Introduction to derivatives

What is a Derivative?

- A derivative is an instrument whose value depends on, or is derived from, the value of another asset.
- Examples: futures, forwards, options, swaps, exotics…

https://www.youtube.com/watch?v=m3im-iJdhv4

Why Derivatives Are Important

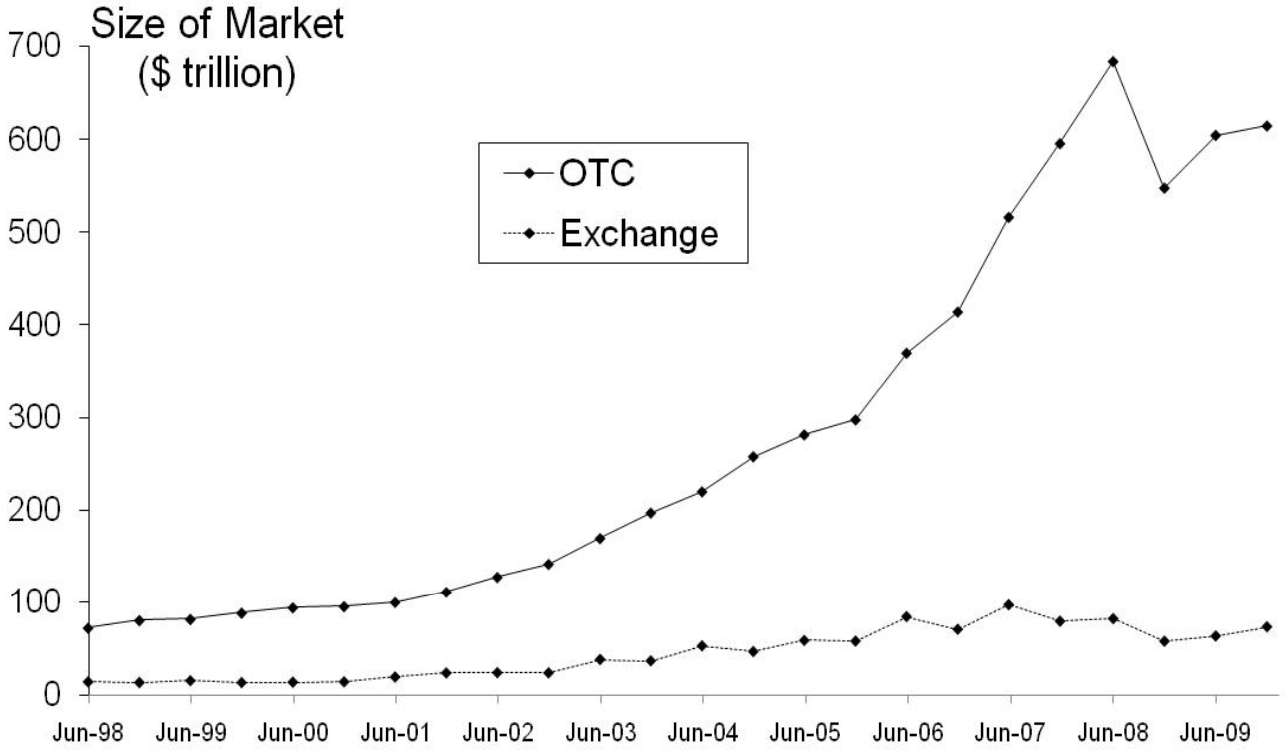
- Derivatives play a key role in transferring risks in the economy
- The underlying assets include stocks, currencies, interest rates, commodities, debt instruments, electricity, insurance payouts, the weather, etc
- Many financial transactions have embedded derivatives
- The real options approach to assessing capital investment decisions has become widely accepted

How Derivatives Are Traded

- On exchanges such as the Chicago Board Options Exchange
- In the over-the-counter (OTC) market where traders working for banks, fund managers and corporate treasurers contact each other directly
- OTC – a dealer network as opposed to a centralized exchange

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

The Lehman Bankruptcy

- Lehman's filed for bankruptcy on September 15, 2008. This was the biggest bankruptcy in US history
- Lehman was an active participant in the OTC derivatives markets and got into financial difficulties because it took high risks and found it was unable to roll over its short term funding
- It had hundreds of thousands of transactions outstanding with about 8,000 counterparties
- Unwinding these transactions has been challenging for both the Lehman liquidators and their counterparties

How Derivatives are Used

- To hedge risks
- To speculate (take a view on the future direction of the market)
- 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

Forward Price

- The forward price for a contract is the delivery price that would be applicable to the contract if were negotiated today (i.e., it is the delivery price that would make the contract worth exactly zero)
- The forward price may be different for contracts of different maturities

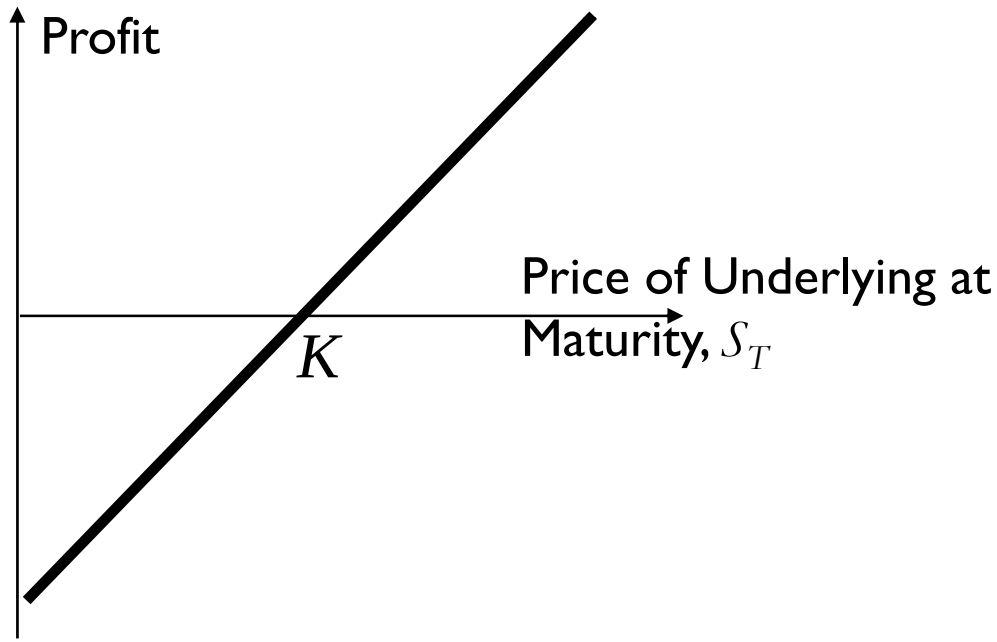
Terminology

- The party that has agreed to buy has what is termed a long position
- The party that has agreed to sell has what is termed a short position

Example

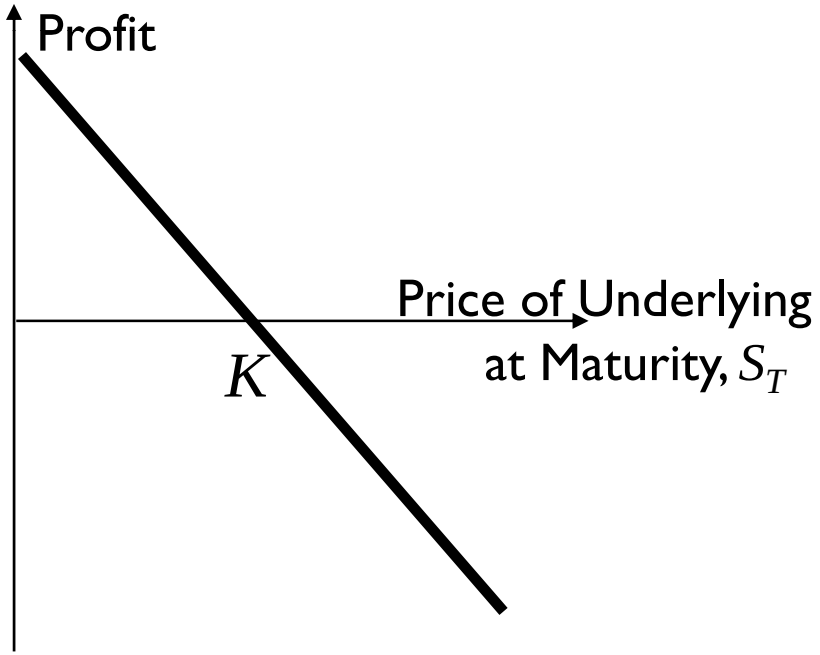
- On May 24, 2010 the treasurer of a corporation enters into a long forward contract to buy £1 million in six months at an exchange rate of 1.4422
- This obligates the corporation to pay $1,442,200 for £1 million on November 24, 2010
- What are the possible outcomes?

Profit from a Long Forward Position (K= delivery price=forward price at time contract is entered into)



Profit from a Short Forward Position

K= delivery price=forward price at time contract is entered into)



Futures Contracts (page 7)

- 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 OTC, a futures contract is traded on an exchange

https://www.youtube.com/watch?v=nwR5b6E0Xo4

Exchanges Trading Futures

- CME Group (formerly Chicago Mercantile Exchange and Chicago Board of Trade)
- NYSE Euronext
- BM&F (Sao Paulo, Brazil)
- TIFFE (Tokyo)
- and many more (see list at end of book)

Examples of Futures Contracts

Agreement to:

- Buy 100 oz. of gold @ US$1400/oz. in December
- Sell £62,500 @ 1.4500 US$/£ in March
- Sell 1,000 bbl. of oil @ US$90/bbl. in April

1. Gold: An Arbitrage Opportunity?

Suppose that:

- The spot price of gold is US$1,400
- The 1-year forward price of gold is US$1,500
- The 1-year US$ 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$1,400
- The 1-year forward price of gold is US$1,400
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The Forward Price of Gold

(ignores the gold lease rate)

If the spot price of gold is S and the forward price for a contract deliverable in T years is F, then

$$F = S(1+r)^T$$

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

In our examples, $S = 1400$, $T = 1$, and $r = 0.05$ so that

$$F = 1400(1+0.05) = 1470$$

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- The 1-year forward price of gold is US$1,500
- The 1-year US$ interest rate is 5% per annum

Is there an arbitrage opportunity?

1. Brow $1400 at 5% for one year
2. Buy once of gold
3. Enter a short forward contract to sell gold for $1500 in one year
4. In year, profit = $1500-$1470= $30

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Suppose that:

- The spot price of gold is US$1,400
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- The 1-year US$ interest rate is 5% per annum

Is there an arbitrage opportunity?

1. Sell the gold for $1400 per once
2. Invest the proceeds at 5%
3. Enter a long forward contract to repurchase the gold in one year for $1400
4. In year, profit = $1470-$1400= $70

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
- Assume rates are continuously compounded

Is there an arbitrage opportunity?

Yes, 125>101.89=95*exp(0.7)

Sell futures, buy spot and carry forward

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
- Assume rates are continuously compounded

Is there an arbitrage opportunity?

Yes, 80<101.89 = 95*exp(0.07)

Buy futures, sell oil spot, deposit proceeds and save storage cost.

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 positions

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

The bid price represents the maximum price that a buyer or buyers are willing to pay for a security.

The ask price represents the minimum price that a seller or sellers are willing to receive for the security

A trade or transaction occurs when the buyer and seller agree on a price for the security

Google Call Option Prices (June 15, 2010; Stock Price is bid 497.07, offer 497.25); See Table 1.2 page 8; Source: CBOE

Strike Price	Jul 2010 Bid	Jul 2010 Offer	Sep 2010 Bid	Sep 2010 Offer	Dec 2010 Bid	Dec 2010 Offer
460	43.30	44.00	51.90	53.90	63.40	64.80
480	28.60	29.00	39.70	40.40	50.80	52.30
500	17.00	17.40	28.30	29.30	40.60	41.30
520	9.00	9.30	19.10	19.90	31.40	32.00
540	4.20	4.40	12.70	13.00	23.10	24.00
560	1.75	2.10	7.40	8.40	16.80	17.70

Google Put Option Prices (June 15, 2010; Stock Price is bid 497.07, offer 497.25); See Table 1.3 page 9; Source: CBOE

Strike Price	Jul 2010 Bid	Jul 2010 Offer	Sep 2010 Bid	Sep 2010 Offer	Dec 2010 Bid	Dec 2010 Offer
460	6.30	6.60	15.70	16.20	26.00	27.30
480	11.30	11.70	22.20	22.70	33.30	35.00
500	19.50	20.00	30.90	32.60	42.20	43.00
520	31.60	33.90	41.80	43.60	52.80	54.50
540	46.30	47.20	54.90	56.10	64.90	66.20
560	64.30	66.70	70.00	71.30	78.60	80.00

Options vs Futures/Forwards

- A futures/forward contract gives the holder the obligation to buy or sell at a certain price
- An option gives the holder the right to buy or sell at a certain price

Types of Traders

- Hedgers
- Speculators
- Arbitrageurs

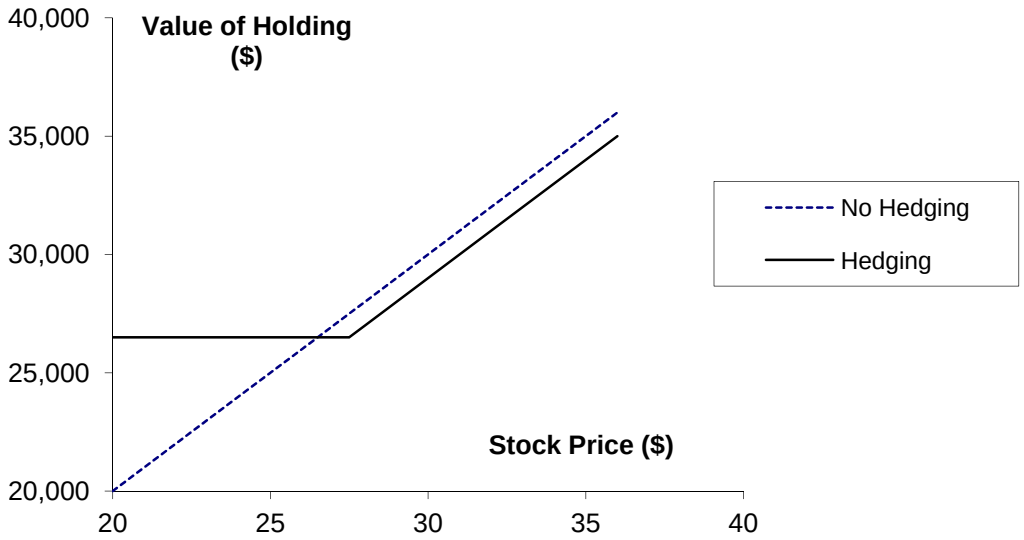
- To reduce the risk using, options, forward, and futures
- To bet on future decisions
- To lock in a profit by taking offset options in two or more instruments

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
- Cost of hedging = $1*100*10=$1000

- https://www.youtube.com/watch?v=kBtrxAjtG04

Value of Microsoft Shares with and without Hedging (Fig 1.4, page 12)



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?
- Invest: 100 shares or 2,000 call options
  - 100 shares and spot price is $27, then 100*(27-20) = $700
  - 2000 options, then 2000*[max(27-22.5,0)-1] = $7,000
  - Leverage effect of derivative trading!

Arbitrage Example

- A stock price is quoted as £100 in London and $140 in New York
- The current exchange rate is 1.4300
- What is the arbitrage opportunity?
  - 1.43*100 – 140 = $3 per share

Dangers

- Traders can switch from being hedgers to speculators or from being arbitrageurs to speculators
- It is important to set up controls to ensure that trades are using derivatives in for their intended purpose
- Soc Gen (see Business Snapshot 1.3 on page 17) is an example of what can go wrong