

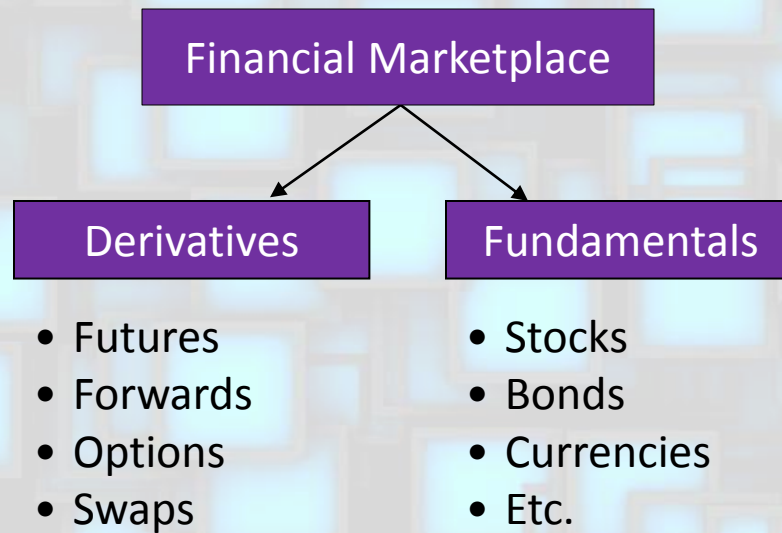
Derivatives

SFM - CA Final

Prashant Ghule
prashantghule@live.in

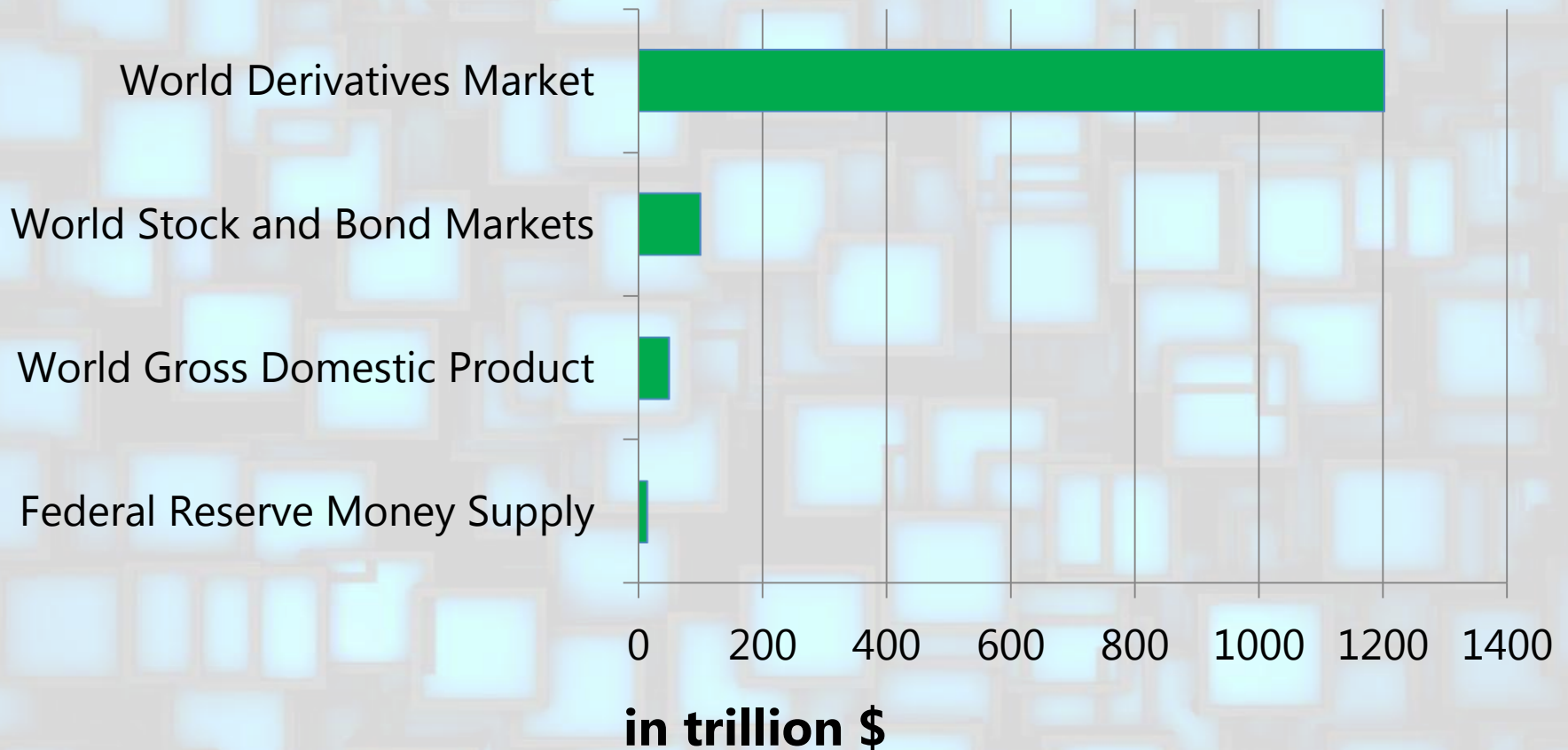
Introduction

In the financial marketplace some instruments are regarded as **fundamentals** while others are regarded as **derivatives**.

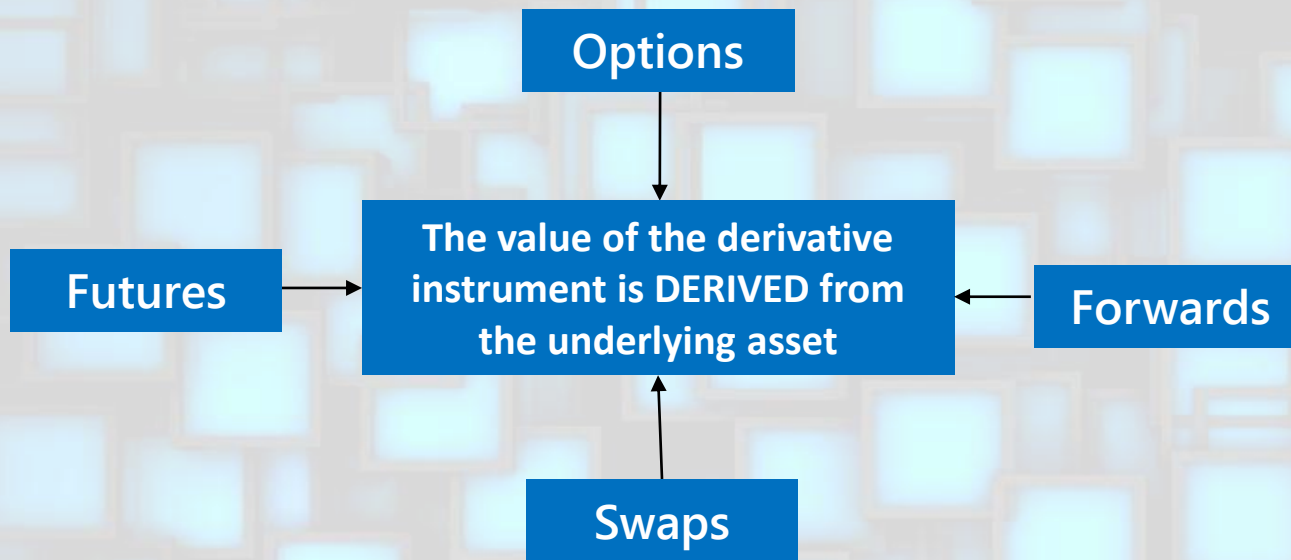


Size of the World Derivatives Market

\$ 1.2 Quadrillion



What is a Derivative?



Derivatives are securities that do not convey ownership, but rather a promise to convey ownership.

Underlying asset may be	Example
Stock	Microsoft Corp. \$MSFT
Bond	Govt Bond, Corporate Bond
Currencies	€, £, ¥ etc.
Commodity	Gold, Silver
Stock Indices	S&P BSE SENSEX, DOW JONES
Interest Rate	LIBOR, MIBOR, US Treasury Yield
And many others (OTC)	Elections Results, Weather etc.

Need for Derivatives

- While managing various assets in doing business, facing risk is common.
- The challenge is to identify and manage them at minimum cost.
- Derivatives play a major role in risk management.

Major Players in Derivatives Market

- **Hedgers**

- Holds a position in cash market and is worried about fall in the value of his portfolio. He takes an opposite position in derivatives market to protect against fall in value of portfolio.

- **Speculators**

- Make an estimation based on research about the movement of stock prices. They accept the risk passed on by the hedgers, in anticipation of making profit. Speculators provide depth and liquidity to the derivatives market and in their absence the price protection sought by the hedgers would be very costly.

- **Arbitrageurs**

- They try to identify deviations in future prices from their fair (theoretical) values in order to obtain a risk free rate of return. Though, deviations persists, arbitrage is not free, nor it is risk less. Arbitrage involves transaction costs, brokerage costs, bid-ask spreads and most importantly, impact cost.

Over the Counter Markets

- The over-the-counter market is an important alternative to exchanges and measured in terms of the total volume of trading, has become much larger than the exchange-traded market.
- It is a telephone- and computer-linked network of dealers. Trades are done over the phone and are usually between two financial institutions or between a financial institution and one of its clients.
- Trades in the over- the-counter market are typically much larger than trades in the exchange-traded market. A key advantage of the over-the-counter market is that **the terms of a contract do not have to be those specified by an exchange.**
- Market participants are free to negotiate any mutually attractive deal. A disadvantage is that **there is usually some credit risk in an over-the-counter trade.**

Forwards

- It is the simplest form of derivative instrument.
- Forward Contract in general is a *“direct agreement between a buyer and a seller, obligating the seller to deliver, a specified asset, of specified quality and quantity, to the buyer on a specified date at a specified place.”*
- One of the parties to a forward contract assumes a long position and agrees to buy the underlying asset on a certain specified future date for a certain specified price.
- The other party assumes a short position and agrees to sell the asset on the same date for the same price.
- The deal may be done for an odd quantity and not necessarily a standard quantity.
- If the counter party defaults, there is no recourse available.



Futures

- Futures Contracts overcomes majority of the weaknesses of the Forward Contracts, such as
 - i. Exchange regulation
 - ii. Transact in standard quantities
 - iii. Counter party guarantee by Clearing Corporation
 - iv. Sufficient Liquidity
- Futures Contracts of equities in India are cash settled like so many global markets. This means if the buyer of futures makes gains, at the end of expiry, he would be credited the cash gains and vice versa.
- Cash Settlement is done as the current infrastructure is found inadequate for physical settlement process.



Forwards vs. Futures

Forwards	Futures
Over the Counter in nature	Trade on an organized exchange
Customized Contract Terms	Standardized Contract Terms
Less Liquid	More Liquid
No Margin Payments	Requires Margin Payments
Settlement happens at the end of period	Follows daily Settlement (MTM)
Physical Settlement	Mostly Cash Settlement
Counter party risk to be borne by the client	Counter party risk shouldered by the exchange clearing corporation.

Options

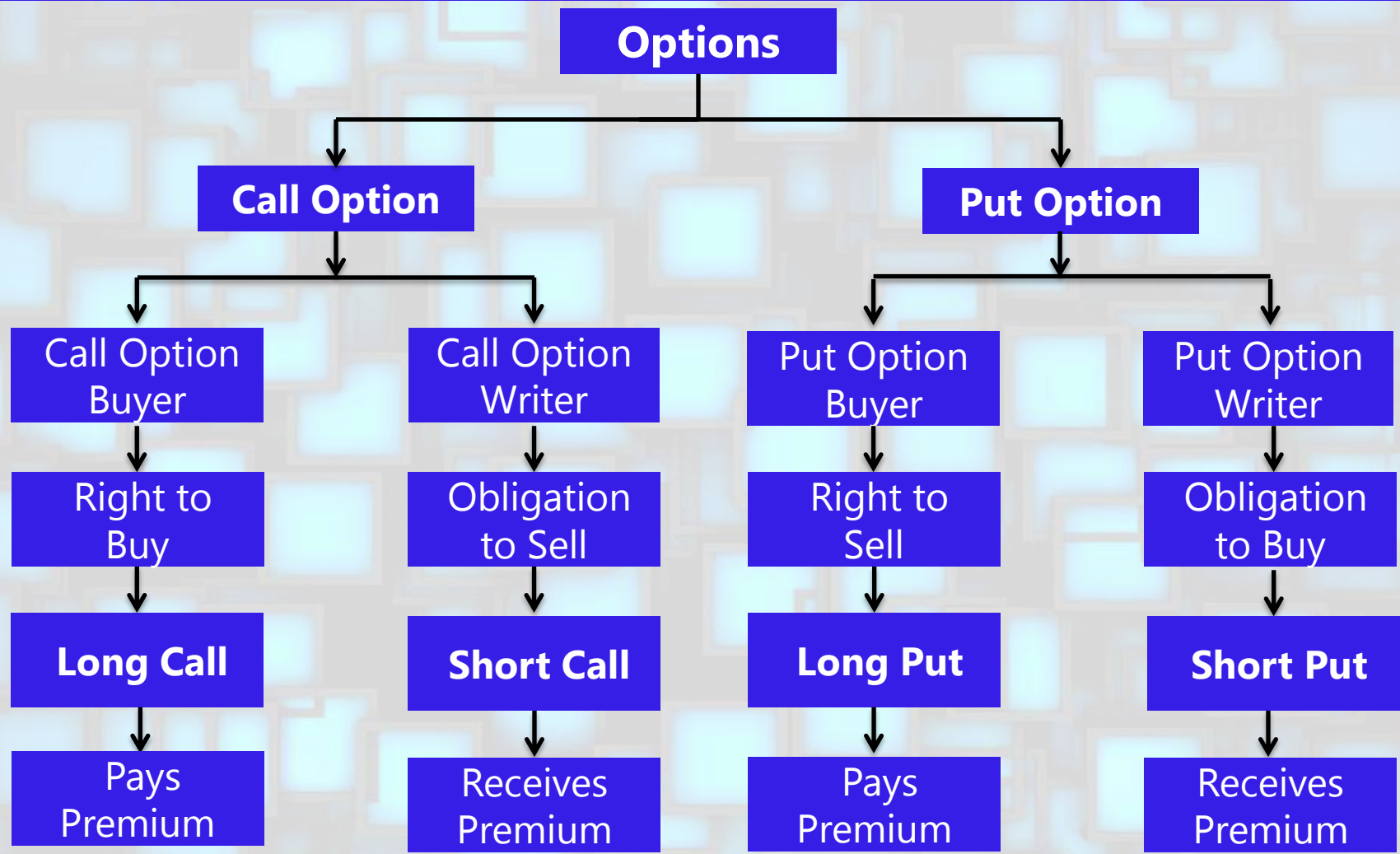
- Options are the instruments which an investor can purchase and take it only if it benefits him and throw it when it does not, although at a very small cost.
- An option is a contract that gives the buyer the right, but not the obligation, to buy or sell a specified quantity of an asset at a pre-determined price, on or before a specified date.*



Basic Option Terminologies

- **Spot Price (ST)**
 - Spot Price of an underlying asset is the *price that is quoted for immediate delivery* of the asset. For example, at the NSE, the spot price of RIL at any given time is the price at which RIL shares are being traded at that time in the Cash Market Segment of the NSE.
- **Strike Price / Exercise Price (X)**
 - The price at which the buyer of an option can buy the stock (in case of a call option) or sell the stock (in case of a put option) on or before the expiry date of the options contract is called strike price. It is the price at which the stock will be bought or sold if the option is exercised.
- **Expiration Date (T)**
 - In case of Forwards, Futures & Options, Expiration Date is the date on which settlement takes place. It is also called as the final settlement date.

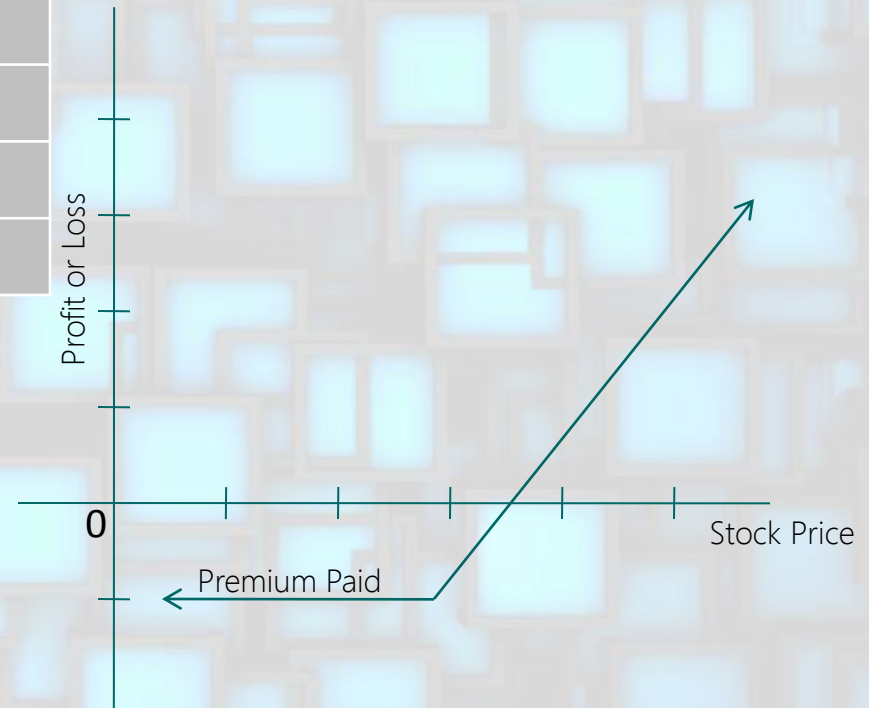
Types of Options and its Participants



Option Positions – Long Call

- Long Call is a **buy** position taken by a trader who is bullish on the market/stock, meaning he expects the price to go up.
- He buys the right to buy at strike price at the expiration. He would therefore make money only when the price increases on the day of exercise.
- If the price is below the strike price, he will prefer to buy directly from the market and hence not exercise the option, thereby losing his premium.

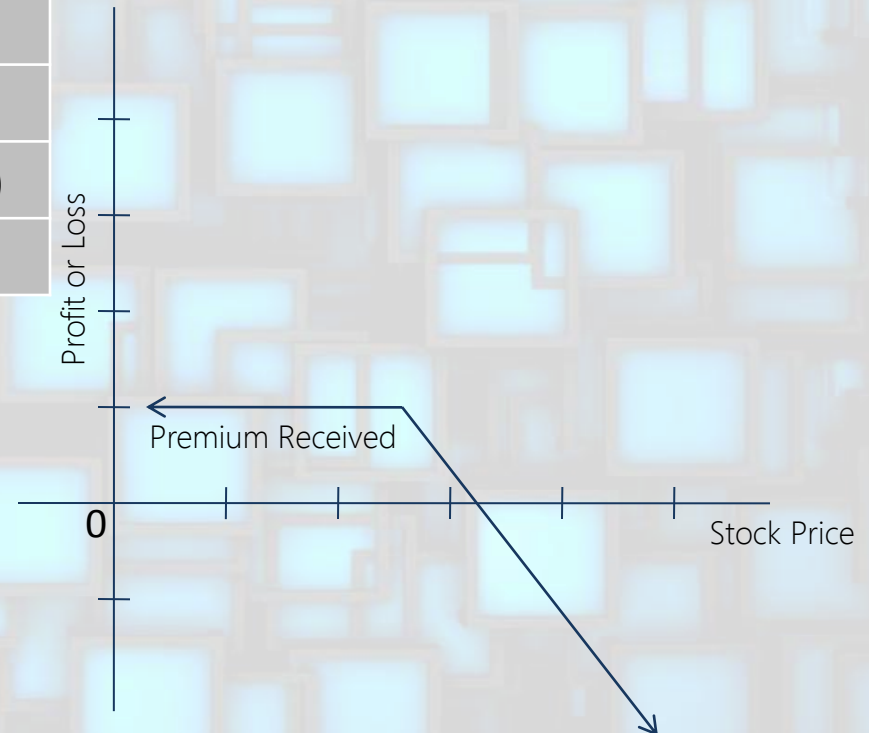
Market View	Bullish
Action	Buy Call
Profit Potential	Unlimited
Loss Potential	Limited (Premium Paid)



Option Positions – Short Call

- Short Call is a **sell** position taken by a trader (also called seller/writer) who is bearish on the market/stock, meaning he expects the price to go down.
- He would therefore make money (to the extent of premium collected) only when the price decreases on expiration. Else he makes unlimited losses.
- He is under an obligation to the buyer and has to deliver stock or equivalent value if the option is exercised by the buyer.

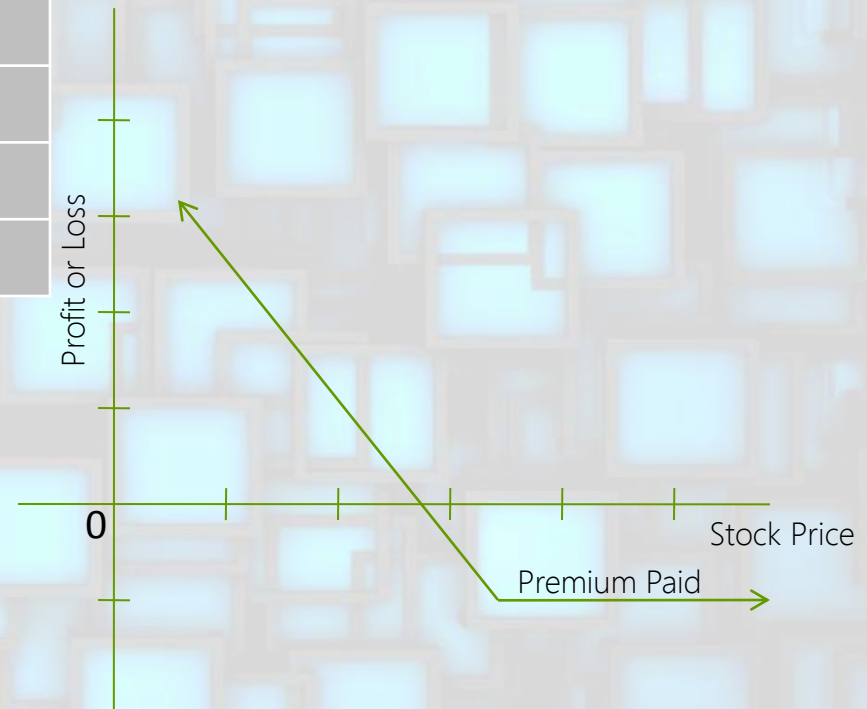
Market View	Bearish
Action	Sell Call
Profit Potential	Limited (Premium Received)
Loss Potential	Unlimited



Option Positions – Long Put

- Long Put is a **sell** position taken by a trader who is bearish on the market/stock, meaning he expects the price to go down.
- He buys the right to sell at strike price at the expiration. He would therefore make money only when the price decreases below strike price on the day of expiration.
- If the price is above the strike price, he will prefer to sell directly in the market and hence not exercise the option, thereby losing his premium.

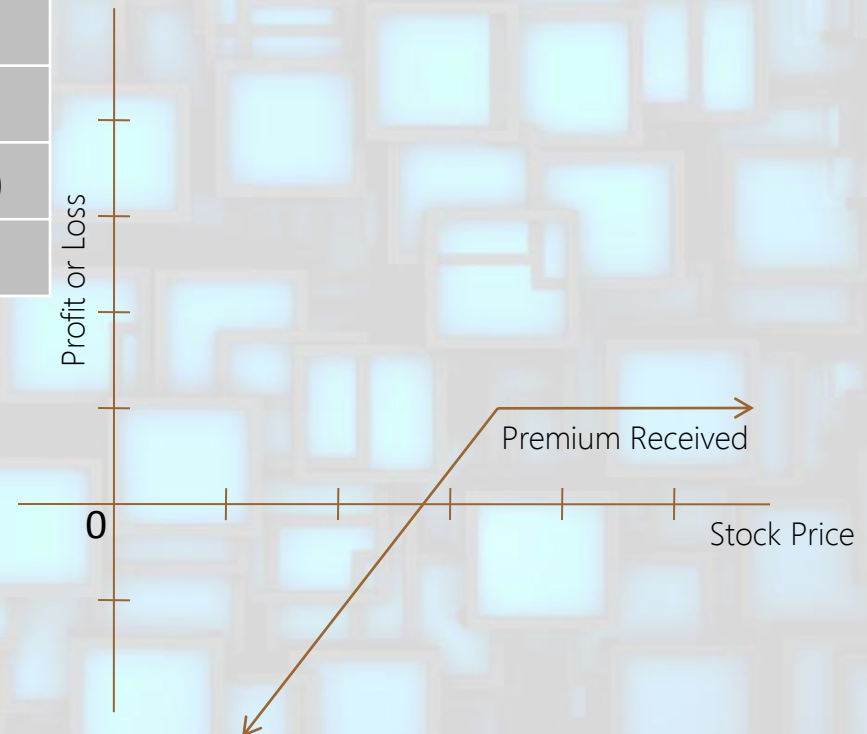
Market View	Bearish
Action	Buy Put
Profit Potential	Large
Loss Potential	Limited (Premium Paid)



Option Positions – Short Put

- Short Put is a **buy** position taken by a trader (also called seller/writer) who is mildly bullish on the market/stock, meaning he expects the price to go up.
- He would therefore make money (to the extent of premium collected) only when the price increases on expiration. Else he makes large losses.
- He is under an obligation to the buyer and has to accept delivery stock and pay Strike Price if the option is exercised by the buyer.

Market View	Bullish
Action	Sell Put
Profit Potential	Limited (Premium Received)
Loss Potential	Large



Option and Futures - Scenarios

Types of Positions Held

Price Movement	Call Buyer	Long Futures Position	Call Seller / Writer	Put Buyer	Short Futures Position	Put Seller
Price Rises	Unlimited Gain	Unlimited Gain	Unlimited Loss	Limited Loss	Unlimited Loss	Limited Gain
Price Falls	Limited Loss	Unlimited Loss	Limited Gain	Unlimited Gain	Unlimited Gain	Unlimited Loss
Price Unchanged	Limited Loss	No Gain or Loss	Limited Gain	Limited Loss	No Gain or Loss	Limited Gain

Moneyness of the Options

- There are three different terms for describing where an option is trading in relation to the price of underlying asset.
- These terms are '**in-the-money**', '**out-of-the-money**' and '**at-the-money**'
- An option is 'In the money' if by exercising the option, the buyer makes gains & an option is 'Out of the money' if exercising of options would result in losses.
- An option is 'At the money' if by exercising neither gain nor loss is witnessed.

Market Scenario	Call Option	Put Option
$S > X$	In the money	Out of the money
$S < X$	Out of the money	In the money
$S = X$	At the money	At the money

Option Rollover

- To rollover an options contract is one of the four things an options trader can do when their options contract is at or near expiration. The other three actions being to Exercise the option, close it off or simply let it expire out of the money.
- To rollover an options contract is simply to push the expiration date of your existing positions to a later date. This is useful when your short term options trade turns out to be profitable for longer than you expect it to and you would like to be invested longer.
- For example: Assuming that you bought 1 contract of INFY's October Rs. 3750 Call Option when INFY was trading at Rs. 3750. Upon expiration, INFY is trading at Rs. 3800 and you expect INFY will continue to do well, taking those Rs. 3750 strike price call options further in the money for more profits. In order to stay invested, you roll forward your INFY October Rs.3750 Call Option to November by closing off your October Rs. 3750 Call Option and the 'BUY TO OPEN' 1 contract of INFY November Rs. 3750 Call Options.
- Orders to use when rolling forward an options contract:

Transaction	Long Position	Short Position
Close Existing Position	SELL TO CLOSE	BUY TO CLOSE
Open New Position	BUY TO OPEN	SELL TO OPEN

Contango

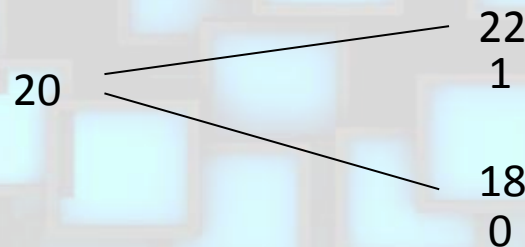
- Contango refers to a situation where the futures price of a commodity is above the expected future spot price.
- This may be due to people's desire to pay a premium to have the commodity in the future rather than paying the costs of storage and carry costs of buying the commodity today.
- When a market is "in Contango" when the delivery price of a particular futures contract has to converge downward to meet the futures price. If prices did not converge, it would set up an opportunity for investors to profit from arbitrage.
- For example, assume an investor goes long a futures contract today at \$100. The contract is due in one year. If the expected future spot price is \$70, the market is in Contango, and the futures price will have to fall (unless the future spot price changes) to converge with the expected future spot price.

Put Call Parity Theorem

- Call & Put prices are highly inter-dependent and are not arbitrarily chosen.
- **Put Call Parity** is a strong mathematical relationship that describes the connection between calls and puts. Critical for understanding the mechanics of the options market and how options are priced.
- "Parity" – means equivalence.
- Parity Relationships simply shows the connections between two or more variables.
- Formula: $S + P - C = P_v(E)$
- S – Stock Price, P – Put Price, C – Call Price, $P_v(E)$ – Present Value of the Exercise Price.
- Left-hand side of equation: represents an investor who owns stocks plus a protective put.
- Right-Hand side of equation: represents an investor who owns a call option plus a deposit of cash, $P_v(E)$.
- This formula says that values of long stock + long put + short call are equal to the present value of the exercise.
- Formula tells us that an investor who buys stock and a put is financially doing the same thing as someone who buys a call and deposits sufficient cash to grow the value to the exercise price at expiration by earning the risk-free rate.
- When you buy a call, you are borrowing money to buy stock and also buying a put option.

Binomial Option Pricing Model

- Binomial option pricing enables us to determine the price of an option, given the characteristics of the stock or other underlying asset.
- The binomial option pricing model assumes that the price of the underlying asset follows a binomial distribution—that is, the asset price in each period can move only up or down by a specified amount.
- Begin with a simple situation:
 - › Assume that a stock is currently trading at \$20 and it is known that at the end of three months the stock price will either be 22 or 18. Further assume no dividends during the life of the option.
 - › Further assume that we want to know the value (or price) of a call option with strike of \$21.
 - › Recall that the terminal value of a call option is $\max(0, S_T - X)$.
 - › Thus, at the end of the three months, the option will take on one of two values. If the stock is worth \$22, the option will be worth \$1, otherwise it will be worth 0. What is this option worth today?



Binomial Option Pricing Model

- We can price this option rather easily if we make one very crucial assumption: that there is no arbitrage in the market.
- To do this, we create a portfolio consisting of positions in the stock and the option that has absolutely no uncertainty. That is, it has the same value at the end of the three months regardless of what happens to the stock price. This lets us discount the cash flows at the risk-free rate (since there is no risk!).
- Since there are two securities and two possible outcomes, there will always be a solution.
- To see this consider portfolio which consists of:
 - Δ shares of the stock.
 - 1 short position in the option.
- Now consider the value of the portfolio in both states of the world:
 - When $ST = 22$: portfolio = $22 \Delta - 1$
 - When $ST = 18$ portfolio = 18Δ .
 - Therefore $22 \Delta - 1 = 18 \Delta$ or $4 \Delta = 1$
 - so $\Delta = .25$.
- Thus the portfolio should consist of the following:
 - Long .25 shares of the stock
 - Short 1 call option
- If the stock price moves up the portfolio is worth:
 $.25 * 22 - 1 = 4.5$
- If the stock price moves down the portfolio is worth
 $18 * .25 - 0 = 4.5$

Binomial Option Pricing Model

- So regardless of the final value of the stock, the portfolio is worth 4.5. Of course that is its value in three months. Since there is no risk in this portfolio, it must be discounted at the risk-free rate. Suppose that the risk free rate is 12%, then the value of the portfolio today is:
 - $4.5e^{-.12 \cdot .25} = 4.367$.
- We know that the stock price today is \$20. Denote the option price as f . The value of the portfolio must be, therefore:
 - $20 \cdot .25 - f = 5 - f$,
- and since we know the portfolio's value today is 4.367, it follows that
 - $5 - f = 4.367$,so,
 $f = 0.633$.

Black Scholes Option Pricing Model

- Fischer Black and Myron Scholes published a formula in their 1973 paper 'The Pricing of Options and Corporate Liabilities' that today is known as the **Black Scholes Model (BSM)**.
- It has become a standard method of pricing options. The Black-Scholes Option pricing model is considered as one of the most important developments in finance in the last 50 years.
- This model takes into account the stock price, strike price, expiration date, risk-free return and the standard deviation (volatility) of the stock's return.
- *Certain Assumptions:*
- Assumptions about stock return distribution
 - Continuously compounded returns on the stock are normally distributed and independent over time (no "jumps").
 - The volatility of continuously compounded returns is known and constant.
 - Future dividends are known, either as absolute amount or as a fixed dividend yield.
- Assumptions about the economic environment
 - The risk-free rate is known and constant.
 - There are no transaction costs or taxes.
 - It is possible to short-sell costlessly and to borrow at the risk-free rate.

Black Scholes Option Pricing Model

- The Model

$$C = SN(d_1) - Ke^{-RT} N(d_2)$$

where

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(R + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \text{ and } d_2 = d_1 - \sigma\sqrt{T}$$

Variable definitions:

S	=	current stock price
K	=	option strike price
e	=	base of natural logarithms
R	=	riskless interest rate
T	=	time until option expiration
σ	=	Annual Volatility (standard deviation of short term returns over 1 year)
ln	=	natural logarithm
N()	=	Area under the normal curve (probability)

BSM – Key Factors

- **Striking Price**
 - The lower the striking price for a given stock, the more the option should be worth.
 - Because a call option lets you buy at a predetermined striking price.
- **Time Until Expiration**
 - The longer the time until expiration, the more the option is worth.
 - The option premium increases for more distant expirations for puts and calls.
- **Stock Price**
 - The higher the stock price, the more a given call option is worth.
 - A call option holder benefits from a rise in the stock price.
- **Volatility**
 - The greater the price volatility, the more the option is worth.
 - The volatility estimate sigma cannot be directly observed and must be estimated.
 - Volatility plays a major role in determining time value.
- **Risk-Free Interest Rate**
 - The higher the risk-free interest rate, the higher the option premium, everything else being equal.
 - A higher “discount rate” means that the call premium must rise for the put/call parity equation to hold.

BSM – Shortcomings

- Black Scholes assumes that the risk free rate and the stock's volatility are constant. This is obviously wrong as risk free rate and volatility fluctuates according to market conditions.
- The Model assumes that stock prices are continuous and that large changes (such as those seen after a merger announcement) don't occur.
- Analysts can only estimate a stock's volatility (implied) instead of directly observing it (historical), as they can for the other inputs.
- The Black Scholes Model tends to overvalue deep out-of-the-money calls and undervalue deep in-the-money calls.
- However, despite these known limitations, the classic Black-Scholes model is still the most popular with options traders today due to its simplicity.

Volatility

- In finance, volatility is a measure for variation of price of a financial instrument over time. Historic volatility is derived from time series of past market prices. An implied volatility is derived from the market price of a market traded derivative (in particular an option). The symbol σ is used for volatility, and corresponds to standard deviation, which should not be confused with the similarly named variance, which is instead the square, σ^2 .
- **Actual Historical Volatility** refers to the volatility of a financial instrument over a specified period but with the last observation on a date in the past.
- **Actual Future Volatility** refers to the volatility of a financial instrument over a specified period starting at the current time and ending at a future date normally the expiry date of an option).
- **Historical Implied Volatility** refers to the implied volatility observed from historical prices of the financial instrument (normally options).
- **Current Implied Volatility** refers to the implied volatility observed from current prices of the financial instrument.
- **Future Implied Volatility** refers to the implied volatility observed from future prices of the financial instrument.

Option Greeks

- Trying to predict what will happen to the price of a single option or a position involving multiple options as the market changes can be a difficult proposition.
- Option traders often refer to the delta, gamma, vega, theta and rho of their option positions.
- Collectively, these terms are known as the “Greeks” and they provide a way to measure the sensitivity of an option’s price to quantifiable factors.
- These terms may seem confusing and intimidating to new option traders, but broken down, the Greeks refer to simple concepts that can help the risk and potential reward of an option position.
- The numbers given for each of the Greeks are strictly theoretical, that means the values are projected based on mathematical models.

Option Greeks

- Delta

- Delta is a number that measures how much the theoretical value of an option will change if the underlying stock moves up or down by Rs.1. It is the rate of change of the option price with respect to the price of the underlying stock.
- $\text{Delta} = \frac{\text{Change in Option Values}}{\text{Change in underlying}}$

- Gamma

- The gamma of an option is defined as the rate of change of the option's delta with respect to the price of the underlying, when all else remains the same.
- $\text{Gamma} = \frac{\text{Change in Delta Values}}{\text{Change in underlying}}$

- Vega

- Vega is the change in the value of an option for a 1-percentage point increase in implied volatility. Higher volatility means higher option prices.
- $\text{Vega} = \frac{\text{Change in Option Values}}{\text{Increase of 1\% in Implied Volatility}}$

Option Greeks

- Theta

- Theta is defined as the change in the price of an option for a 1-day decrease in the time remaining to expiration. Time value represents the subjective value of the option – the hope that it offers its owner.

- $$\text{Theta} = \frac{\text{Change in Option Values}}{\text{Decrease of 1 day to time to expiration}}$$

- Rho

- Rho is a measure of how much the option premium would change, with a one percent change in the risk-free interest rate. A Rho of 0.1 means that for every 1 percent increase in interest rates, there is a corresponding 0.1 increase in the option value/price.

- $$\text{Rho} = \frac{\text{Change in Option Values}}{\text{Change of 1\% in risk-free interest rate}}$$

- Summary

Delta	Gamma	Vega	Theta	Rho
Measures impact of a change in price of underlying.	Measures the rate of change of delta.	Measures the impact of a change in volatility.	Measures the impact of a change in time remaining.	Measures the sensitivity of a interest rate.

Interest Rate Swaps

- **Definition:**
 - A swap is an exchange of cash flows, CFs.
 - It is a legal arrangement between two parties to exchange specific payments.
- **Plain Vanilla or Generic Interest Rate Swap** involves the exchange of fixed-rate payments for floating-rate payments.
 1. Parties to a swap are called **counterparties**. There are two parties:
 - Fixed-Rate Payer.
 - Floating-Rate Payer.
 2. Rates:
 - Fixed rate is usually a T-note rate plus basis points.
 - Floating rate is a benchmark rate: LIBOR.
 3. Reset Frequency: Semiannual
 4. Principal: No exchange of principal.
 5. Notional Principal (NP): Interest is applied to a notional principal; the NP is used for calculating the swap payments.
 6. Maturity ranges between 3 and 10 years.
 7. Dates: Payments are made in arrears on a semiannual basis:
 - Effective Date is the date when interest begins to accrue.
 - Payment Date is the date when interest payments are made.
 8. Net Settlement Basis: The counterparty owing the greater amount pays the difference between what is owed and what is received—only the interest differential is paid.

Floors, Caps and Collars

- **Interest Rate Floors**

- A floor provides a guarantee to the *owner* of a floating note that the coupon payment each period will be no *less* than a certain floor rate or strike rate. Floors are generally embedded in a floating rate note, but could also be purchased separately from a dealer.
- Each payment date, the floor pays the difference, if positive, between a the floor rate and the floating rate multiplied by the notional amount of principle or par value, divided by the annual payment frequency.

- **Interest Rate Caps**

- A cap provides a guarantee to the issuer of a floating or variable rate note or adjustable rate mortgage that the coupon payment each period will be no higher than a certain amount.
- In other words, the coupon rate will be capped at a certain ceiling or cap rate or strike rate. Caps are either offered over-the-counter by dealers or embedded in a security.
- Each payment date, the cap pays the difference, if positive, between a floating index rate and the cap rate multiplied by a prespecified notional amount of principle or par value, divided by the annual payment frequency.

- **Interest Rate Collars**

- A collar is a long position in a cap and a short position in a floor.
- The issuer of a floating rate note might use this to cap the upside of his debt service, and pay for the cap with a floor. Collars are generally embedded in a floating rate note, but could also be purchased separately from a dealer.

Thank You

Prashant Ghule
prashantghule@live.in