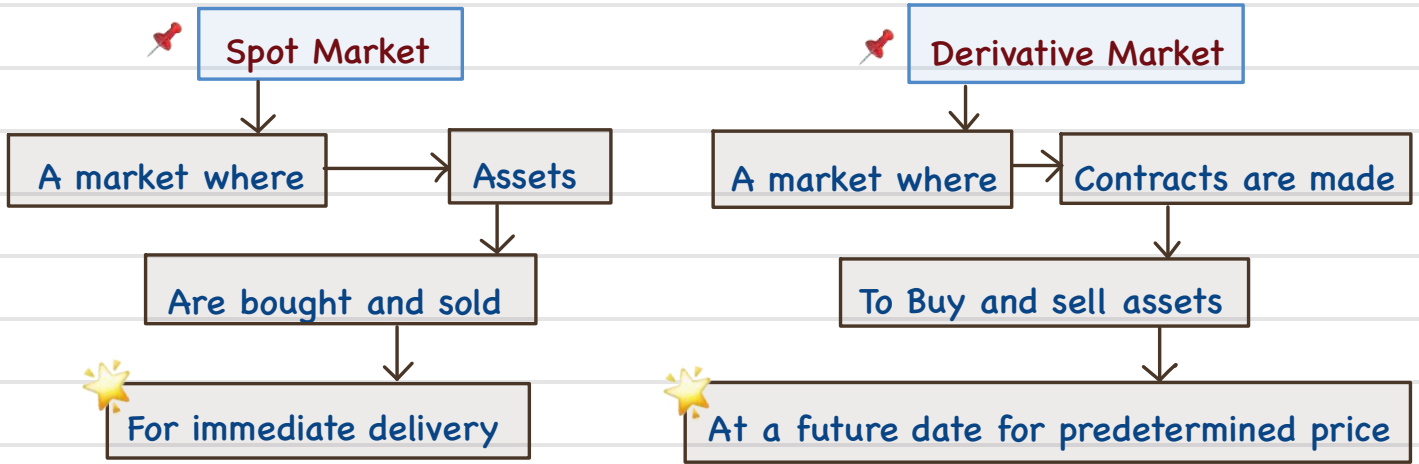
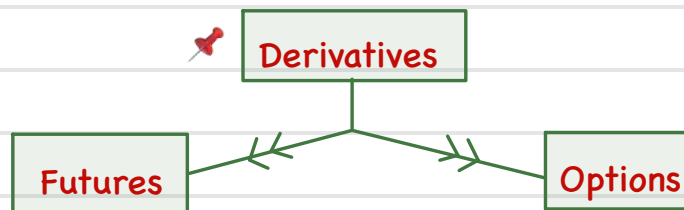
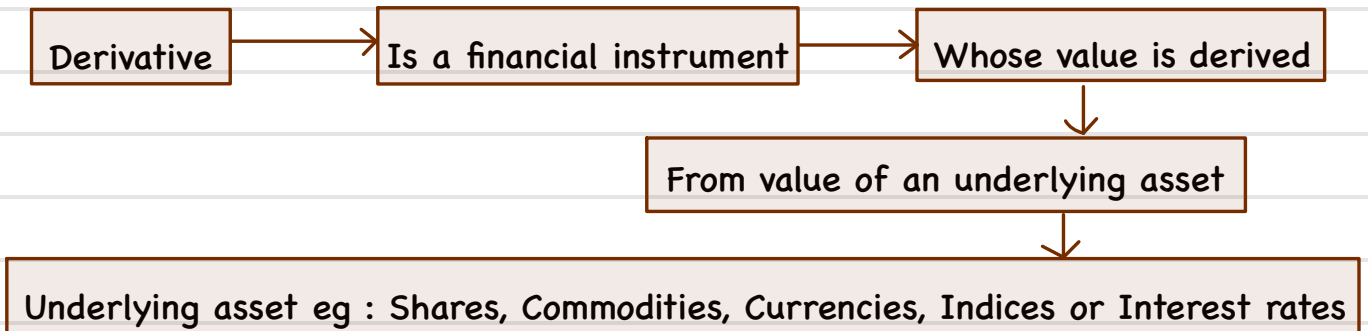


# Derivatives

## Introduction to Derivatives



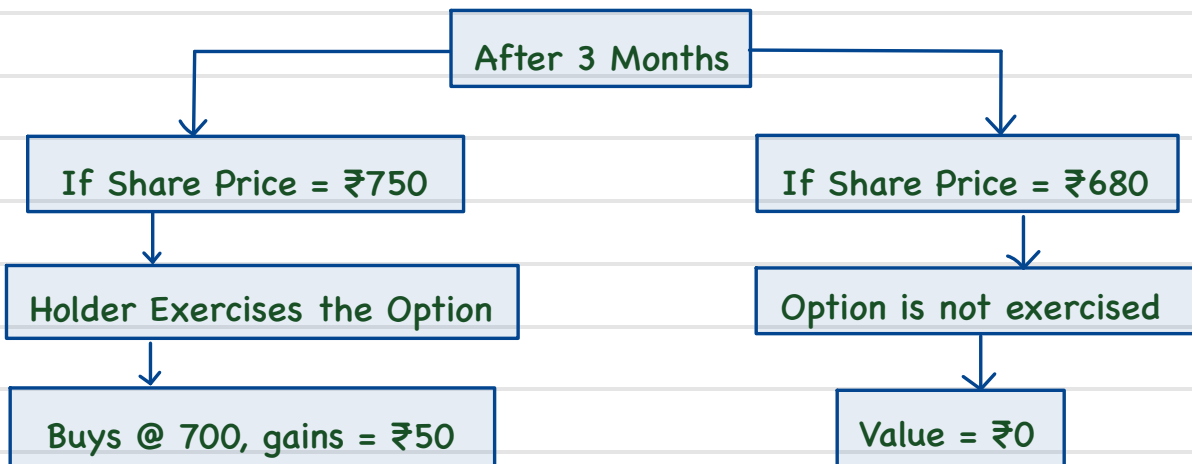
## Meaning of Derivative



### Example

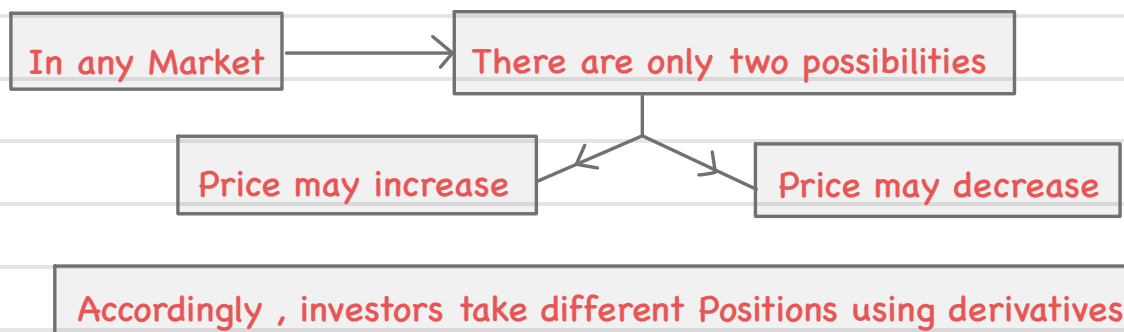
A call option on Tata Motors  
its Strike Price ₹700  
for 3months





✨ Thus the value of the derivative depends on the underlying asset

### Expectations in Market



📌 Positions Based on Expectations

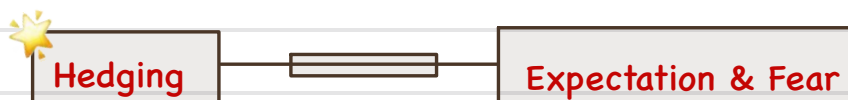
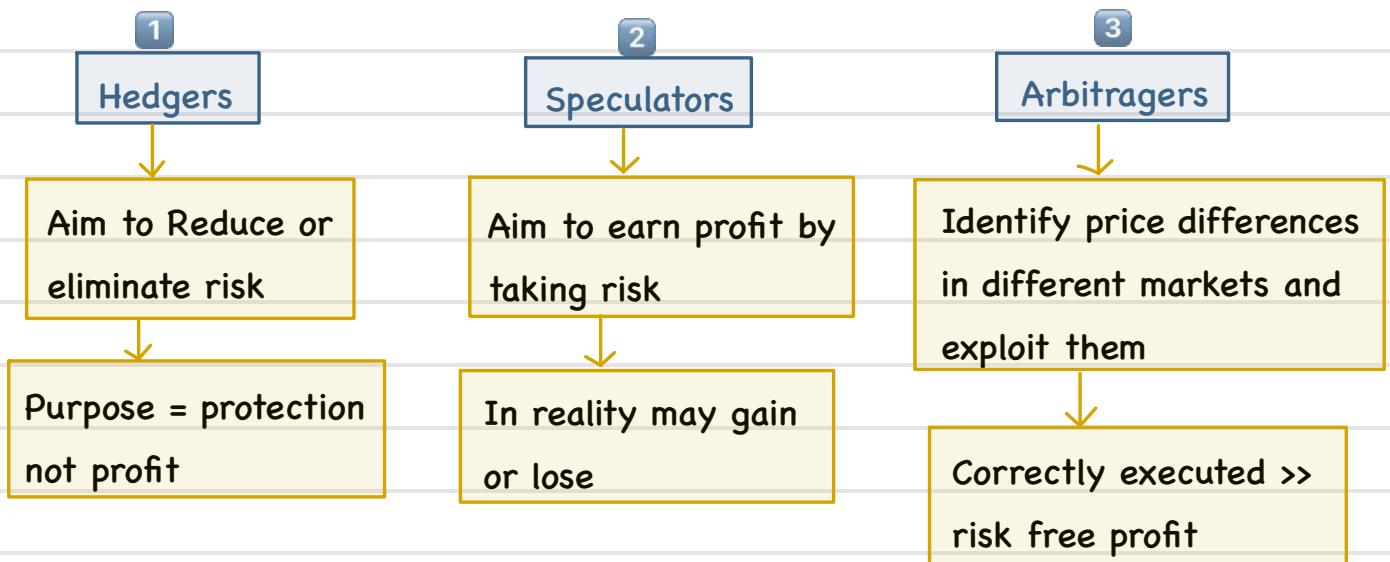
⬆️ If Price is Expected to increase

- Buy in Spot Market (eg: Tata Motors Shares)
- Take a long position in Forward Contract
- Take a long position in Futures Contract
- Buy a call option (eg: Tata Motors 700 CE)
- Sell a put Option

↓ If Price is Expected to Decrease

- Short sell in Spot Market
- Take a Short Position in Forward Contract
- Take a Short Position in Futures Contract
- Sell a Call option
- Buy a put option

### Types of Market Participants

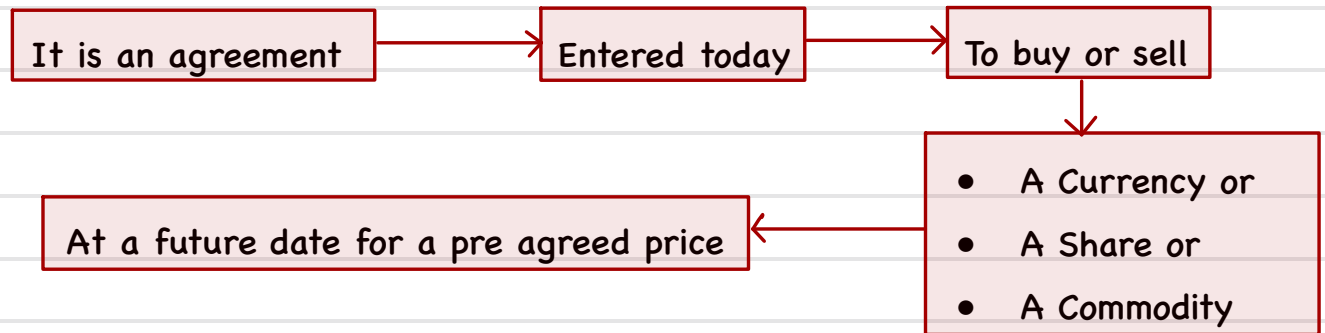


Expectation	Price will increase	Price will Decrease
Fear	What if it decreases?	What if it increases?

This Combination of expectation & fear leads to hedging

Where an investor uses derivatives to protect against unfavourable price moments

## Futures Contract

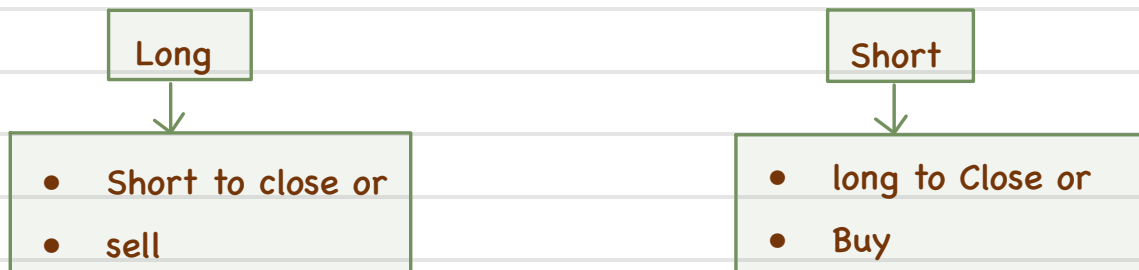


### Positions in Futures



### ★ Closing a Futures Contract

To Close a futures Contract at maturity, an investor takes the Opposite Position



✓ Long Position

Asset : Tata Motors Shares

Futures Contract :

Buy 100 Shares at ₹700 each, delivery in 1month (long Position)

Expectations : Price will increase

Possible outcomes at maturity

Profit

Market price = ₹750

Close the Contract by Selling at ₹750

Profit =  $(₹750 - ₹700) \times 100 = ₹5,000$

Price increased  as expected

Profit realized 

Loss

Market price = ₹680

Close the Contract by selling at ₹680

Loss =  $(₹700 - ₹680) \times 100 = ₹2,000$

Price decreased  against expectation

Loss incurred 

 key point

→ Profit if price rises , loss if price falls

✓ Short Position

Asset : Tata Motors Shares

Futures Contract :

Buy 100 Shares at ₹700 each, delivery in 1month (short Position)

Expectations : Price will Decrease

Possible outcomes at maturity

Profit

Market price = ₹680

Close the Contract by buying at ₹680

Profit =  $(₹700 - ₹680) \times 100 = ₹2,000$

Price Decreased ↓ as expected

Profit realized 🏆

Loss

Market price = ₹750

Close the Contract by Buying at ₹750

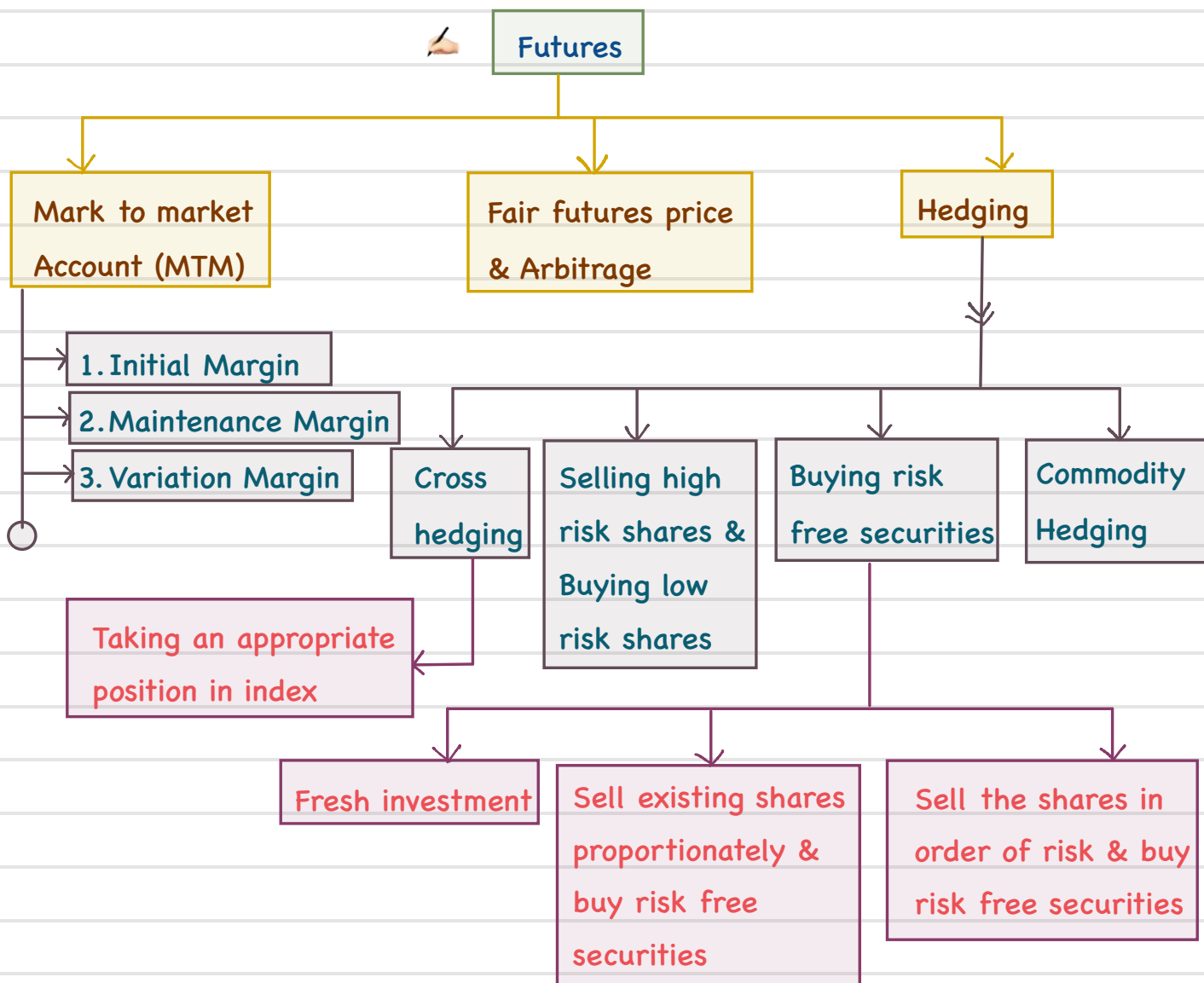
Loss =  $(₹750 - ₹700) \times 100 = ₹5,000$

Price increased ↑ against expectation

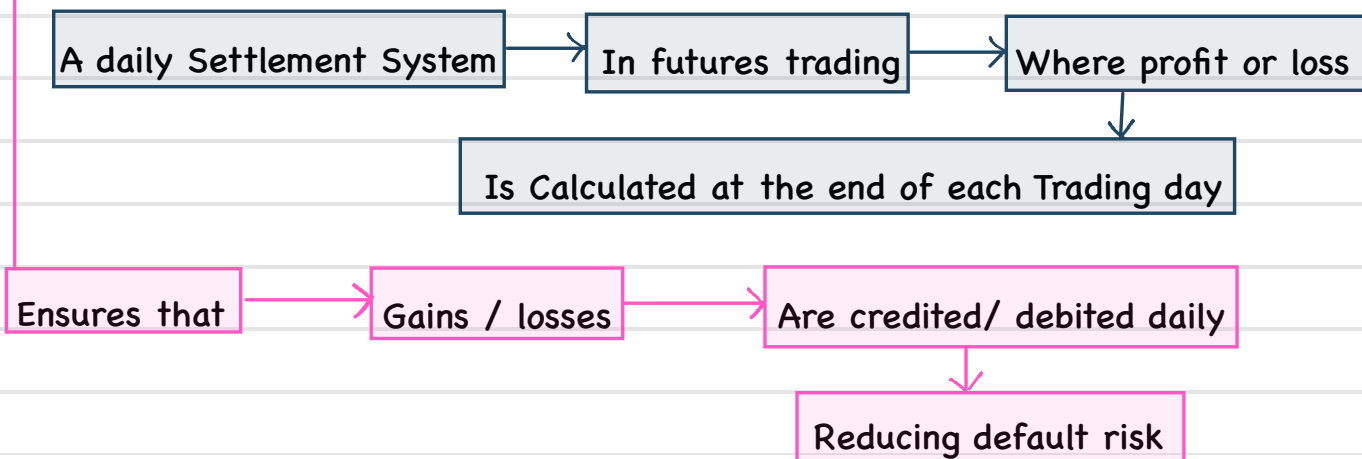
Loss incurred 😞

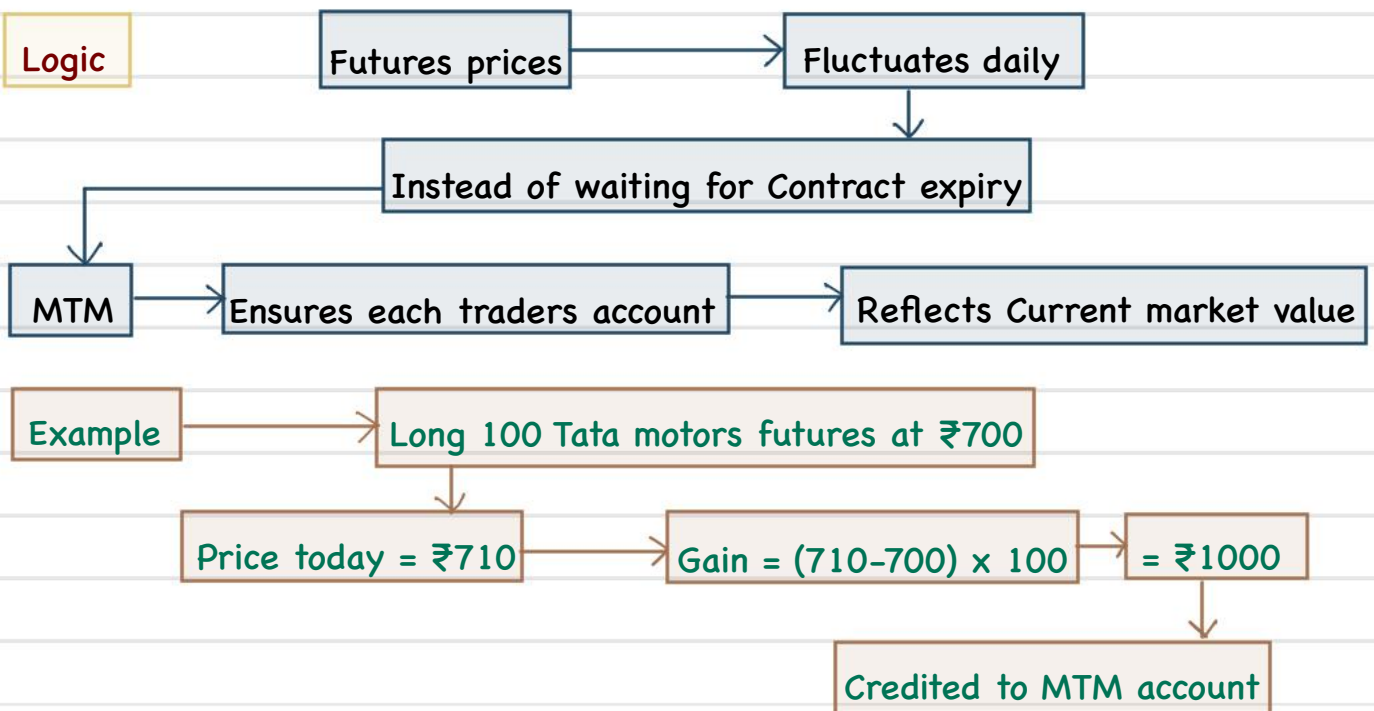
🔑 key point

→ Profit if price falls , loss if price raises

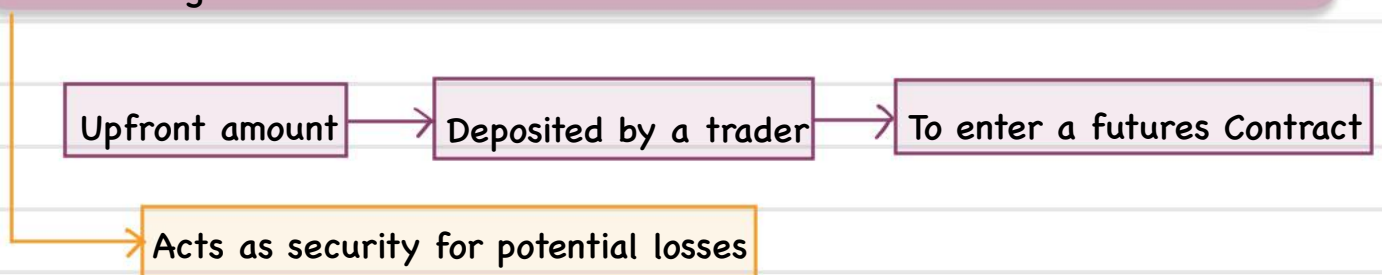


Mark to Market account





### Initial Margin



**Formula**

$$\text{Initial margin} = \mu + 3\sigma$$

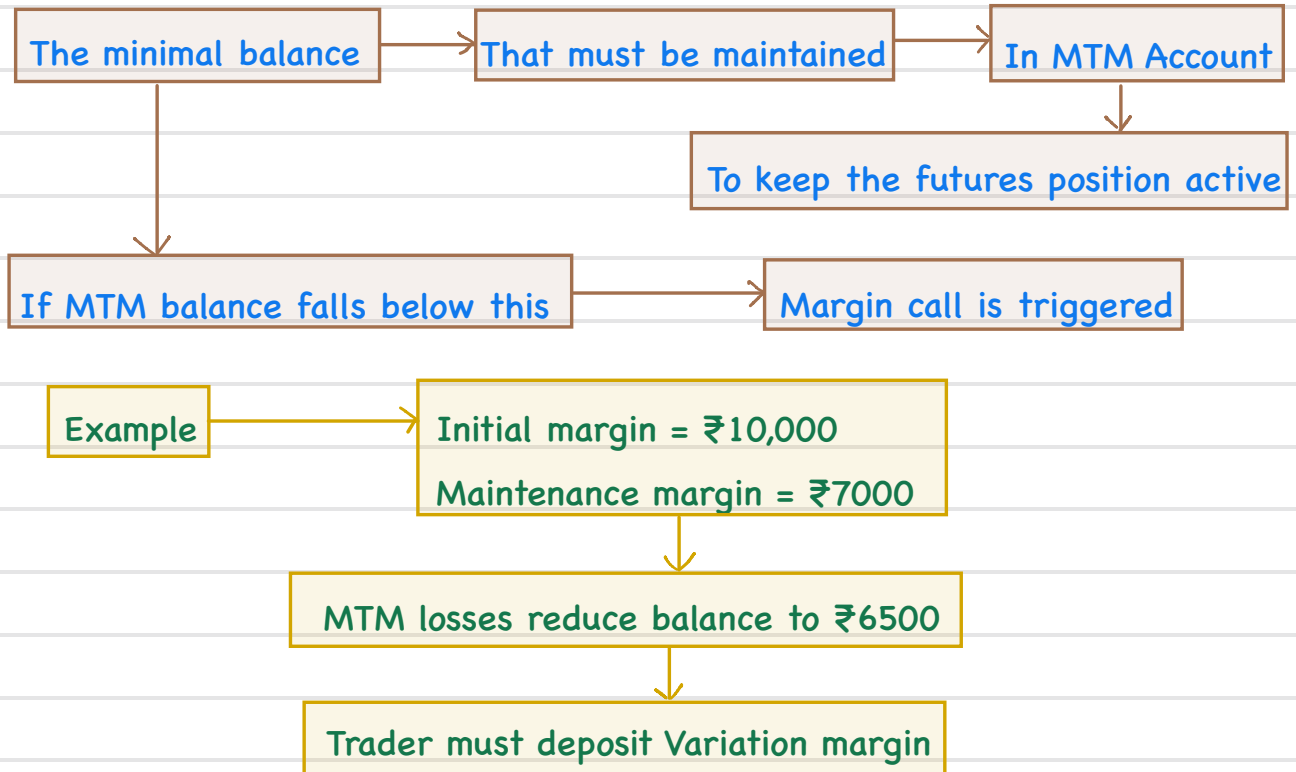
**Logic for formula**

$$\text{Initial margin} = \text{Daily absolute Change} + 3 \times \text{standard Deviation}$$

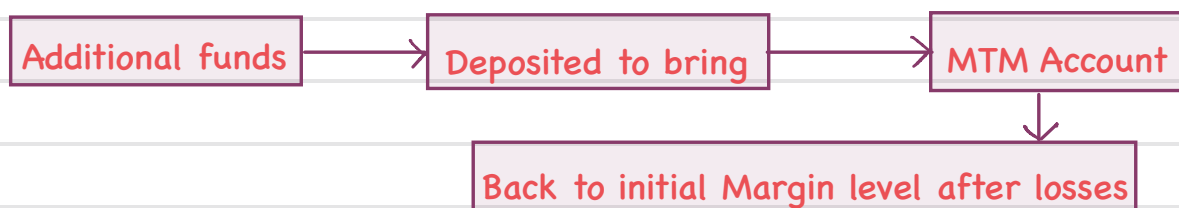
- Daily absolute Change : Covers normal day to day price movement
- 3 x Standard Deviation : Covers extreme price movements

Ensures that most price fluctuations are covered and reduces default risk

## Maintenance Margin



## Variation Margin



Fair futures price



Formula

Fair futures price = Spot price + Carrying Cost - yield/income

Or

Fair futures price = Spot price  $\times e^{tr}$  - yield

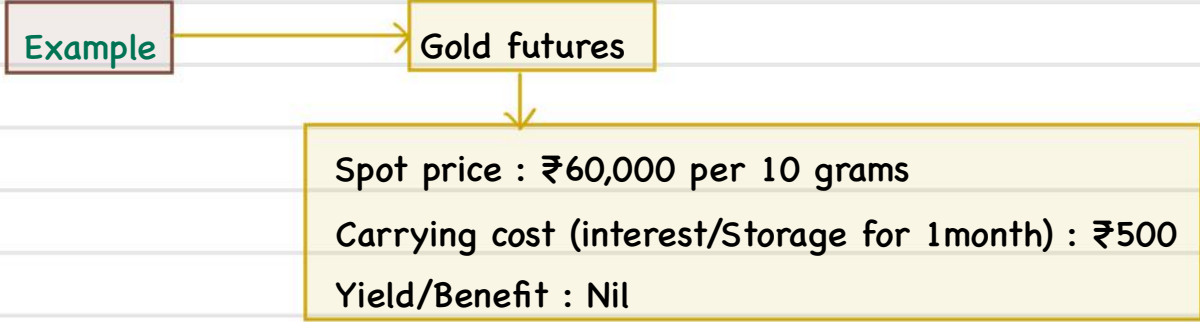
Or

Fair futures price = Spot price  $\times e^{t(r-y)}$

Logic

- Spot price : current market price of the asset
- Carrying Cost : Cost to hold the asset until expiry (interest, storage, insurance)
- Yield / income : any benefits from the asset (dividends for shares, yield for bonds)
- Idea : Futures Price reflects Cost of Carry minus any benefits , so traders cannot earn risk free profits

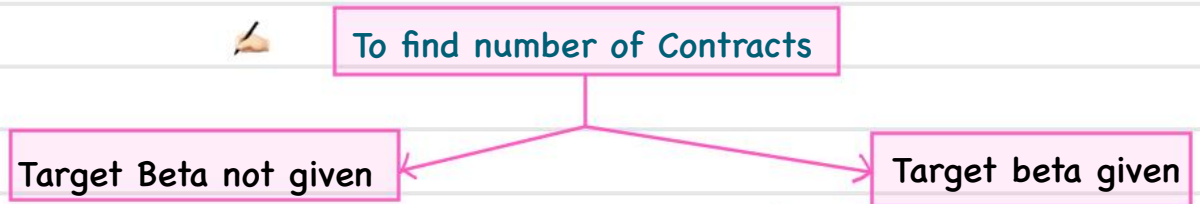
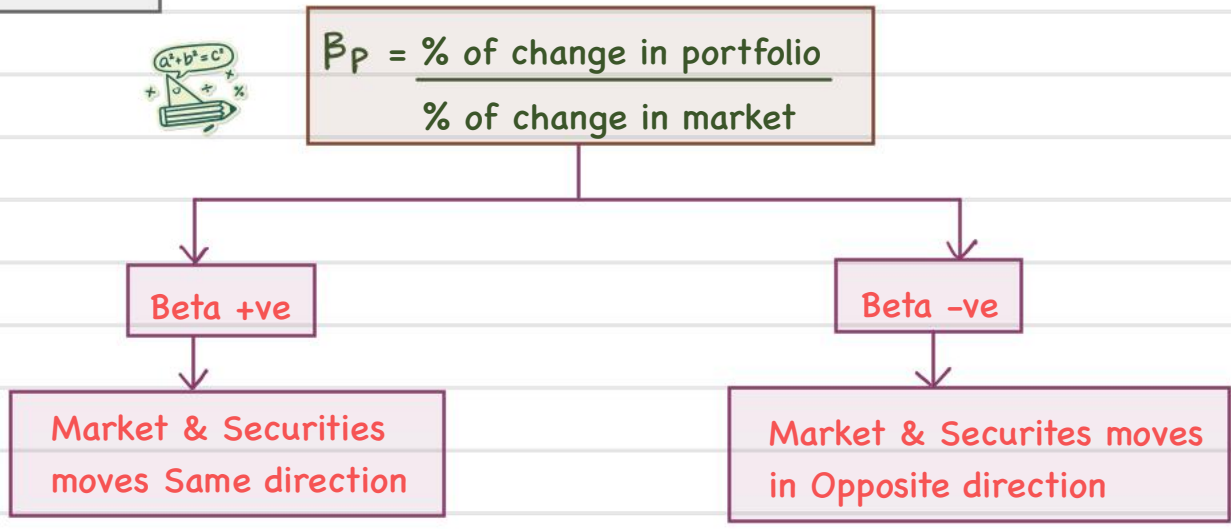
Case	Futures market	Action
AFP=FFP	Correctly valued	No scope for arbitrage
AFP>FFP	Over valued	Sell future , Buy spot
AFP<FFP	Undervalued	Buy future, sell spot

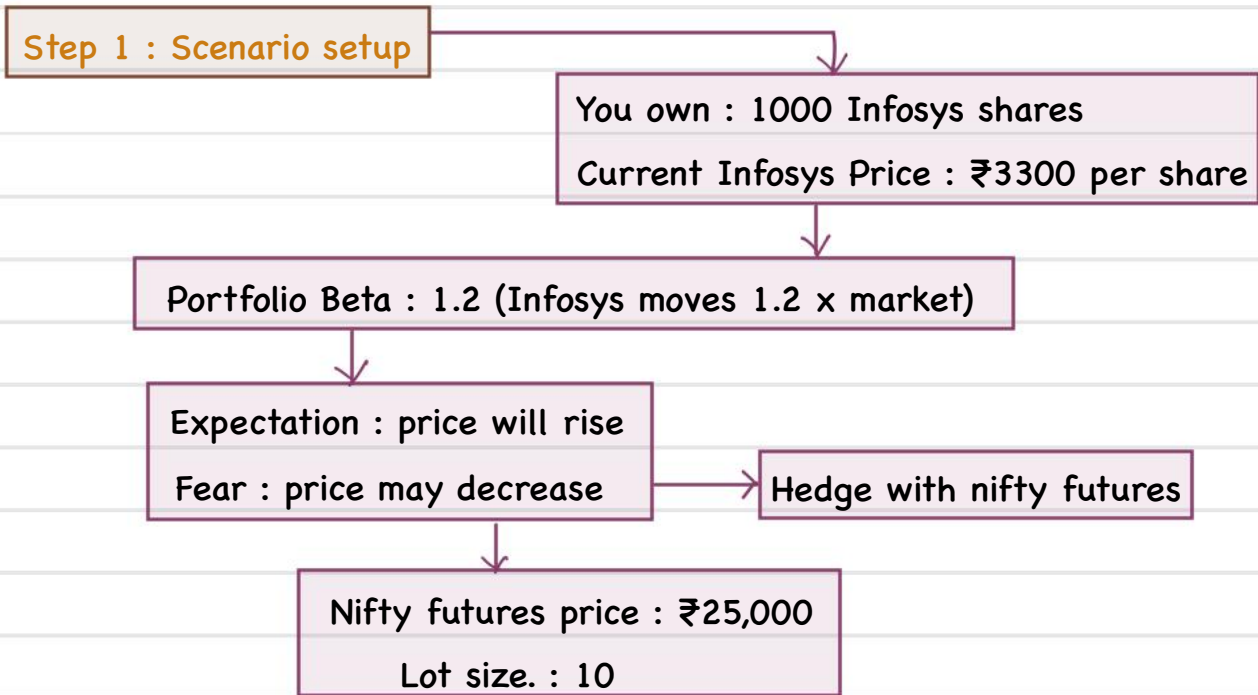
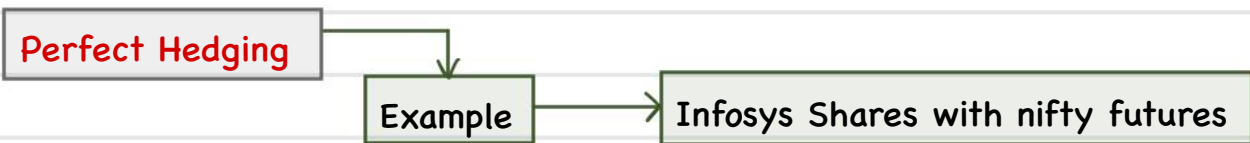
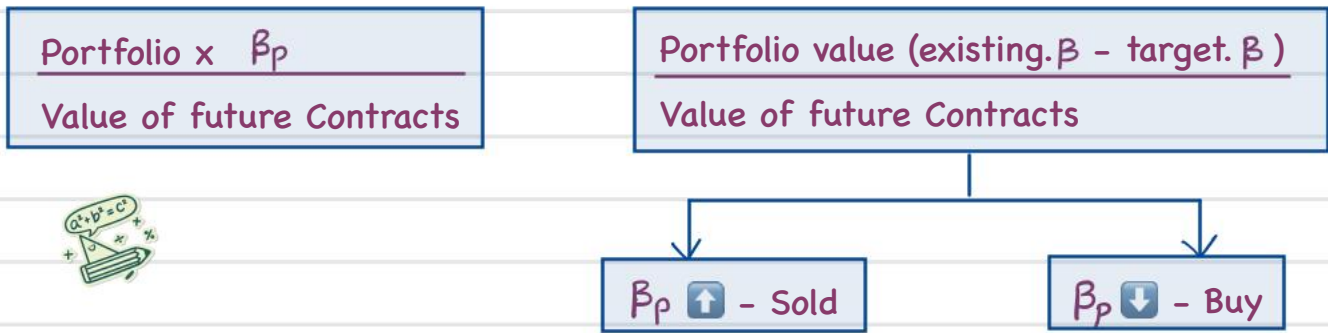


	Arbitrage
If the futures Contract is above ₹60,500	Sell futures, buy spot
If the futures Contract is below ₹60,500	Buy futures, sell Spot

Hedging with index future

Formulas





Futures position value = portfolio value x Beta

Portfolio value = $3,300 \times 1,000 = 33,00,000$ Futures position value = $33,00,000 \times 1.2 = 39,60,000$
---



$$\text{Number of Contracts} = \frac{\text{portfolio value} \times \text{Beta}}{\text{value of future contracts}}$$

$$= \frac{39,60,000}{25000 \times 10}$$

$$= 16 \text{ Contracts}$$

✓ perfect whole Number of Contracts ,,,, net gain /loss = 0

Step 3 : Market moves

Case 1	Case 2
Market falls by 10%	Market raises by 10%
Infosys portfolio loss : 3,96,000	Infosys portfolio gain : 3,96,000
Nifty futures gain : 3,96,000	Nifty futures loss : 3,96,000
Net effect 0	Net effect 0

Step 4 : key Takeaways

Hedging with index futures

Protects your stock portfolio from market risk

Perfect hedge formula

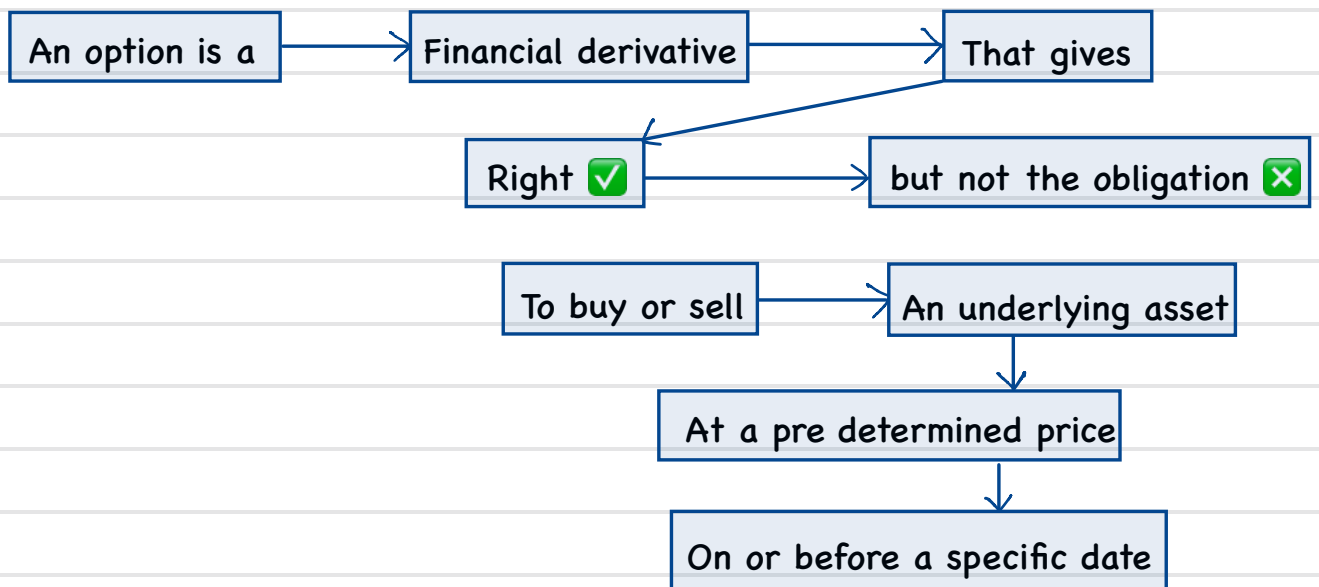


$$\text{Futures position value} = \text{portfolio value} \times \text{Beta}$$

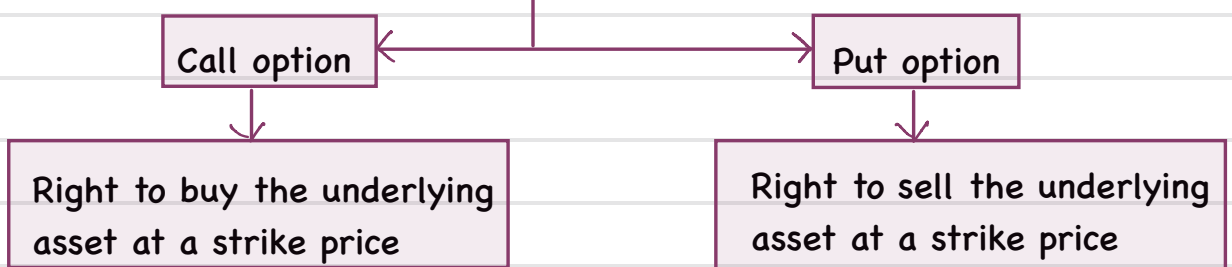
Outcome : any gain / loss in stock is exactly offset loss / gain in futures

Introduction to options

Meaning of options



✍️ Types of Options



Exercised	FSP > X	FSP < X
Break even point	FSP = X+P	FSP = X-P
Holder	<u>Unlimited Profit</u> Limited loss	<u>Profit = X-P</u> Limited loss
Writer	<u>Limited profit</u> unlimited loss	<u>Profit = premium</u> Loss = X-P

## Example

Call option on HDFC Bank  
Strike price ₹1700 , Expiry 3months

If after 3 months

HDFC Bank = ₹1850

Holder exercises call

Buys at ₹1700

Profit = ₹150/share

If HDFC Bank < ₹1700

Option not exercised

Value = 0

Put option on ICICI Bank  
Strike price ₹900, Expiry 3 months

If after 3 months

ICICI Bank = ₹800

Holder exercises put

Sells at ₹900

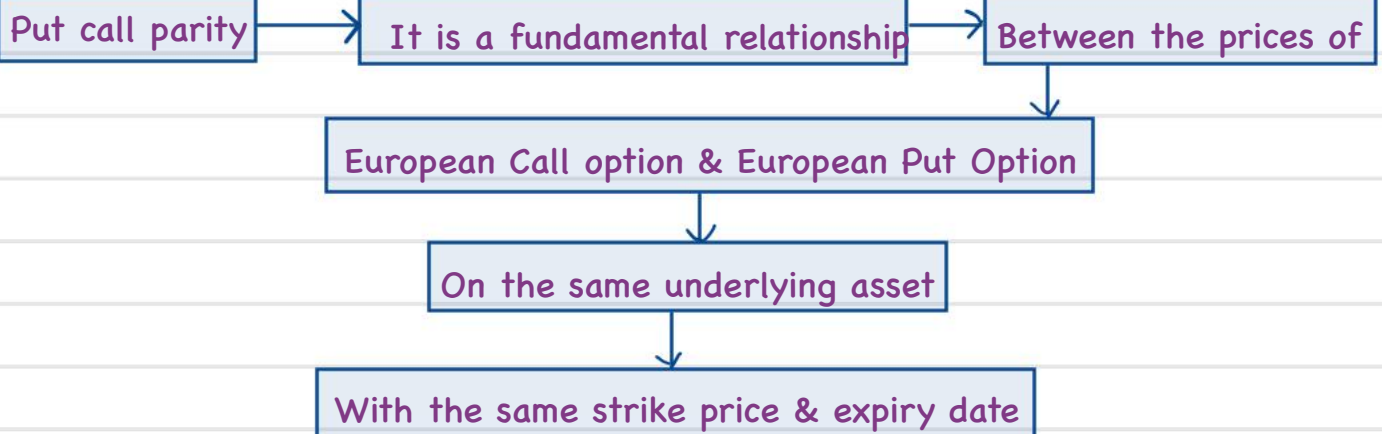
Profit = ₹100/ shares

If ICICI Bank > ₹900

Option not exercised

Value = 0

## Put call parity



## Purpose

It ensures

No arbitrage opportunity

Exists in the market

I.e,

You cannot make a risk free profit by exploiting mispricing between call and put options

## Equation



$$C + PV(K) = P + S$$

## Where

C = call option price / minimum Value of call

P = put option price / minimum value of put

K = spot price of the underlying asset

S = strike price

P = present value of strike price

## Minimum Value of Call (C)



$$\text{Spot price} - X \cdot e^{-trf}$$

## Minimum Value of put (P)



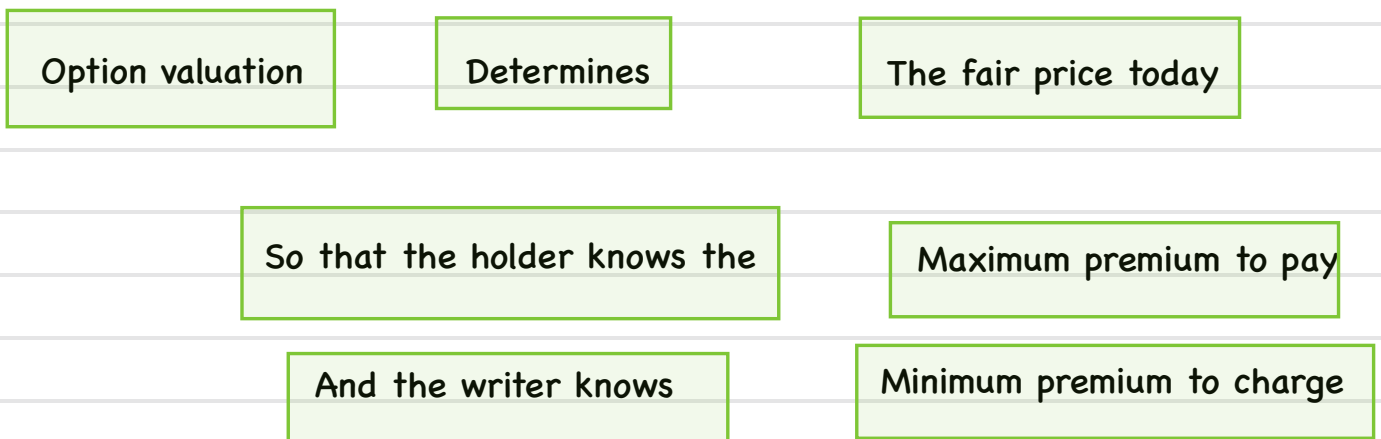
$$X \cdot e^{-trf} - \text{spot price}$$

Interpretation in Simple words

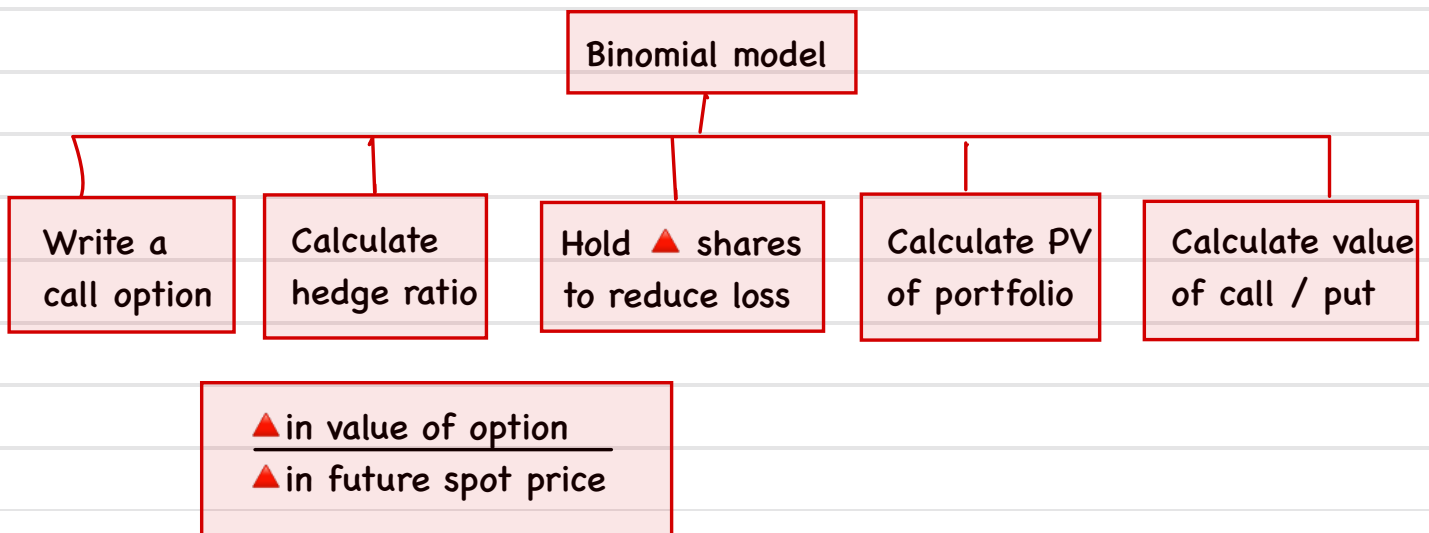
Cost of buying a call option and investing PV of strike price  
=  
Cost of buying a put option and buying the underlying asset

Key idea : If this relationship doesn't hold, there does exist a risk free profit by arbitrage

Option Valuation



Binomial Model



## 1. Construct a risk free portfolio

You write a call option and hold a certain number of shares ( $\Delta$ ) of underlying

$\Delta$  is chosen such that the combined portfolio's value does not depend on the future price of underlying

## 2. Future value is Certain

Because the portfolio is hedged with  $\Delta$  shares

No matter how the underlying move, the portfolio has a known value at maturity

This removes the uncertainty

The portfolio is effectively risk free

## 3. Discount to present

Since a portfolio is risk free

Its future value can be discounted at the risk free rate to get its present value

## 4. Derive the option value

The portfolio today consist the call option and  $\Delta$  shares

If you subtract the value of  $\Delta$  shares today, the remaining portion is the fair value of the call option

## Risk - Neutralization method

To know the exact value of call & put

Probability of FSP





$$(P \times UFSP) + (1-P) \times DFSP = \text{spot price} \times e^{trf}$$

Assume investors are risk neutral

Expect the risk free return

Future spot price can go up or down

Assign probabilities (up)  and (down) 

Calculate call values for up and down scenarios

Discount expected call value at risk free rate

It gives fair price of option today

## Two period Binomial Model

1. Step 1 - Construct Price tree

The underlying asset can move up  or down  in each period

Build a two step binomial tree of possible future prices

**2. Step 2 - Calculate Risk - Neutral Probability**

Use the risk free rate to determine

Neutral probability of an upward move  $\uparrow$  (P)**3. Step 3 - compute option value at maturity**

At the final nodes (end of two periods)

Calculate the option pay off for each scenario

**4. Step 4 - work backwards to present value**Use risk neutral probabilities  
to calculate the expected value at the previous node

Repeat until you reach today's date

Gives the present value of the option

### Black scholes Model

In the black scholes

We assume continuous price movement

The stock can move anywhere, not just two discrete possibilities

Volatility is used to model the expected range of price movement

Works only for European options (exercise at maturity)

Assumes no dividends are paid during the options life

### Formula



$$\text{Step 1 : } d_1 = \ln\left(\frac{S}{X}\right) + \left(r + \frac{\sigma^2}{2}\right) \frac{t}{\sigma \times \sqrt{t}}$$

$$\text{Step 2 : } d_2 = d_1 - (\sigma \times \sqrt{t})$$

$$\text{Step 3 : } n(d_1)$$

$$\text{Step 4 : } n(d_2)$$

$$\text{Step 5 : } V_e = \text{Spot price} (n d_1) - \text{Strike price} \times e^{-trf} (n d_2)$$

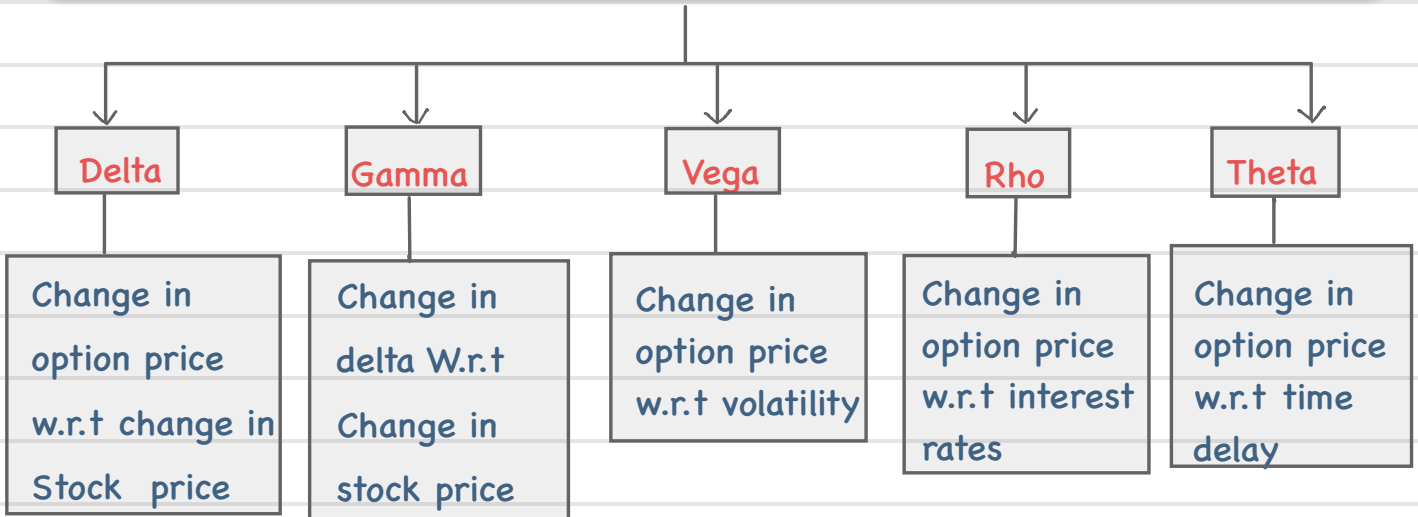
$$\text{Step 6 : } V_p = \text{Strike price} \times e^{-trf} n(-d_2) - \text{Spot price} \times n(-d_1)$$

$$n(-d_1) = 1 - nd_1$$

$$n(-d_2) = 1 - nd_2$$

- $S_p$  = Spot price
- $X$  = Strike Price
- $\ln$  = natural Log
- $r$  = rate of interest
- $\sigma$  = standard deviation
- $t$  = time

Greek Words



		Strike price	Expiry date
Strangle	Buying a call & put	Different	Same
Straddle	Buying & selling a call & put option	Same Same	Same
Horizontal option spread	Buying & selling call or put option	Same	Different