Lecture 1

INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Class: SY BSc

Subject : Financial Engineering

Chapter Name: Derivatives :- An Overview

Today's Agenda

1. Derivatives
   1.1 What are Derivatives ?
   1.2 What is Derivative Trading

2. Arbitrage
   2.1 Arbitrage – Definition
   2.2 Principal of No Arbitrage

3. Option
   3.1 Forward and Futures
   3.2 Option – Definition
   3.3 Understanding Various Terminology Applicable in an Option Contract

1.1 What are Derivatives ?

What kind of financial instruments are derivatives ???

Which are the common types of derivatives?

Derivatives -Definition

Derivatives

A derivative is **a contract between two parties which derives its value/price from an underlying asset**. The most common types of derivatives are futures, options, forwards and swaps. Generally stocks, bonds, currency, commodities and interest rates form the underlying asset

Simply put, derivatives are financial instruments which derive their value from an underlying asset.

Common Types of Derivatives

- Forwards
- Futures
- Options
- Swaps

1.2 *Derivative Trading*

What is Derivative Trading ?

- Derivatives are financial instruments that derive value from an underlying asset (stock, bond or commodity) and can be used for various purposes in the portfolio of assets.
- Common derivatives include futures contracts, forwards, options and swaps.
- Most derivatives are not traded on exchanges and are used by institutions to hedge risk or speculate on price changes in the underlying asset.
- Exchange-traded derivatives like futures or stock options are standardized and eliminate or reduce many of the risks of over-the-counter derivatives. Thus one can easily buy and sell derivative instruments.

1.2 Why do we need Derivatives ?

- The main purpose of derivatives is **to reduce and hedge risk**. Many businesses and individuals are exposed to financial risk that they would like to get rid of. For example, an airline needs to buy fuel to power its planes. ... Derivative contracts allow them to get rid of their risk.

- Example

Exporters face a lot of risk related to foreign exchange. Their goods are invoiced in foreign currency. However, they have to pay their expenses in local currency. The exchange rates between the foreign and local currency change every second. Hence, the profitability of such an export oriented firm is hit by these changes in the commodity prices. They too feel that there is a need for a financial instrument which can provide them a stable exchange rate regardless of the ups and downs in the market so that they can plan their operations based on this stable platform. The Derivatives used here are called **Currency Derivatives**

2.1 Can you think of what is Arbitrage??

Define Arbitrage.

State the principle of “NO ARBITRAGE“.

2.1 What is Arbitrage?

- Arbitrage is the purchase and sale of an asset in order to profit from a difference in the asset's price between markets. It is a trade that profits by exploiting the price differences of identical or similar financial instruments in different markets or in different forms.

- Arbitrage exists as a result of market inefficiencies and would therefore not exist if all markets were perfectly efficient.

2.2 Principle of no arbitrage

The fundamental principle underlying much of financial engineering is the principle of no arbitrage.

“Principle of no Arbitrage asserts that two securities that provide the same future cash flow and have the same level of risk must sell for the same price.”

In derivatives markets, arbitrage is the certainty of profiting from a price difference between a derivative and a portfolio of assets that replicates the derivative’s cash flows.

Derivatives are priced using the no-arbitrage or arbitrage-free principle: the price of the derivative is set at the same level as the value of the replicating portfolio, so that no trader can make a risk-free profit by buying one and selling the other.

Here, a replicating portfolio for a particular asset or a series of cash flows in mathematical finance is a portfolio of assets sharing the same properties as the reference assets.

3.1 Forwards and Futures

What are forwards and futures??
List down the differences
between them.

Forward Pricing

Consider that S_0 is the stock price at time 0, r is the risk free rate of interest, T is the tem of the forward contract, then derive the equation for the price of the forward contract.

Note: Ignore income, expenses and dividends.

State the two portfolios to be set up at time 0 and then using the principle of no arbitrage, derive the forward price.

Derive the forward price

Consider an asset with price S_t at time t, paying a dividend at a constant dividend yield, D. Dividends are paid at the end of each year and are immediately reinvested in the asset. The continuously compounded risk-free rate of interest is r p.a.

Derive the forward price, K of a contract issued at time t, with maturity at time T, to trade one unit of the asset, where T-t is an integer number of years.

3.2 And what about Options??

Exercise for you!! All the best.

- What are Option contracts?
- What is a Call Option?
- What is Put Option?
- How do American and European Options differ?
- Explain Long and Short holding positions in Options.
- Who do you think pays premium in option contracts? And why ?

Factors affecting option prices

Fill the following table; (say whether the price of the option will increase, decrease or remain unchanged in each of the following situations).

Factors	Price of Call option	Price of Put options
Price of the underlying increases.		
A lower Strike price		
Time to expiry a) Longer b) Lesser		
Volatility decreases		
Risk free interest rate increases		
Value of income received on the underlying is high		

Intrinsic Value and Time Value

Intrinsic Value

Intrinsic value is **a measure of what an asset is worth**.

Time Value

Time value refers to the portion of an option's premium that is attributable to the amount of time remaining until the expiration of the option contract.

Intrinsic Value and Time Value

What do you understand by Intrinsic value and Time value of an option?

Question: Suppose that the price of Share of RIL is 114 and that a put option on the share of RIL with an exercise price of 110 is currently priced at 5.

Calculate the intrinsic value and time value of the option.

Put Call Parity

Consider the two portfolios:

A: one call plus cash of $Ke^{-r(T-t)}$

B: one put plus one share

Derive the put-call parity relationship.

Bounds on Options

Let the strike price be K on an underlying non-dividend paying share with price S_t at time t and option exercisable at time T.

By considering a suitably chosen notional portfolio or portfolios (should be specified), derive the lower bound for the following,

1. European call Option

2. American Put Option

Bounds on Options

Let the strike price be K on an underlying non-dividend paying share with price S_t at time t and option exercisable at time T.

By considering a suitably chosen notional portfolio or portfolios (should be specified), derive the Upper bound for:

1. European put Option

2. American call Option

Try to Calculate!

1. Stock price is $98, a European call option struck at $100 with an expiration of nine months has a value of $9.07. The nine-month, continuously compounded, interest rate is 4.5%. What is the value of the put option with the same strike and expiration?

2. Calculate the lower bound for a 3-month European put option on Share Y if the current share price is 96 , the strike price is 100 and the continuously compounded risk free rate is 11.5% pa.

3. Discuss why is it not optimal to exercise an American call option on a non-dividend paying share early (i.e. before expiry). Also do you suggest the same in case if there is a dividend.

Solutions

1. $p_t = 7.75$
2. Lower bound = 1.165934

Arbitrage Example

Explain the strategy to earn arbitrage profit if the price p was 25 instead if u have the following two strategies

Strategy A

- Xe^-rt in the risk free asset
- Call Option of Maturity 120 at price c

Strategy B

- Put Option Maturity 120
- Share

X = 120 r = 6% T = 3/12

So = 123 q = 12% c = 30

p = 28.85

*p and c are calculated using put call parity

Solution

If p = 25

Price of Strategy A = 30 + 120*e^-0.06*(3/12) = 148.21

Price of Strategy B = 25 + 123 = 148

Strategy B is cheaper than Strategy A

Arbitrage Strategy :- Sell A and Buy B

At Maturity

If

St<X

Payoff of Strategy A = -120

Payoff of Strategy B = 120-St + St = 120

Total Payoff = 0

Solution

If St>x

Payoff Strategy A = St-120+120 = -St

Payoff Strategy B = St

Total payoff = 0

As we can see, the payoffs in both cases are zero

Price of the strategy is = +148.21 – 148 = 0.21

Hence we have made a profit of 0.21 and we have zero payoff in the future in all scenarios and hence we have made arbitrage profit.

Quick Recap

- A derivative is **a contract between two parties which derives its value/price from an underlying asset**
- Common Types of Derivatives are Forwards Futures Options Swaps
- The main purpose of derivatives is **to reduce and hedge risk**. Many businesses and individuals are exposed to financial risk that they would like to get rid off.
- Arbitrage is the purchase and sale of an asset in order to profit from a difference in the asset's price between markets. It is a trade that profits by exploiting the price differences of identical or similar financial instruments in different markets or in different forms.
- Principle of no Arbitrage asserts that two securities that provide the same future cash flow and have the same level of risk must sell for the same price.
- Intrinsic value is **a measure of what an asset is worth** and Time value refers to the portion of an option's premium that is attributable to the amount of time remaining until the expiration of the option contract.