

EC3070 Financial Derivatives

Introduction

Options, Futures, and Other Derivatives, 7th
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1. Introduction

- ◉ **Derivative**: a financial instrument whose value depends (or derives from) the values of other, more basic, underlying values (Hull, p. 1).

Ways Derivatives are Used

- To hedge risks.
- To speculate (take a view on the future direction of the market).
- To lock in an arbitrage profit.
- To change the nature of a liability.
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another.

1. Introduction

- ◎ **Derivatives exchange**: a market where individuals trade standardised contracts previously defined by the exchange.

Exchanges Trading Options

- ◉ Chicago Board Options Exchange
- ◉ American Stock Exchange
- ◉ Philadelphia Stock Exchange
- ◉ Pacific Exchange
- ◉ LIFFE (London)
- ◉ Eurex (Europe)
- ◉ and many more (see list at end of book)

Exchanges Trading Futures

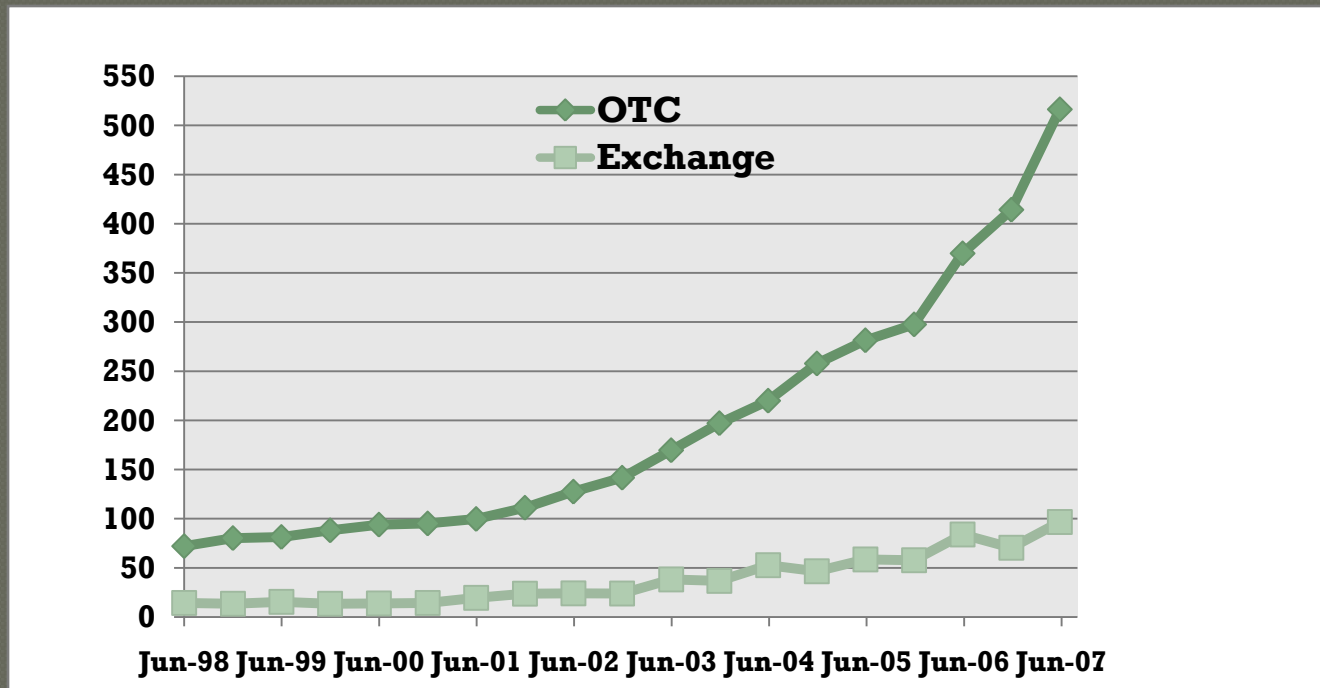
- ◉ Chicago Board of Trade
- ◉ Chicago Mercantile Exchange
- ◉ LIFFE (London)
- ◉ Eurex (Europe)
- ◉ BM&F (Sao Paulo, Brazil)
- ◉ TIFFE (Tokyo)
- ◉ and many more (see list at end of book)

1. Introduction

- ◉ Derivatives **over-the-counter markets**: a telephone- and computer-linked network of dealers.
- ◉ Contracts are not standardised.
- ◉ Trades are among two financial institutions or among a financial institution and one of its customers (eg fund manager).
- ◉ Financial institutions usually act as market makers: prepared to quote a bid price (at which they buy) and an offer price (at which they sell).

Size of OTC and Exchange-Traded Markets

(Figure 1.1, Page 3)



Source: Bank for International Settlements. Chart shows total principal amounts for OTC market and value of underlying assets for exchange market

2. Forward contracts

- ◉ Agreement to buy or sell an asset at a certain future date (τ) for a future price (K_τ).
- ◉ Traded in the over-the-counter market.
- ◉ Entering a forward contract has no cost.
- ◉ **Long** position: agrees to **buy** the asset.
- ◉ **Short** position: agrees to **sell** the asset for the same price at the same date.

2. Forward contracts

- ◉ **Spot price** (S_0): price of the asset in the open market at time 0.
- ◉ **Delivery price** (K_τ): price agreed for the transaction to be completed at time τ .

2. Forward contracts

- ◉ **Forward price** ($F_{\tau|t}$): delivery price prevailing at time t for a delivery scheduled for time τ (i.e. $F_{\tau|t} = K_{\tau}$)
- ◉ It is the delivery price that would make the contract worth exactly zero today.
- ◉ The forward price may be different for contracts of different maturities.

2. Forward contracts

• The **forward price** ($F_{\tau|t}$): is the sum of two components:

- Expected value of the spot price at time τ , $E(S_{\tau})=S_0$.
- A compensation for the party taking the short position for the loss of investment income occasioned by holding the asset (R).
- Suppose the contract is to mature in one year. Then:

$$F_{1/0} = S_0(1+r)$$

2. Forward contracts

◉ Example:

- Consider a stock that pays no dividend and is worth £10 today ($S_0 = £10$).
- Suppose the current annual interest rate is $r = 5\%$ (you can borrow or lend money at 5%).
- What should the 1-year forward price of the stock ($F_{1/0}$) be?

$$F_{1/0} = S_0(1+r) = 10(1.05) = 10.5$$

2. Forward contracts

◉ Why?

◉ If $F_{1|0} > S_0(1+r)$ you could:

- borrow S_0 today for 1 year,
- buy the asset,
- engage in a forward contract to sell it in 1 year for $F_{1|0}$.
- and make a profit of $F_{1|0} - S_0(1+r) > 0$

2. Forward contracts

◉ Why?

- ◉ If $F_{1|0} < S_0(1+r)$ an investor owning the asset could:
 - Sell the asset today for S_0 ,
 - Invest the proceeds to get $S_0(1+r)$ in 1 year,
 - enter in a forward contract to buy the asset back in 1 year.
 - make a profit of $S_0(1+r) - F_{1|0} > 0$

2. Forward contracts

- More generally ($\tau > 1$): If the spot price of gold is S_0 and the forward price for a contract deliverable in $\tau > 1$ years is $F_{\tau|0}$, then

$$F_{\tau|0} = S_0 (1+r)^\tau$$

- where r is the 1-year (domestic currency) risk-free rate of interest.

2. Forward contracts

- Forward contracts on foreign exchange:
A popular example used to hedge foreign currency risk.

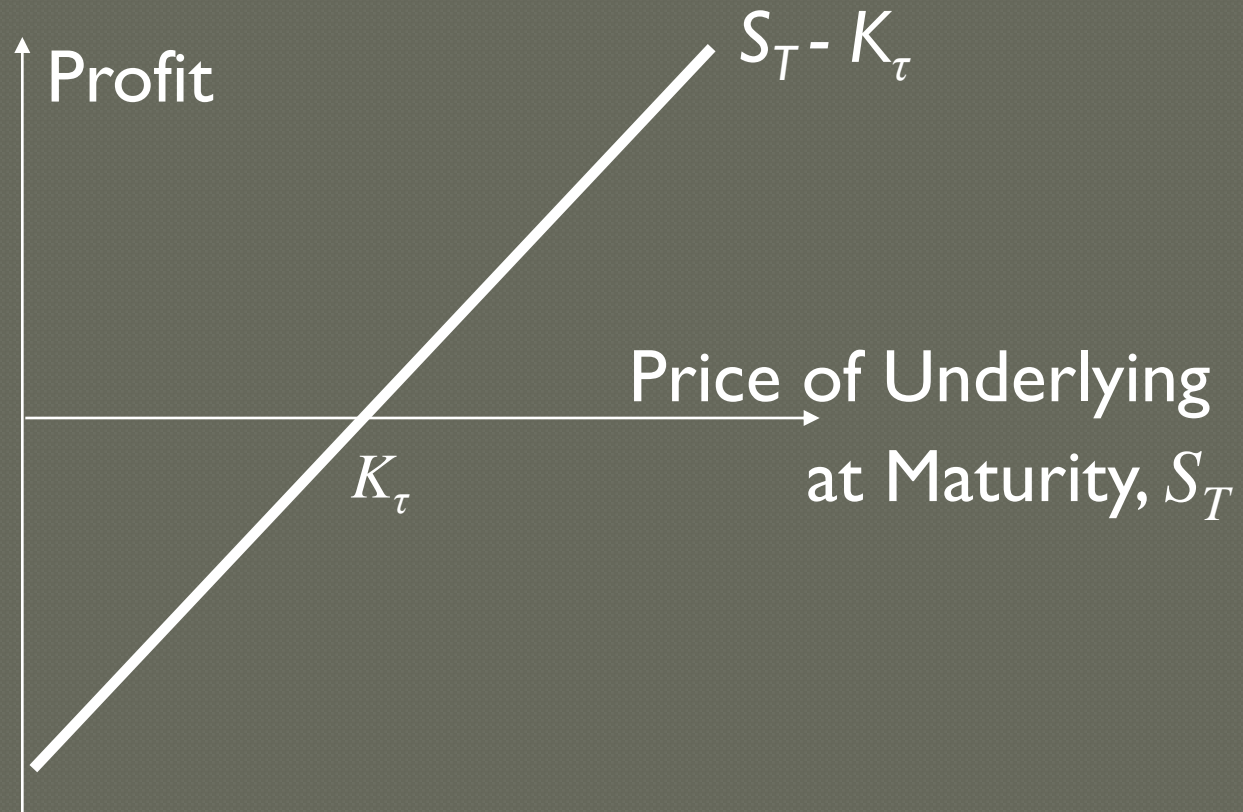
Example (page 4)

- On July 20, 2007 the treasurer of a corporation enters into a long forward contract to buy £1 million in six months at an exchange rate of 2.0489
- This obligates the corporation to pay \$2,048,900 for £1 million on January 20, 2008
- What are the possible outcomes?

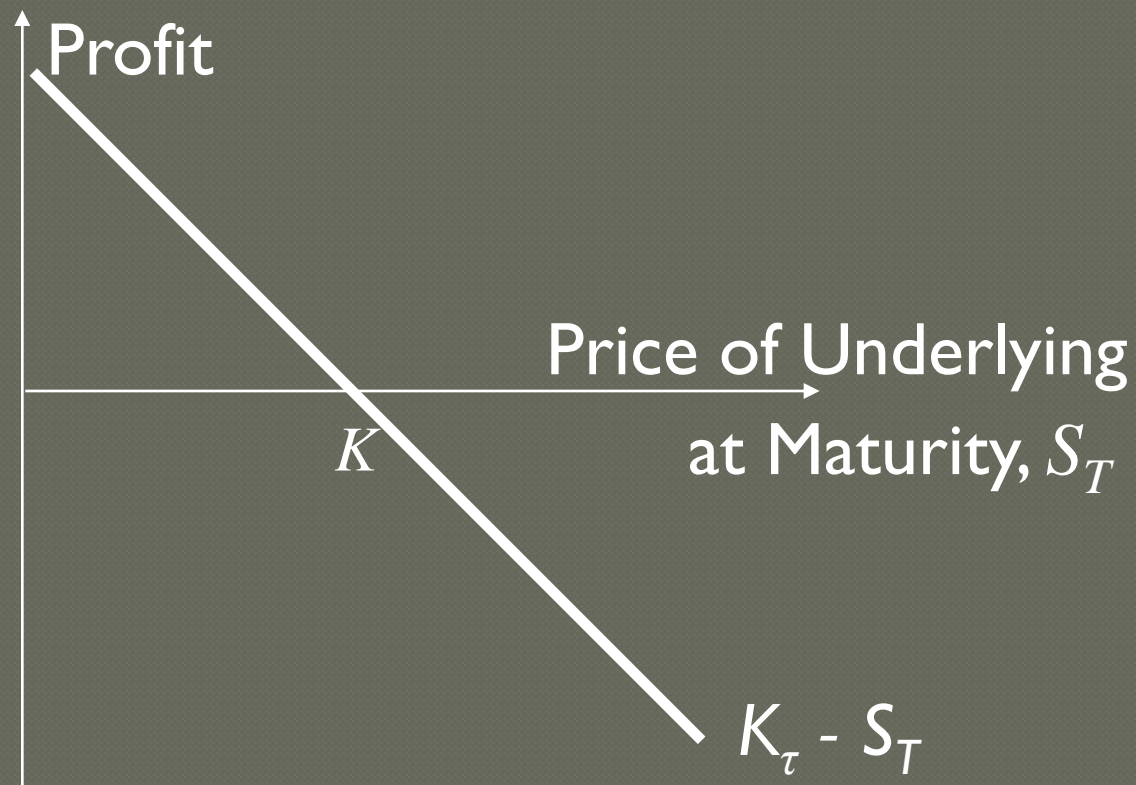
Foreign Exchange Quotes for GBP, July 20, 2007 (See page 4)

	Bid	Offer
Spot	2.0558	2.0562
1-month forward	2.0547	2.0552
3-month forward	2.0526	2.0531
6-month forward	2.0483	2.0489

Profit from a Long Forward Position:



Profit from a Short Forward Position



3. Futures Contracts

- Agreement to buy or sell an asset for a certain price at a certain time.
- Similar to forward contract.
- Whereas a forward contract is traded in OTC markets, a futures contract is traded on an exchange.

Examples of Futures Contracts

Agreement to:

- Buy 100 oz. of gold @ US\$900/oz. in December (NYMEX)
- Sell £62,500 @ 2.0500 US\$/£ in March (CME)
- Sell 1,000 bbl. of oil @ US\$120/bbl. in April (NYMEX)

4. Options

- ⦿ A **call** option is an **option to buy** a certain asset by a certain date for a certain price (the strike price).
- ⦿ A **put** option is an **option to sell** a certain asset by a certain date for a certain price (the strike price).

4. Options

- ◉ The party adopting the **short position** in the contract is said to be on the short side. A short position implies the **liability** to sell (call option) or buy (put option).
- ◉ The party adopting the **long position** in the contract is said to be on the long side. A long position implies the **right** to buy (call option) or sell (put option).

4. Options

Options:

	Call	Put
Short	<i>liability to sell</i>	<i>liability to buy</i>
Long	<i>right to buy</i>	<i>right to sell</i>

- The **short** party is known as the **writer** of the contract and *sells* the option.
- The **long** party is said to be the **holder** of the option and purchases the option.

Options vs Futures/Forwards

- ◉ There is **no price** to pay in order to enter in a **forward/futures** contract.
- ◉ On the other hand, the **(long) party** getting the right to sell or buy must **pay a premium** (or price) when the option contract is written.

4. Options

- ◉ The party adopting the **long position** pays a **premium p** when the contract is written in exchange of the right to buy or sell.
- ◉ Let P be the value at maturity (time τ) of the premium:
$$P = p(1+r)^\tau$$
- ◉ where r is again the risk free interest rate.

4. Options

- ◉ The price (premium) of a **call** option is *decreasing in the strike price*.
- ◉ The premium of a **put** option is *increasing in the strike price*.
- ◉ The longer the maturity of an option the more expensive it usually is.

American vs European Options

- ◉ An **American option** can be exercised at any time during its life.
- ◉ A **European option** can be exercised only at maturity.

Intel Option Prices (Sept 12, 2006; Stock Price=19.56); See
Table 1.2 page 7; Source: CBOE

Strike Price	Oct Call	Jan Call	Apr Call	Oct Put	Jan Put	Apr Put
15.00	4.650	4.950	5.150	0.025	0.150	0.275
17.50	2.300	2.775	3.150	0.125	0.475	0.725
20.00	0.575	1.175	1.650	0.875	1.375	1.700
22.50	0.075	0.375	0.725	2.950	3.100	3.300
25.00	0.025	0.125	0.275	5.450	5.450	5.450

4. Options

- **Call option:** long party will exercise the option if:

$$S_{\tau} > K_{\tau}$$

i.e. if the spot price at time τ is above the strike price.

- It will be profitable for the long party if:

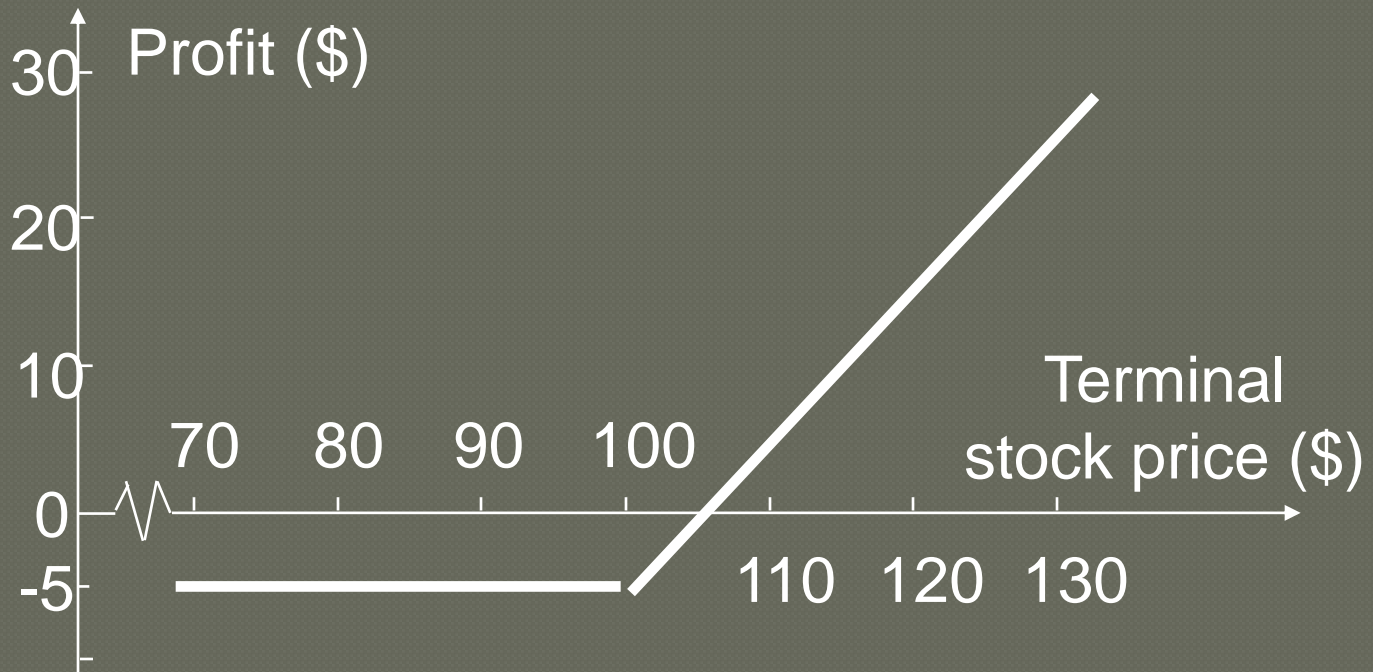
$$S_{\tau} > K_{\tau} + P$$

so that the purpose is to benefit from a rise in prices.

Long Call

(Figure 8.1, Page 180)

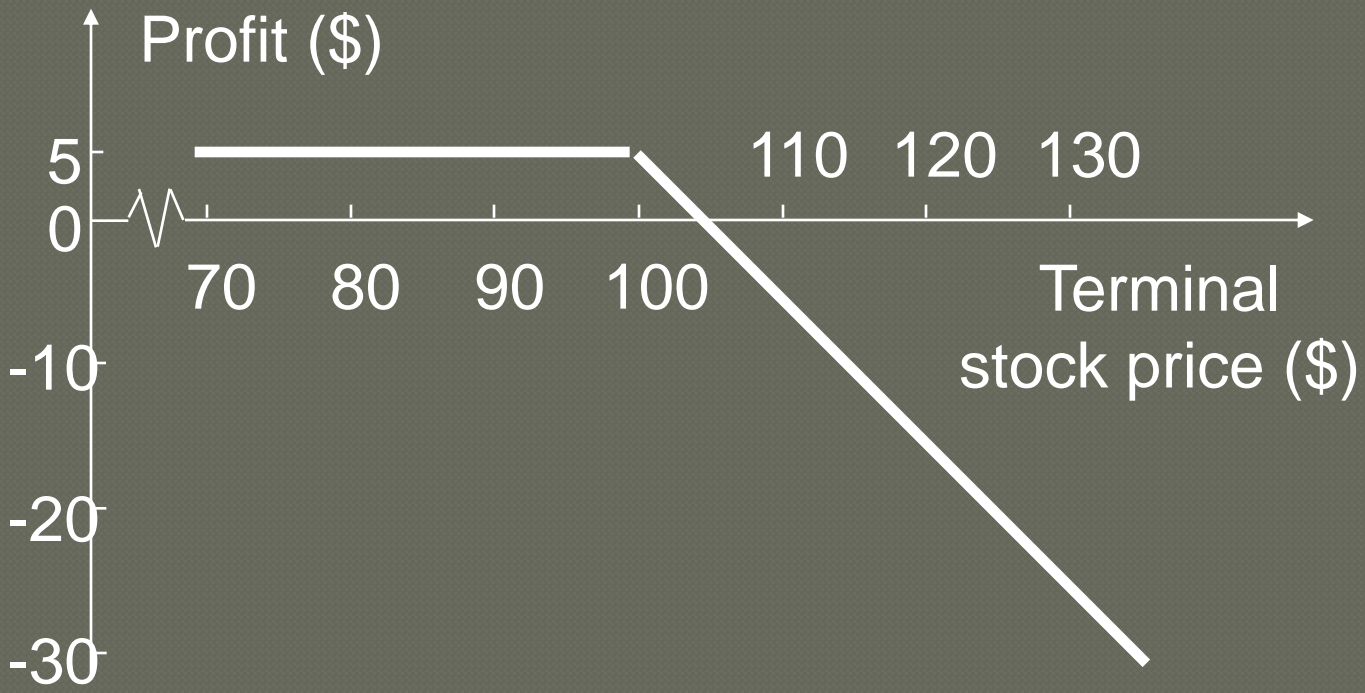
Profit from buying one European call option: option price = \$5, strike price = \$100, option life = 2 months



Short Call

(Figure 8.3, page 182)

Profit from writing one European call option: option price = \$5, strike price = \$100



4. Options

- ◎ **Put option**: long party will exercise the option if:

$$S_{\tau} < K_{\tau}$$

i.e. if the spot price at time τ is below the strike price.

- ◎ profitable for the long party if:

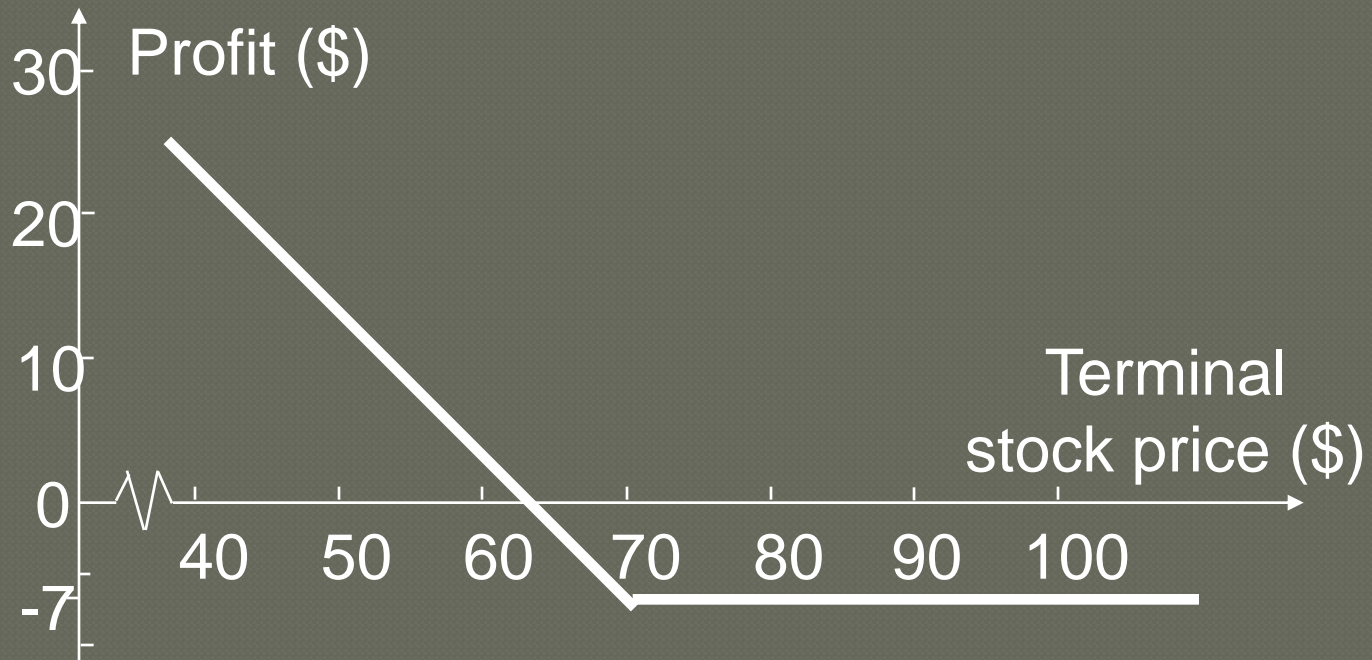
$$S_{\tau} + P < K_{\tau}$$

purpose is to benefit from a decrease in prices.

Long Put

(Figure 8.2, page 181)

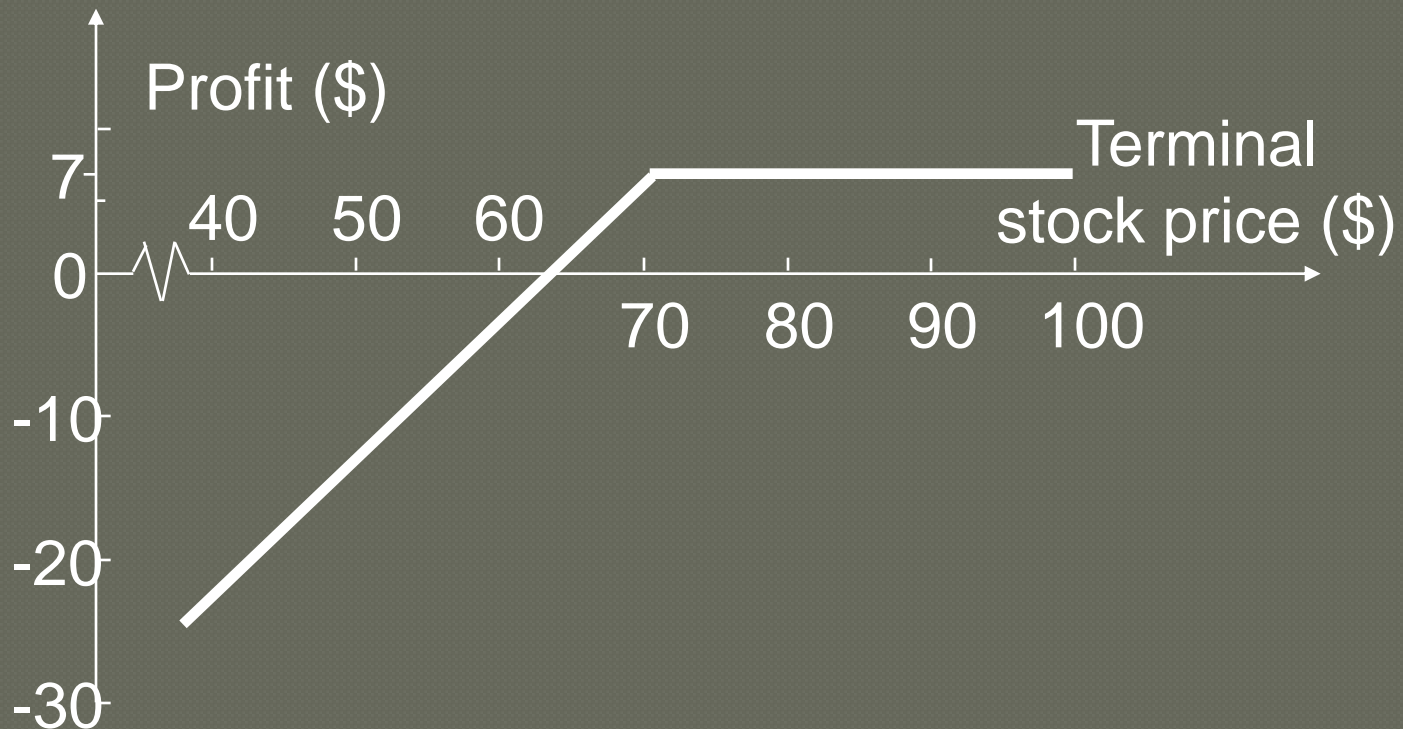
Profit from buying a European put option: option price = \$7, strike price = \$70



Short Put

(Figure 8.4, page 182)

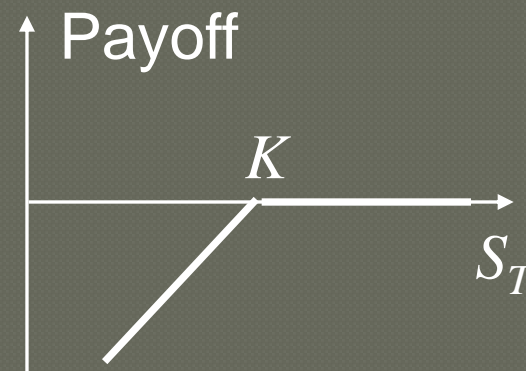
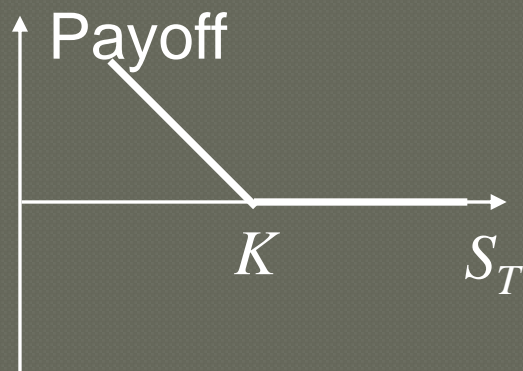
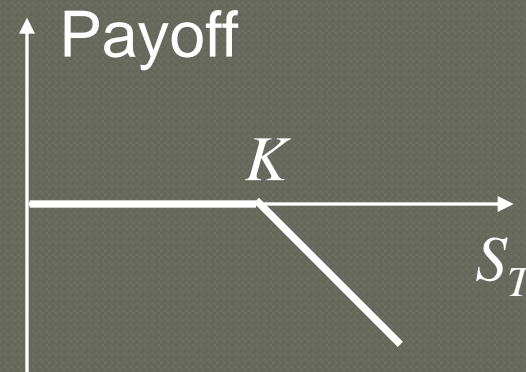
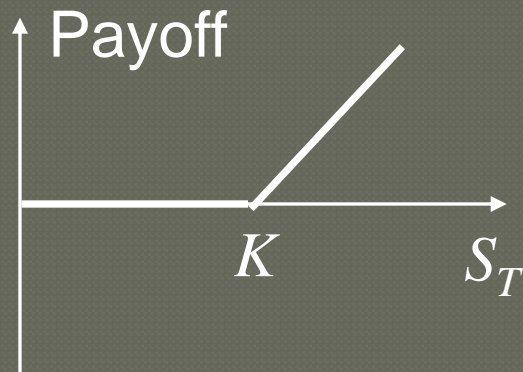
Profit from writing a European put option: option price = \$7, strike price = \$70



Payoffs from Options

What is the Option Position in Each Case?

K = Strike price, S_T = Price of asset at maturity



Options vs Futures/Forwards

- A **futures/forward** contract gives the holder the **obligation** to buy or sell at a certain price. There is no price to enter in a forward contract.
- An **option** gives the holder the **right** to buy or sell at a certain price.

5. Types of Traders

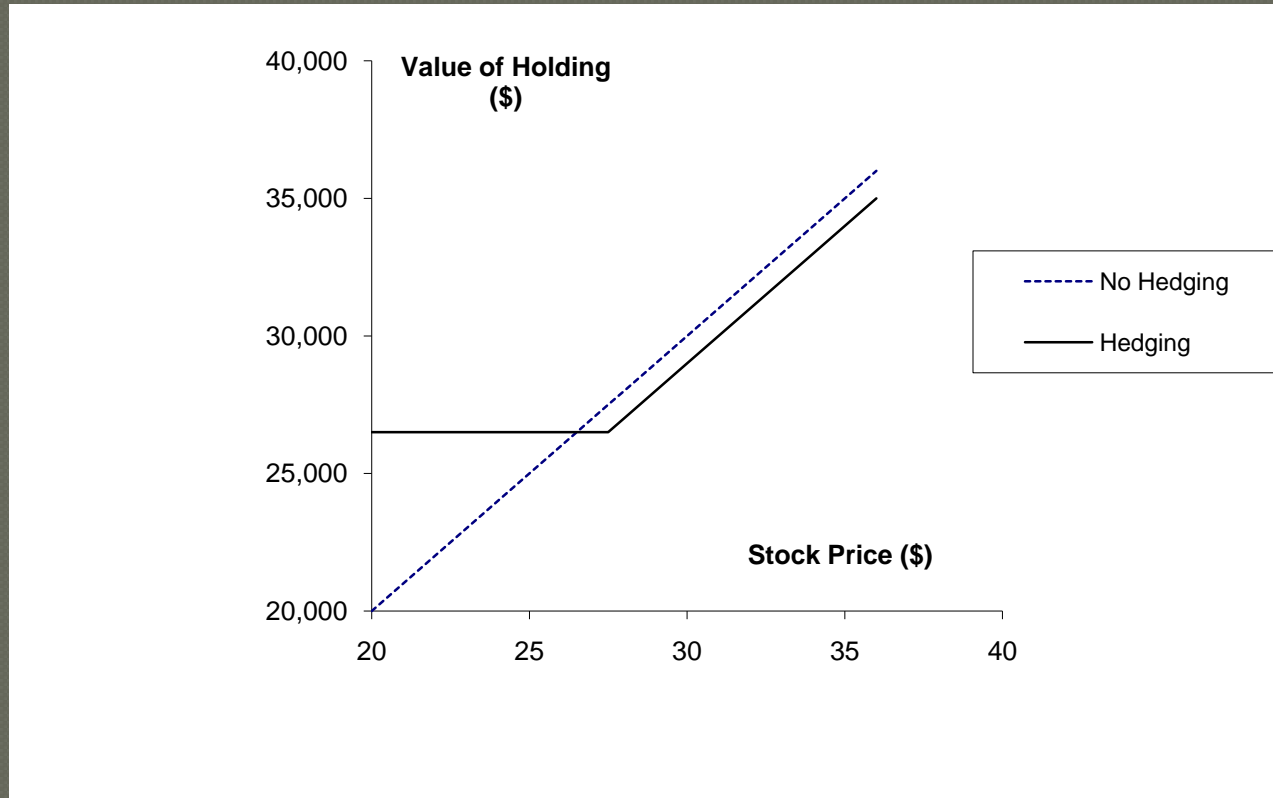
- Hedgers
- Speculators
- Arbitrageurs

Some of the largest trading losses in derivatives have occurred because individuals who had a mandate to be hedgers or arbitrageurs switched to being speculators (See for example Barings Bank, Business Snapshot 1.2, page 15)

Hedging Examples

- A US company will pay £10 million for imports from Britain in 3 months and decides to hedge using a long position in **a forward contract**.
- An investor owns 1,000 Microsoft shares currently worth \$28 per share. A two-month **put** with a strike price of \$27.50 costs \$1. The investor decides to hedge by buying 10 contracts

Value of Microsoft Shares with and without Hedging (Fig 1.4, page 11)



Arbitrage Example

- A stock price is quoted as £100 in London and \$200 in New York.
- The current exchange rate is 2.0300.
- What is the arbitrage opportunity?

1. Gold: An Arbitrage Opportunity?

Suppose that:

The spot price of gold is US\$900

The 1-year forward price of gold is
US\$1,020

The 1-year US\$ interest rate is 5% per
annum

Is there an arbitrage opportunity?

2. Gold: Another Arbitrage Opportunity?

Suppose that:

- The spot price of gold is US\$900
- The 1-year forward price of gold is US\$900
- The 1-year US\$ interest rate is 5% per annum

Is there an arbitrage opportunity?

1. Oil: An Arbitrage Opportunity?

Suppose that:

- The spot price of oil is US\$95
- The quoted 1-year futures price of oil is US\$125
- The 1-year US\$ interest rate is 5% per annum
- The storage costs of oil are 2% per annum

Is there an arbitrage opportunity?

2. Oil: Another Arbitrage Opportunity?

Suppose that:

- The spot price of oil is US\$95
- The quoted 1-year futures price of oil is US\$80
- The 1-year US\$ interest rate is 5% per annum
- The storage costs of oil are 2% per annum

Is there an arbitrage opportunity?

Speculation Example

- An investor with \$2,000 to invest feels that a stock price will increase over the next 2 months. The current stock price is \$20 and the price of a 2-month call option with a strike of 22.50 is \$1.
- What are the alternative strategies?

Hedge Funds

(see Business Snapshot 1.1, page 9)

- Hedge funds are not subject to the same rules as mutual funds and cannot offer their securities publicly.
- Mutual funds must
 - disclose investment policies,
 - makes shares redeemable at any time,
 - limit use of leverage
 - take no short positions.

Hedge Funds

(see Business Snapshot 1.1, page 9)

- Hedge funds are not subject to these constraints.
- Hedge funds use complex trading strategies are big users of derivatives for hedging, speculation and arbitrage