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# FINA 1082 Financial Management

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# Lecture 12

## Derivatives I

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# Introduction to Futures Contracts

- Examine what futures contracts are, how they are traded and their major weakness
- Examine how futures contracts are priced
- Analyze speculative and hedging strategies using futures contracts

# Overview of Derivatives Markets

- A derivative contract is an instrument whose value derives from that of an underlying product
  - The underlying product can be commodities, shares, market indices, interest rates, currencies, etc
- Forward and futures contracts are **obligations** to purchase or sell the underlying product at a prespecified price at a prespecified maturity (or expiration) date
- Option contracts are **rights**, but not obligations, to purchase or sell the underlying product at a prespecified price at, or before, a prespecified maturity (or expiration) date

# Overview of Derivatives Markets

- Since forward and futures contracts are obligations they protect the holder (or buyer) from losses but they also preclude any gains from favorable movements in the price of the underlying product
- Since option contracts are rights they give the holder (or buyer) the opportunity to gain from favorable price movements while protecting the holder from unfavorable price movements in the underlying product
  - However, this upside potential comes at a price!
- We examine forward and futures contracts in this lecture and option contracts in lectures 23 and 24

# Overview of Derivatives Markets

- Over-the-counter derivatives are traded privately between two parties with prices set by mutual negotiation
- Exchange traded derivatives are traded on a public exchange with prices set by a bidding process
- Derivatives markets dominated by the Chicago Mercantile Exchange (CME)
  - International Financial Futures Exchanges in London (LIFFE) and Tokyo (TIFFE) also important markets

# Forward and Futures Contracts

- A forward contract is an agreement to buy or sell the underlying asset at a specified price on a specified future date
  - Note that it costs nothing to buy or sell a forward contract and there is no premium paid by one party to another
- Long versus short positions
  - The party who agrees to buy the underlying asset on a certain specified future date for the specified price is **long** a forward contract or has **bought** the forward contract
  - The party who agrees to sell the underlying asset on a certain specified future date for the specified price is **short** a forward contract or has **sold** the forward contract

# Forward and Futures Contracts

- Spot price

- The price at which the underlying asset can be bought and sold in the spot market

- Delivery price

- The specified delivery price on the forward contract

- Forward price

- The forward price and the delivery price are equal at the time the contract is entered into
- With the passage of time, the forward price will change while the delivery price remains fixed



# Forward and Futures Contracts

- **Maturity or delivery date**

- The specified date on which the contract is settled
- The holder of the short position delivers the asset to the holder of the long position in return for the delivery price
- Some contracts are settled in cash since it is either impossible or impractical to deliver the underlying asset

- **Settlement**

- **Physical delivery** where the underlying security is exchanged for cash
- **Cash settlement** where payment is made by the buyer to the seller of an amount equal to the forward price **minus** the market price at settlement multiplied by the number of units in the contract

# Forwards Versus Futures Contracts

- Futures are **standardized** forward contracts
  - Contract is for the exchange of the underlying commodity or security at a future date, at a prespecified price
  - Contract is standardized in terms of size, maturity, quotations, settlement, delivery, etc
- **Major differences in forwards and futures contracts - see next slide**
  - Daily marking-to-market in futures contracts implies that a futures contract can be viewed of as a **series of one-day forward contracts**
  - **Note that the standardization of futures contracts is also a major weakness of these contracts**

# Forwards Versus Futures Contracts

<i>Feature</i>	<i>Forward Contract</i>	<i>Futures Contract</i>
1. Type	Informal arrangements	Standardized by exchange
2. Maturity	Any maturity (usually multiples of 30 days)	Few, prespecified maturity dates
3. Contract size	Generally over \$1,000,000	Smaller and prespecified
4. Security arrangements	Customers maintain minimum deposit with bank	Minimum margin deposits as a percent of contract's face value
5. Cash flows	None until delivery	Daily settlement from margin account
6. Final settlement	Majority settled by delivery	Delivery is rare - settlement through contract reversal
7. Default risk	Higher than futures	Minimal (exchange guarantee)
8. Commissions	Dealer's bid-ask spread	Floor traders, brokers pay and receive fees
9. Regulation	Self-regulated	External regulation

# Pricing of Forwards and Futures

- Forward and futures prices depend on the cost of carrying the underlying commodity to the delivery date
  - Storage costs
  - Insurance costs
  - Transportation costs
  - Financing costs
- The cost of carry model
  - $F_{0,t} = S_0 \times (1 + c)$
  - $F_{0,t}$  = Futures (or forward) price today for delivery at time  $t$
  - $S_0$  = Spot price of underlying commodity today
  - $c$  = Cost of carrying the underlying commodity to the settlement date as a fraction of the spot price

# Pricing of Forwards and Futures

- Cost of carry arbitrage exists when:  $F_{0,t} > S_0 \times (1 + c)$
- Reverse cost of carry arbitrage exists when:  $F_{0,t} < S_0 \times (1 + c)$
- Cost of carry arbitrage:  $F_{0,t} > S_0 \times (1 + c)$ 
  - Borrow funds
  - Buy spot now
  - Sell forward (or futures) contract
- Reverse cost of carry arbitrage:  $F_{0,t} < S_0 \times (1 + c)$ 
  - Sell short spot
  - Lend funds
  - Buy forward (or futures) contract

# Pricing of Forwards and Futures

## Example:

Suppose the price of an ounce of gold is USD 800 and the futures price for settlement in one year's time is USD 890. Assume no other costs other than financing costs and a borrowing and lending rate of 10% p.a. What will traders do?

What will they do if the price of gold is USD 820? What will happen in equilibrium?

# Pricing of Forwards and Futures

## Case 1:

Cost of carry arbitrage opportunity exists...

$$F_{0,t} > S_0 \times (1 + c)$$

$$890 > 800 \times (1 + 0.10) = 880$$

<i>Time 0</i>	
Borrow \$800 for 1 year	+800
Buy an ounce of gold	-800
Sell a futures contract	0
Net amount	0
<i>Time 1</i>	
Remove gold from storage	0
Deliver gold against futures contract	+890
Repay loan with interest	-880
Net profit	+10

# Pricing of Forwards and Futures

## Case 2:

Reverse cost of carry arbitrage opportunity exists...

$$F_{0,t} < S_0 \times (1 + c)$$

$$890 < 820 \times (1 + 0.10) = 902$$

<i>Time 0</i>	
Sell short an ounce of gold	+820
Lend \$820 for 1 year	-820
Buy a futures contract	0
Net amount	0
<i>Time 1</i>	
Collect proceeds from the loan	+902
Accept delivery on futures contract	-890
Use gold to cover short sale	0
Net profit	+12



# Introduction to Options Contracts

- Examine what options are and how they are traded
- Analyze the payoffs associated with purchasing a call option
- Analyze the payoffs associated with selling a call option
- Analyze the payoffs associated with purchasing a put option
- Analyze the payoffs associated with selling a put option

# Overview of Options Markets

- Option contracts are instruments that give the holder of the contract the right, but not the obligation, to buy or sell the underlying instrument at a prespecified price
  - Equity option contracts usually represent 1000 shares of the underlying stock
  - The exercise (or strike) price is the prespecified price for which the underlying security may be purchased or sold by the option buyer/holder if the option is exercised
- Equity option holders do not enjoy the rights due stockholders
  - For example, voting rights, regular dividends, etc
- In an exchange market, option prices are set in a competitive auction market among various buyers and sellers

# Overview of Options Markets

- Over-the-counter instruments

- Contracts are privately negotiated and tailored to meet customer needs
- Transactions occur off-market or outside registered exchanges
- Counterparty risk is a major consideration
- Products typically traded through commercial banks, investment banks and brokers

- Exchange traded instruments

- Contracts are standardized
- Clearinghouse acts as a middleman between the buyer and seller
- Counterparty risk or the risk of default is quite low
- Products are liquid and can be easily traded

# Call and Put Options

- An option gives the holder the **right** to buy or sell the underlying security at, or before, a specified expiration date, at a pre-specified exercise (or strike) price
  - To the buyer/holder the contract is an option and **not an obligation** (unlike forwards and futures contracts)
  - A **call** option gives the right to **purchase** the underlying security
  - A **put** option gives the right to **sell** the underlying security
- **To the option writer (or seller) the contract is an obligation**
  - The writer of a call option has the **obligation** to **sell** the underlying security
  - The writer of a put option has the **obligation** to **purchase** the underlying security

# Call and Put Options

Contract type	Buyer or Holder	Seller or Writer
Call option	<i>Right</i> , but no obligation, to <i>buy</i> the underlying security	<i>Obligation</i> , and not a right, to <i>sell</i> the underlying security if option exercised
Put option	<i>Right</i> , but no obligation, to <i>sell</i> underlying security	<i>Obligation</i> , and not a right, to <i>buy</i> the underlying security if option exercised

Is a bought call option the same as, or similar to, a sold put option?  
Is a bought put option the same as, or similar to, a sold call option?

# Call and Put Options

- American versus European options
  - An American option can be exercised at any time up to and including the expiration date
  - A European option can be exercised only at expiration
- American options are more common than European ones
- All else being the same, which option would you value more?

# Payoff and Profit on Call Options

- The payoff to a **call option** buyer is:  $\text{Max}(S_T - X, 0)$ 
  - $S_T$  = Stock price at expiration
  - $X$  = Exercise (or strike) price of the option
- The profit to a **call option** buyer is:  $\text{Max}(S_T - X, 0) - C$ 
  - $C$  = Call option price (or premium)
- **$\text{Max}(S_T - X, 0)$  means...**
  - If  $S_T - X > 0$  then  $\text{Max}(S_T - X, 0) = S_T - X$
  - If  $S_T - X \leq 0$  then  $\text{Max}(S_T - X, 0) = 0$
  - The **payoff** from an option cannot be negative!

Note that the payoff and profit to a call option seller (or writer) are the negatives of the above

# Payoff and Profit on Put Options

- The payoff to a **put option** buyer is:  $\text{Max}(X - S_T, 0)$ 
  - $S_T$  = Stock price at expiration
  - $X$  = Exercise (or strike) price of the option
- The profit to a **put option** buyer is:  $\text{Max}(X - S_T, 0) - P$ 
  - $P$  = Put option price (or premium)
- **$\text{Max}(X - S_T, 0)$  means...**
  - If  $X - S_T > 0$  then  $\text{Max}(X - S_T, 0) = X - S_T$
  - If  $X - S_T \leq 0$  then  $\text{Max}(X - S_T, 0) = 0$
  - The **payoff** from an option cannot be negative!

Note that the payoff and profit to a put option seller (or writer) are the negatives of the above



# Moneyness of Options

- **At-the-money option:** Current spot price,  $S_t = \text{Exercise price (X)}$
- **In-the-money option:** If profitable to exercise at the spot price
  - Call option: Current spot price,  $S_t > \text{Exercise price (X)}$
  - Put option: Current spot price,  $S_t < \text{Exercise price (X)}$
- **Out-of-the-money option:** If unprofitable to exercise at the spot price
  - Call option: Current spot price,  $S_t < \text{Exercise price (X)}$
  - Put option: Current spot price,  $S_t > \text{Exercise price (X)}$
- **Breakeven prices are where the profit to the buyer is zero**
  - Call option: Exercise price (X) + Option premium (or price, C)
  - Put option: Exercise price (X) – Option premium (or price, P)

## Payoff and Profit on Long Call Options

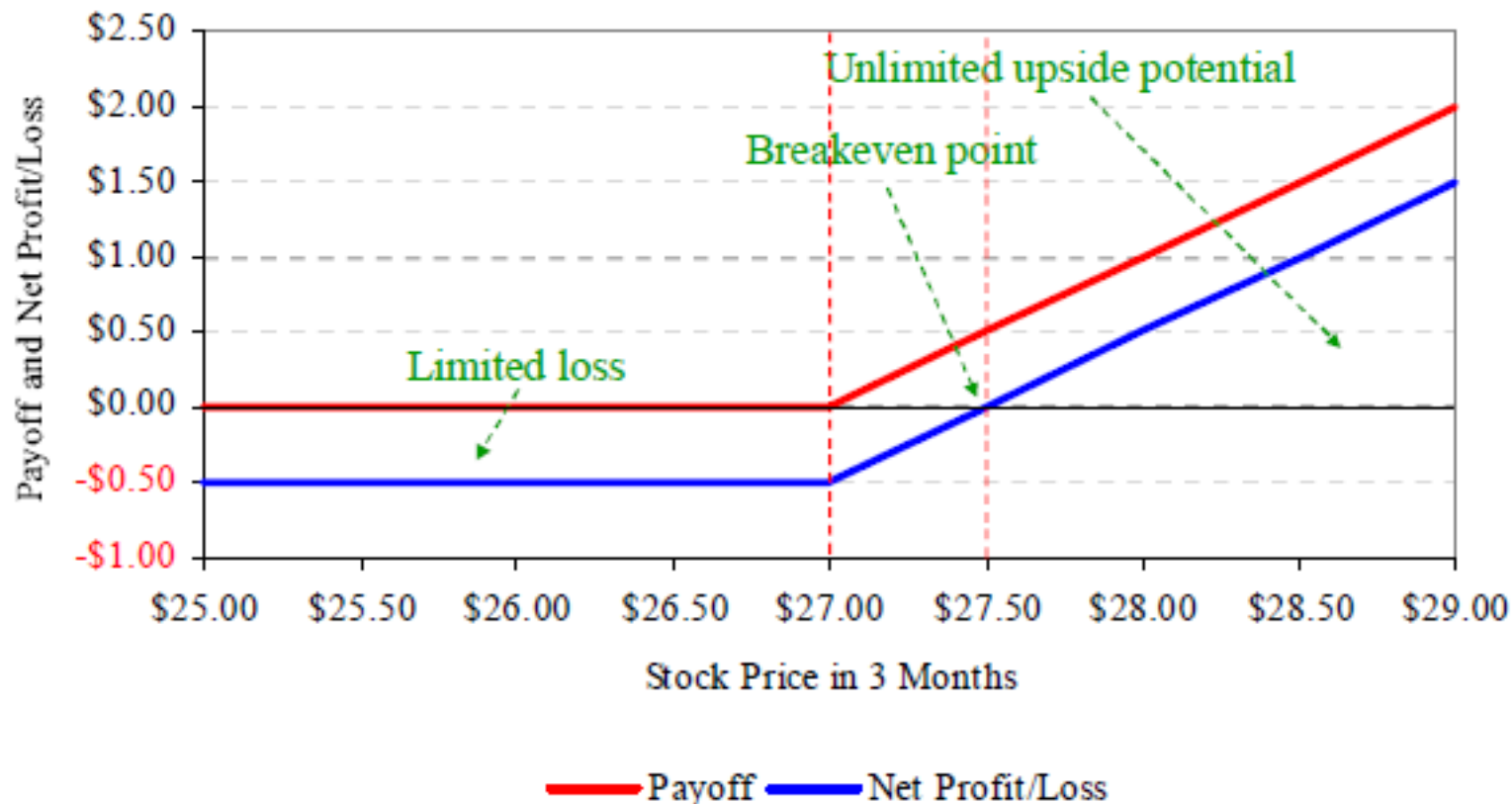
Example: You purchase a call option on ANZ Bank shares expiring in three months' time at a premium of \$0.50. The exercise price of the call is \$27 per share. What is the payoff and profit to the buyer if the price of ANZ's shares in three months is \$25, \$26, \$27, \$28 and \$29?

Payoff to call option buyer =  $\text{Max}(S_T - X, 0)$

Profit to call option buyer =  $\text{Max}(S_T - X, 0) - C$

Spot Price in 3 Months	Payoff	Profit
\$25	\$0.00	-\$0.50
\$26	\$0.00	-\$0.50
\$27	\$0.00	-\$0.50
\$28	\$1.00	\$0.50
\$29	\$2.00	\$1.50

# Payoff and Profit on Long Call Option



What are your expectations regarding the future price of ANZ shares?

## Payoff and Profit on Short Call Option

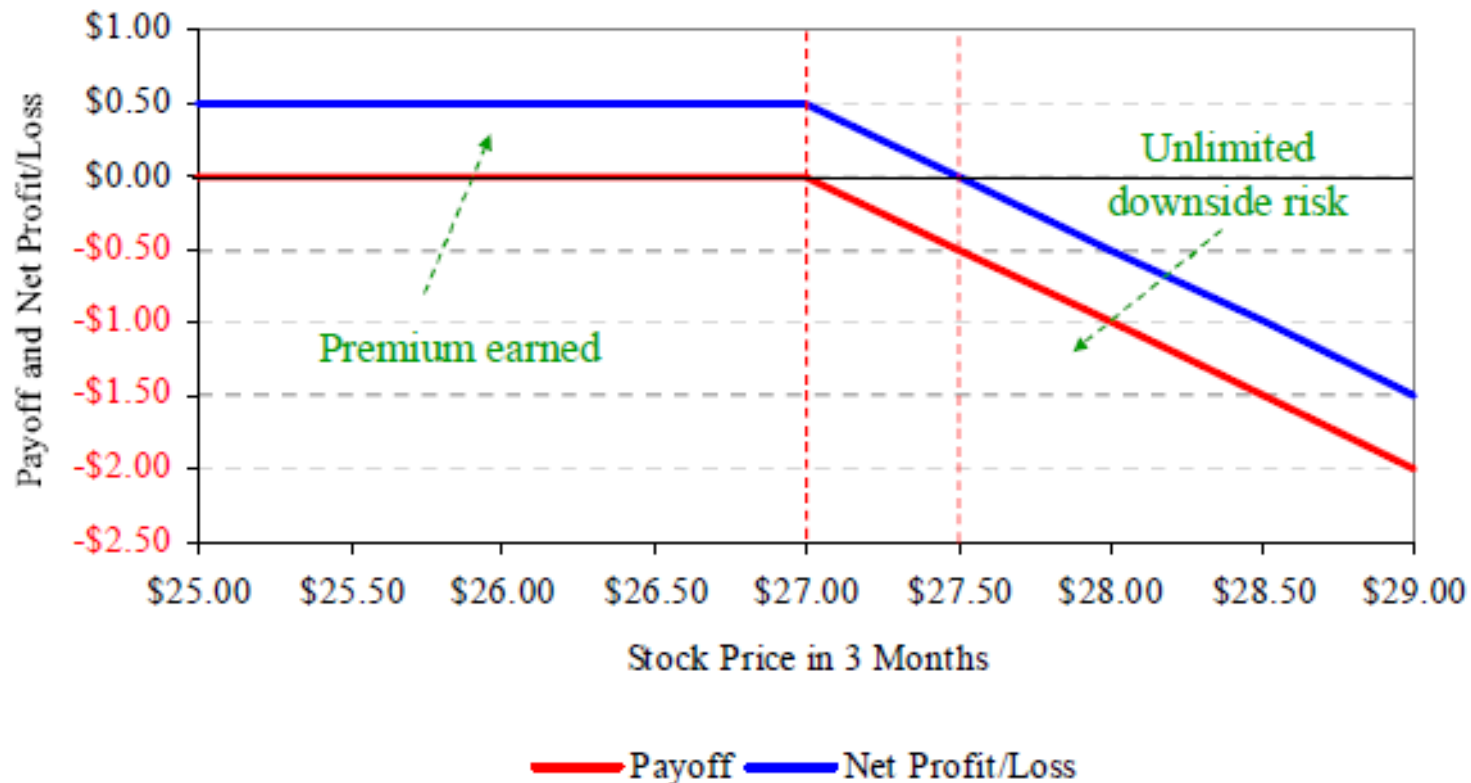
**Example (continued):** If you are the seller of the call option in the previous example what would your payoff and profit be if the price of ANZ's shares in three months is \$25, \$26, \$27, \$28 and \$29?

Payoff to call option seller =  $-\text{Max}(S_T - X, 0)$

Profit to call option seller =  $C - \text{Max}(S_T - X, 0)$

Spot Price in 3 Months	Payoff	Profit
\$25	\$0.00	\$0.50
\$26	\$0.00	\$0.50
\$27	\$0.00	\$0.50
\$28	-\$1.00	-\$0.50
\$29	-\$2.00	-\$1.50

# Payoff and Profit on Short Call Option



What are your expectations regarding the future price of ANZ shares?

## Payoff and Profit on Long Put Option

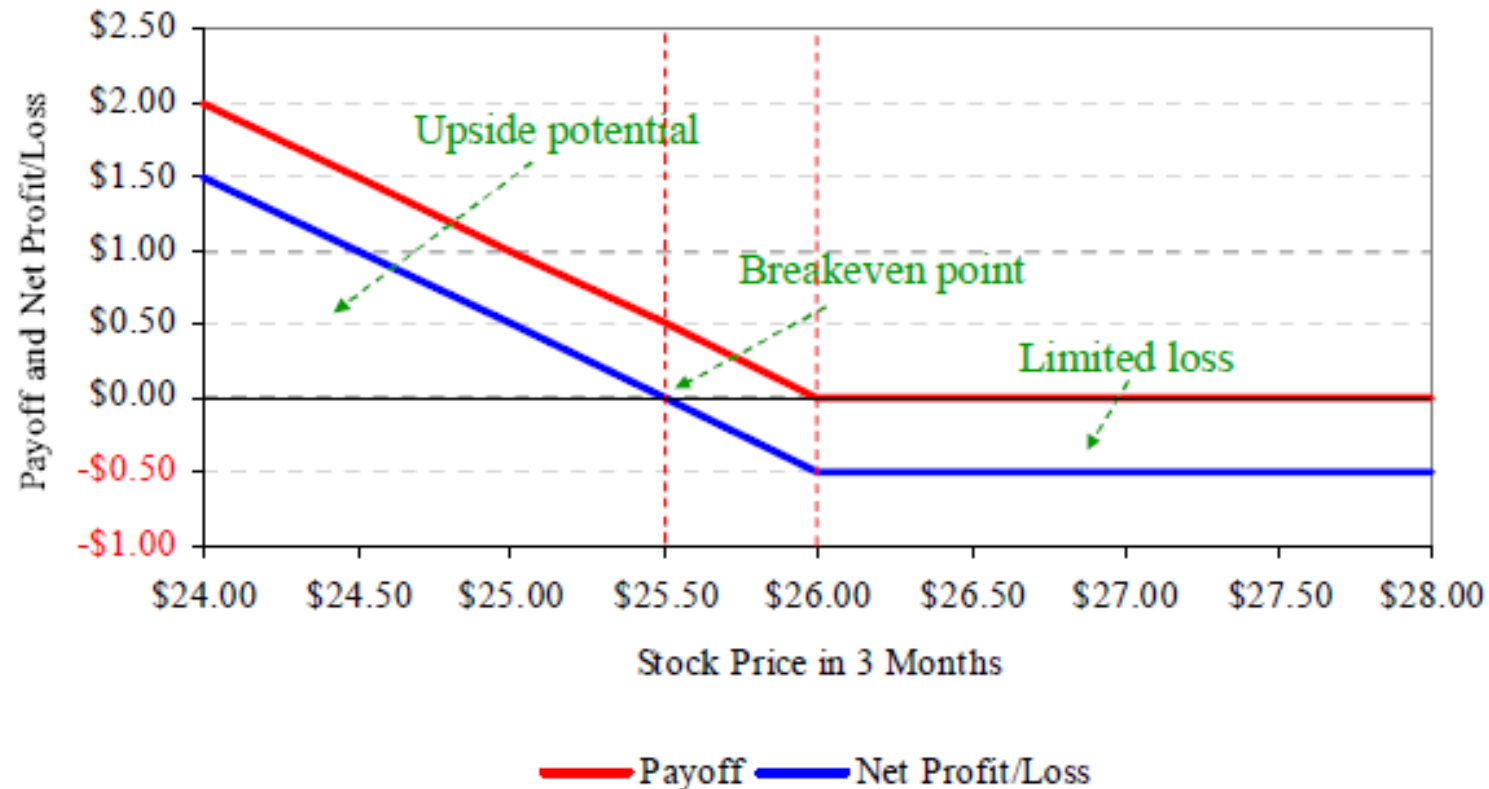
**Example:** You purchase a put option on ANZ Bank shares expiring in three months' time at a premium of \$0.50. The exercise price of the put is \$26.00 per share. What's the payoff and profit to the buyer if the price of ANZ's shares in three months is \$24, \$25, \$26, \$27 and \$28?

Payoff to put option buyer =  $\text{Max}(X - S_T, 0)$

Profit to put option buyer =  $\text{Max}(X - S_T, 0) - P$

Spot Price in 3 Months	Payoff	Profit
\$24	\$2.00	\$1.50
\$25	\$1.00	\$0.50
\$26	\$0.00	-\$0.50
\$27	\$0.00	-\$0.50
\$28	\$0.00	-\$0.50

# Payoff and Profit on Long Put Option



What are your expectations regarding the future price of ANZ shares?

## Payoff and Profit on Short Put Option

**Example (continued):** If you are the seller of the put option in the previous example what would your payoff and profit be if the price of ANZ's shares in three months is \$24, \$25, \$26, \$27 and \$28?

Payoff to put option seller =  $-\text{Max}(X - S_T, 0)$

Profit to put option seller =  $P - \text{Max}(X - S_T, 0)$

Spot Price in 3 Months	Payoff	Profit
\$24	-\$2.00	-\$1.50
\$25	-\$1.00	-\$0.50
\$26	\$0.00	\$0.50
\$27	\$0.00	\$0.50
\$28	\$0.00	\$0.50

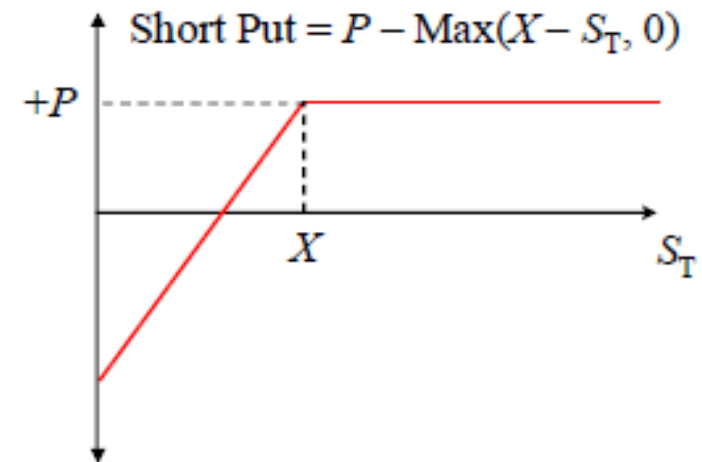
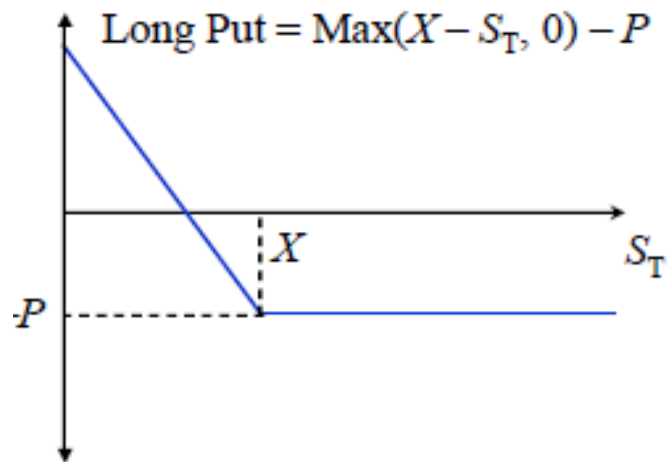
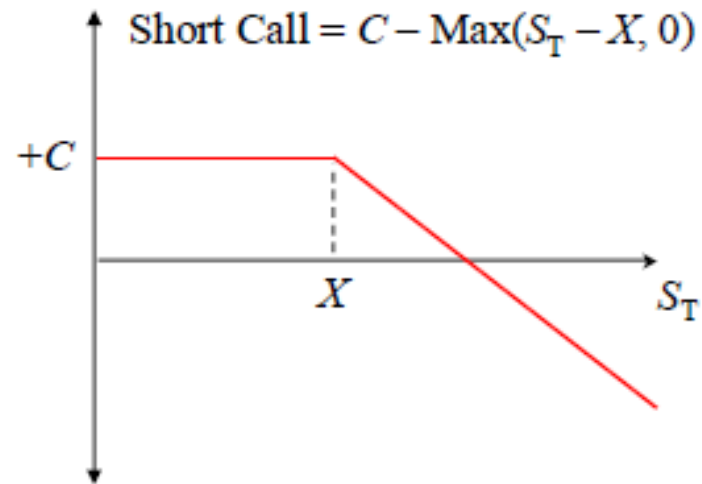
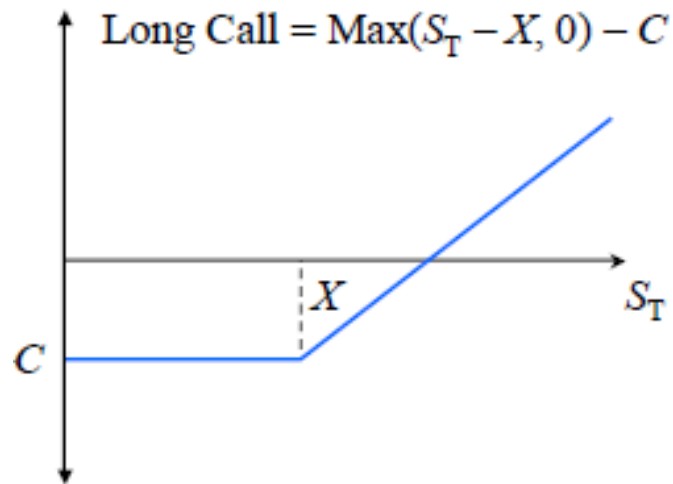


# Payoff and Profit on Short Put Option



What are your expectations regarding the future price of ANZ shares?

# Summary of Profits on Option Contracts



# THE WALL STREET JOURNAL.

## **LISTED OPTIONS QUOTATIONS**

Tuesday, February 21, 2006

			-CALL-		-PUT-	
OPTION/STRIKE		EXP	VOL	LAST	VOL	LAST
Amazon	35	Jul	...	...	1,758	1.75
	38.29	37.50	Mar	1,015	1.85	2,083
	38.29	37.50	Apr	231	2.50	902
	38.29	40	Mar	1,072	.50	1,155
	38.29	40	Apr	1,219	1.15	969
	38.29	42.50	Mar	2,708	.10	144
	38.29	45	Mar	2	.05	27,662
	38.29	45	Jul	112	1.25	1,762
	38.29	50	Apr	12	.05	6,002
						11.60

- Last recorded price \$38.29
- Options are traded on Amazon at exercised prices of \$35 through \$50 (strike prices)
- At any time both in-the-money and out-of-the-money options will be listed (as in Amazon).
- Volume, number of contracts traded
- Closing price for the *call and put*

- The value of the *call* is lower when the exercise price is higher, for the same maturity.

- Ex: The March maturity AMAZON call option with a strike price \$37.5 sells for \$1.85, \$40/\$0.50, \$42.5/\$0.10 and \$45/\$0.05

- The right to buy a share at a give exercise price is not as valuable when the purchase price is higher

- Conversely, the value of a *put* is higher when the exercise price is higher, for the same maturity

- Ex: The March maturity AMAZON put option with a strike price \$37.5 sells for \$0.70, \$40/\$2.10, \$42.5/\$4.10 and \$45/\$6.50

- The right to sell a share at a give exercise price is more valuable when the purchase price is higher

# Factors affecting value of Call

The value of call is contingent on certain characteristics of the underlying security

$$C = f (S_T, \sigma_2, X_T, T, R_F)$$

Where:

$S_T$  = stock price (+ related to call price as the payoff increases with the stock price)

$\sigma_2$  = Variance of stock price (+ related as increase chance of exercise)

$X_T$  = exercise price (- related as lower probability of being exercised)

$T$  = Time til maturity (+ related as greater chance of exceeding exercise price)

$R_F$  = risk free rate (+ related as present value of delay of payment of exercise price becomes more valuable as interest rates rise)

# Factors in call option value (resume)

## Increase in factor

- ☐ Stock price
- ☐ Exercise price
- ☐ Volatility of stock price
- ☐ Time to expiration
- ☐ Interest rate
- ☐ Dividend Rate

## Effect on call value

- ☐ Increases
- ☐ Decreases
- ☐ Increases
- ☐ Increases
- ☐ Increases
- ☐ Decrease

# Key Concepts

- An option gives the holder the right to buy or sell the underlying security at, or before, a specified expiration date, at a pre-specified exercise (or strike) price
- A call option gives the right to purchase the underlying security
- A put option gives the right to sell the underlying security
- To the option writer (or seller) the contract is an obligation
- American options can be exercised at any time up to and including the expiration date while European option can be exercised only at expiration
- In the money options are profitable to exercise now while at or out of the money options are not profitable to exercise now



# Key Relationships/Formula Sheet

Payoff to a call option buyer:  $\text{Max}(S_T - X, 0)$

Profit to a call option buyer:  $\text{Max}(S_T - X, 0) - C$

Payoff to a put option buyer:  $\text{Max}(X - S_T, 0)$

Profit to a put option buyer:  $\text{Max}(X - S_T, 0) - P$