Introduction

**Derivatives and Arbitrage**

# What are Derivatives?

* Derivatives are financial instruments whose value is **derived** from the value of a more basic **underlying variable** (Usually other assets, but can be *any measurable variable*)
* There are **three main types** of Derivatives:

|  |  |  |
| --- | --- | --- |
| **Forwards & Futures** | **Options** | **Swaps** |
| **Obligation** to trade an underlying asset at a specified future time at a specified price | **Right NOT obligation** to trade an underlying asset on a specified future time at a specified price | **Obligation** to **exchange one series of cashflows for another** over a specified period |

# Why use Derivatives?

|  |  |  |
| --- | --- | --- |
| **Hedging** | **Speculating** | **Arbitrage** |
| To seek **protection** from adverse price movements | To seek **profit** from price movements | To seek riskless profits from mispricing |
| Using a derivative whose **value offsets unwanted changes** in the existing position | **Gambling** on the price movements | **Simultaneously** trading derivatives and synthetics |
| Hedgers and Speculators **provide liquidity for each other** | Hedgers **avoid risk** while Speculators **assume the risks** | Eliminates the arbitrage opportunity; ensures no arbitrage |

**Other reasons to use Derivatives:**

* Reduce transaction cost
* Avoid regulatory, tax and accounting constraints

# Exploiting Arbitrage

* Understanding "*Riskless Profit*":
  + **Riskless** → No net investment → **No negative cashflows**
  + **Profit** → At least **one positive cashflows**
  + 
* We can make Riskless Profits when there is a mispricing of Assets - **Buy Low & Sell High**
  + Assume that there is an Actual Price & a Theoretical Price
  + Buy the lower one & sell the higher one
  + The initial cashflows should offset each other (**No Negative Cashflow**) and the difference in prices will result in a profit at maturity (**At least one Positive Cashflow**)
* Naturally, Arbitrage opportunities are rare - even if they exist, they will immediately be eliminated by the people who exploit them
  + Investors buy assets that are priced lower than expected, bidding up their price till they are normally priced
  + Investors sell assets that are prices higher than expected, bidding down their price till they are normally priced
  + Thus, we typically assume that arbitrage does NOT exist - **Law of One Price**

## Synthetic Positions

* If the price that the Asset is trading at is wrong, how can we trade the correct price?
* Derivatives can be *replicated* using a combination of one or more other assets (Synthetic Derivatives)
* The price of these Synthetic Positions is the "correct" price of the Derivative

## Checking for Arbitrage

* There are two ways to check for Arbitrage
  + Check no Arbitrage Conditions
  + Make the initial cashflow 0 and check final payoff
* If the above is violated, then Arbitrage is possible

## Buy Low and Sell High

* Write the time 0 price inequality that is **OBSERVED,**
  + 
* Move everything to do **greater than side**,
  + 
* Use the Cashflow perspective to determine. Since this is an **initial cashflow**,
  + **Positive** → Sell
  + **Negative** → Buy

**Trading**

# Market Makers

* Financial Assets such as Stocks and Derivatives are *mainly* traded on Exchanges
* Market Makers have special arrangements with Exchanges to facilitate trading of their Assets
* Market Makers facilitate trades by fulfilling the role of a counterparty in a trade
  + In every trade, there must be a Buyer and a Seller who are agree on a price
  + When there are no sellers available, they **sell assets to the investors**
  + When there are no buyers available, they **buy assets from the investors**
  + Thus, they have to hold their own inventory of Assets from the various Exchanges
* They ensure that continuous trading can occur in any Exchange, "*making the market* work"

# How do Market Makers earn money?

## Commission

* Whenever an investor trades with a market maker, they are charged a **commission fee for using the liquidity** provided by them
  + Flat Commission
  + Percentage Commission
* The effect of commissions depend on whether you buying or selling
  + **Buying → Added** to purchase price
  + **Selling → Subtracted** from sale
  + Follow the directing that is **least favourable** to the investor

## Bid-Ask Spreads

* Market Makers both buy and sell assets at the same time, they have a unique price for each
  + **Bid Price** is how much they will **buy** the asset from the investor
  + **Ask Price** is how much they will **sell** the asset to the investor
  + Note the naming convention is **from the Market Makers perspective** of Buying/Selling
* The **Ask Price will always be higher than the Bid price**
  + The market maker earns a profit through **buying low and selling high**
  + If both prices were the same, an investor who immediately opens and closes a position would result in 0 profit for the market maker
  + Thus, in order to earn a profit, the Ask Price *must* be higher than the Bid price
  + 
* Bid-Ask prices are constantly being updated to match the market sentiment to ensure that investors are willing to trade at these prices so that trades are occurring

## Round Trip Transaction Cost

* We can measure the impact of the above two fees by considering the round trip transaction cost
* It is the cost of **opening and closing a position immediately** using the SAME bid-ask spread
* However, we typically assume that there are **no transaction costs**, unless stated otherwise



# How are trades conducted?

## Trading Orders

|  |  |  |
| --- | --- | --- |
| **Market Order** | **Limit Order** | **Stop-Loss Order** |
| Executes the trade at the **best possible price** | Executes the trade at a **specified price or BETTER** | Executes a Market Order once the price **passes a specified point** |
| **Guaranteed** that the trade will execute regardless of the price | **No guarantee** that the trade will execute as the price **may not move favourably** | **No guarantee** that the trade will execute as the price **may not move favourably** |
| **No Control** over price | **Precise Control** over price | **Some Control** over price; could be better or worse |

|  |  |
| --- | --- |
| **Good Till Executed** | **Good Till Date** |
| Order remains in effect until executed | Order remains in effect till expiry date |

## Trading Positions

|  |  |
| --- | --- |
| **Long Position** | **Short Position** |
| **Buy** the stock now & **sell it later**  **Benefit** when the **price increases** | Borrow the asset, **sell it now buy/return it later**  **Benefit** when the **price decreases** |
| **Close** a long position | **Cover** a short position |
| **Borrow to buy the stock**  **Pay it back with interest later** | **Lend the proceeds of the sale**  **Receive it back with interest later** |
| Dividends **owned by investor**  **Lend the dividends out**  **Receive it back with interest later** | Dividends **paid to lender**  **Borrow to pay the dividends**  **Pay it back with interest later** |

### Short Selling Dividends

* Dividends are **paid to the owner** of the stock at the time
* During a short sale, the owner of the stock is **neither the Lender nor the Short Seller**
* Since the **Lender would have earned the dividends** had they not lent it out, the Short Seller must **compensate the Lender for the dividends they would have earned**
* If the dividends are paid at maturity, then they must be **paid with interest**

### Short Selling Collateral

* The lender of the asset will always be concerned that the asset will not be returned (Ill-intentions)
* Thus, the lender will **hold on to the proceeds** of the short sale as **Collateral**
* There is another risk that if the price of the asset rises too much, they will not be able to afford to buy back the asset, even if they are willing to
* Hence, the lender will require **additional collateral** in the form of a **Haircut**
* The **lender of the asset** will have to compensate the short seller with **interest on BOTH forms of collateral**
  + The interest credited is known as the **Short Rebate Rate** (Stocks) or **Repo Rate** (Bonds)
  + Both of these rates are typically **lower than the market interest rate** - to allow the lender to earn the spread as a profit

**Payoffs and Profits**

# Payoffs & Profits

* We use two metrics to measure investments:
  + **Payoffs** → Net Cashflow only at **maturity**
  + **Profits** → Net Cashflow **across all time**
  + The main difference is whether or not the initial cashflow (Cost) is considered
* We can visualize the two in the forms of **Payoff & Profit diagrams** - the difference between the two is often a **parallel shift** representing the initial cashflow

**Payoff & Profit for a Long and Short Stock**

payoff 
Profit 
Spot Price 
Spot price 

i Ods 
iOds 

# 

**Payoff & Profit for a Long and Short Bond**

Payoff 
Profit 
o 
Spot price 
Spot price 

# 

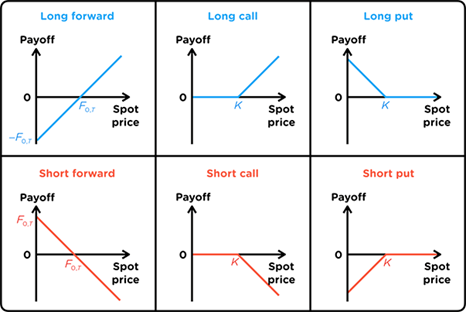
03!Jd aOdS 
JJOÄed 

# To remember Bonds better, just remember that Short Positions have initial cash inflows while Long Positions have initial cash outflows

# 

## More on Payoffs

* Trading is a **Zero Sum Game** - if one party gains, another party must have lost
* Thus, the Payoff and Profit for a Long and Short position must be **equal & opposite**:
  + 
  + 
* Graphically, the payoff diagrams for both Long & Short positions are mirrored about the x-axis



## More on Profits

* There are two kinds of profits:
  + 
  + 
  + Unless stated otherwise, this course will focus on **Economic Profit**
* Economic Profit takes into account the **opportunity cost** of earlier cashflows
  + Note that Opportunity Cost is an **implicit cost** - it does not *actually* occur
* We refer to two kinds of Profits
  + **Gain** → Positive Profit
  + **Loss** → Negative Profit