this strategy?
G) \$12
Y) \$7
R) \$5



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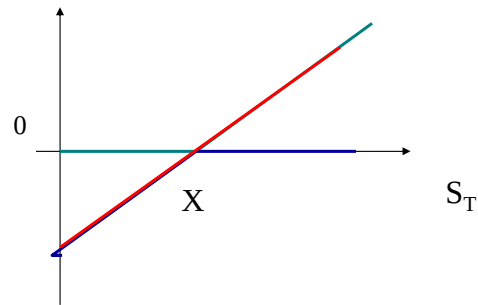
European VS American options

- A European option: exercised only at expiration date
- An American option: exercised any time before or at expiration date
- The price of an American option is at least equal to or higher than its European equivalent
- Most exchange-traded options in the US are American
- Examples of European options are index options and interest rate options

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Put-call parity

Suppose you buy a call and write (sell) a put with the same exercise price and expiration date

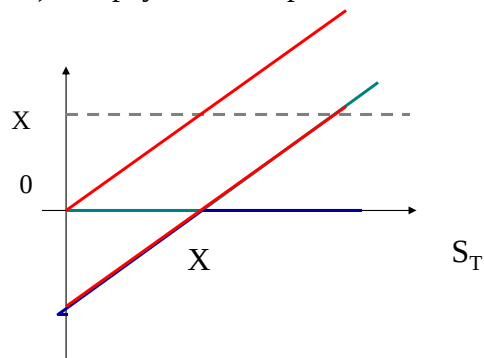


One step further: Suppose in addition you buy today a risk-free zero coupon bond that pays $\$X$ at option expiry

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Put-call parity

1. buy a call, 2. write (sell) a put with the same exercise price and expiration date, 3. buy a risk-free bond (no coupon) that pays $\$X$ at expiration.



What is the payoff at T of this portfolio? S_T

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Put-call parity

Portfolio A: 1. buy a call, 2. write (sell) a put with the same exercise price and expiration date, 3. buy a risk-free bond (no coupon) that pays \$X at expiration

Portfolio B: Buy the stock

$$C_T - P_T + X = S_T$$

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Put-call parity

- Pay off of each portfolio at maturity

Portfolio A: $C_T - P_T + X$

Portfolio B: Buy the stock S_T

$$C_T - P_T + X = S_T$$

- Law of one price: Two investments strategies that have the same payoff in the future in all states of the world must have the same price today
- Put-call Parity Theorem (no dividends)

$$C_t - P_t + PV(X) = S_t \longrightarrow C_t = P_t + S_t - \frac{X}{(1 + r_f)^T}$$

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Put-call parity cont.

With dividends

$$C_t = P_t + S_t - \frac{X}{(1 + r_f)^T} - PV(\text{dividends})$$

Does not hold for American calls and puts that may be optimally exercised early

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Arbitrage

- An arbitrage is an investment trading strategy that either
 1. generates a positive cash flow today and no chance of negative cash flows in the future
 2. costs nothing today and generates positive cash flow in the future
- How to take advantage of an arbitrage opportunity?
 - Construct two portfolios that generate the same cash flow
 - Buy low sell high

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Arbitrage

- An example: IBM's current stock price is 110. A European call option on IBM with strike price 100 expiring in 6 months is priced at \$15. The put price of the same strike price is \$4. The interest rate for 6 months is 3%.
- Is there an arbitrage opportunity?
- From put-call parity:

$$P = C - S + PV(X) = 15 - 110 + 100 / (1.03) = 2.087$$
 Yes!

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Arbitrage - An Example: IBM

- How do we take advantage of this mispricing?
- $P > C - S + PV(X)$
- Sell the LHS and buy the RHS

	Investment	$S_T > 100$	$S_T < 100$
Sell IBM put	4	0	$-(100 - S_T)$
Buy IBM call	-15	$S_T - 100$	0
Sell IBM stock	110	$-S_T$	$-S_T$
Lend money	-97.087	100	100
PV (100)			
Total	1.913	0	0

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Concept check

Intel's current stock price is 110. A European call option on INTC with strike price 100 expiring in 6 months is priced at \$18. The put price of the same strike price is \$4. The interest rate for 6 months is 3%. Is there an arbitrage opportunity?

G) Yes.

R) No.

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Arbitrage: practice

How do we take advantage of this mispricing?

Buy P and sell C-S+PV(X) $\rightarrow$ -C+S-PV(X)

	Investment	$S_T > 100$	$S_T < 100$
Buy INTC put	-4	0	$100 - S_T$
Sell INTC call	18	$-(S_T - 100)$	0
Buy INTC stock	-110	S_T	S_T
Borrow money	97.087	-100	-100
<u>PV (100)</u>			
Total	1.087	0	0

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Option-like securities: Callable bonds

- The issuer has the option to buy back the bond at a predetermined price
- Callable bonds often have a call protection period
- The call price is par or schedule prices that decline to par at maturity
- Callable bond can be thought of as: straight bond – call option
- A callable bond should be selling at a lower price than a straight bond with the same cash flow

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Concept check



- Suppose the period of call protection is extended. How will the coupon rate the company needs to offer on its bonds change to enable the issuer to sell the bond at par value?

- G) The coupon needs to increase
- Y) The coupon needs to decrease
- R) The coupon remains the same

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Option-like securities: Convertible bonds

- Gives the investor the right to return the bond and received a predetermined number of stocks of the company
- The conversion ratio is the ratio of number of stocks the bond holder will received per number of bonds
- Conversion value is the value of the convertible bond if the bond is converted immediately
- Bond floor is the value the bond would have if it were not convertible into stock

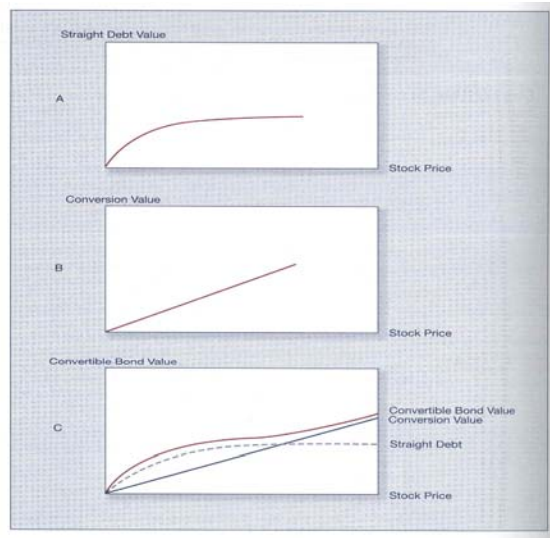
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Option-like securities: Convertible bonds

- Example: Bond A, maturity=10 years, annual coupon= \$80, conversion ratio =20, current stock price = \$30, value as straight debt= 967, value as convertible bond = 972.
- Conversion value = \$600
- Bond floor = 967
- When the stock price is low such that the conversion value is much less than the bond value, the convertible bond price is close to the bond floor and it trades like a straight bond

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Option-like securities: Convertible bonds



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Option-like securities: Warrant

- It is a call option issued by the firm
- When a warrant is exercised, the firm issues a new share, and the total number of shares outstanding increases
- It is protected against stock split
- Warrants are often issued in conjunction with other securities such as a bond
- Some employee stock options are warrants

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Option-like securities: Levered equity

- When a firm has debt, the shareholders' equity can be thought of as a call option
- The maturity is when debt is due; the exercise price is the amount of debt due

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Summary

- What are options
- Option markets
- Profit/loss of option
- Option trading strategies
- Put call parity
- Option-like securities

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