UNIT-V
OPTIONS

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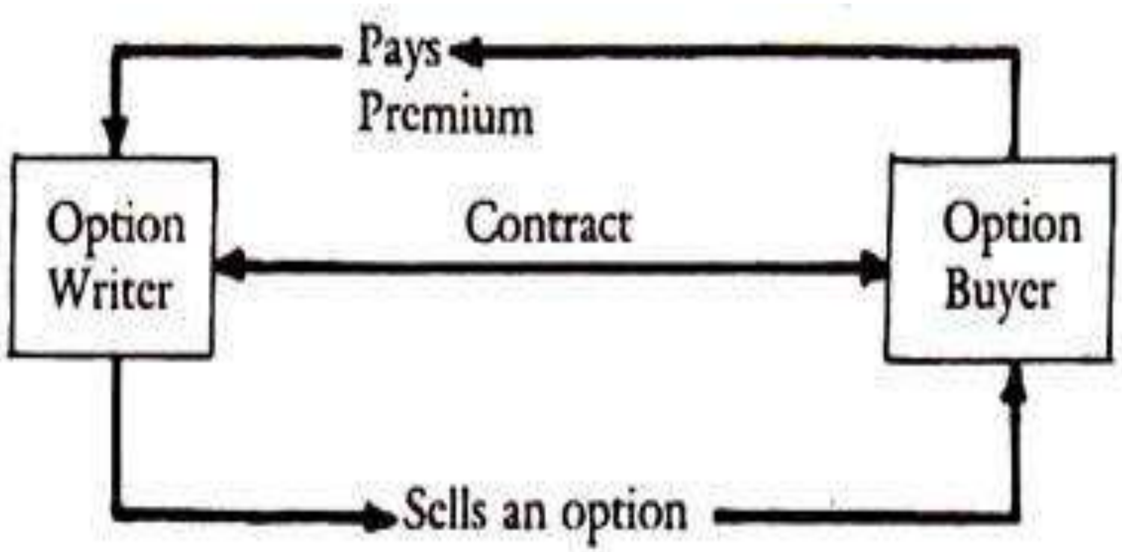
Definition

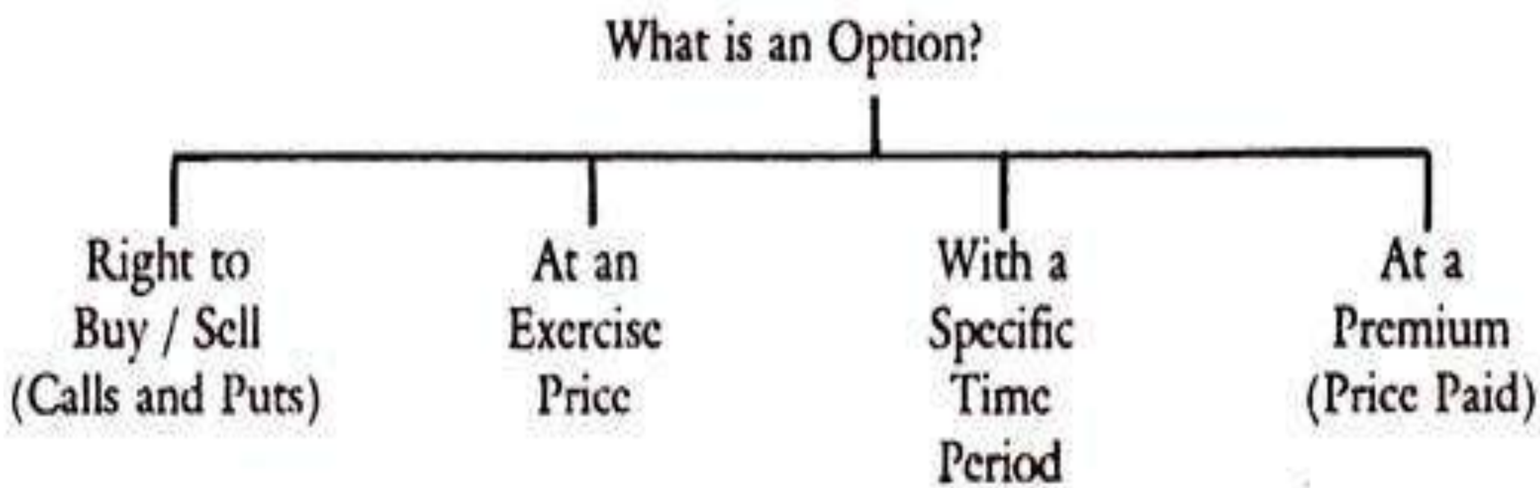
- An **option** is a financial derivative contract that gives an investor(Option buyer) the ***right***, but ***not the obligation***, to either buy or sell an asset at a pre-determined price (known as the ***strike price***) by a specified date (known as the ***expiration date***).


Risk
Option Buyer
Option Seller
Premium

- Options are derivative instruments, meaning that their prices are derived from the price of their ***underlying security***, which could be almost anything: stocks, bonds, currencies, indexes, commodities, etc.
- Many options are created in a standardized form and traded on an options exchange like the Chicago Board Options Exchange (CBOE).

- Every option represents a contract between the ***options writer(seller;holds a short position)*** and the ***options buyer(Investor; holds a long position)***.
- The options writer is the party that "**writes**," or **creates**, the options contract, and then sells it.
- If the investor who buys the contract chooses to exercise the option, the ***writer is obligated*** to fulfill the transaction by buying or selling the underlying asset, depending on the type of option he wrote.
- If the buyer chooses to not exercise the option, the writer does nothing and gets to ***keep the premium*** (the price the option was originally sold for).


Pays
Premium
Option
Writer
Contract
Option
Buyer
Sells an option


What is an Option?
Right to
Buy / Sell
(Calls and Puts)
At an
Exercise
Price
With a
Specific
Time
Period
At a
Premium
(Price Paid)

- The options buyer has a lot of power in this relationship.
- He chooses whether or not they will complete the transaction.
- When the option expires, if the buyer doesn't want to exercise the option, he doesn't have to.
- The buyer has purchased the option to carry out a certain transaction in the future -- hence the name.

What is an Option?

- Options is a contract between two parties in which the buyer of the option (here we call the *option buyer*) has the right but not obliged, to buy or sell a certain asset at a certain price before/on a certain date from the seller of the option (here we call the *option seller*).
- The *option buyer* who buys the option has the right but not obliged to exercise the option unless he wishes to.
- As for the *option seller*, he is obliged to perform according to the terms of the contract once the *option buyer* exercises the option.

What Are Options?

Options are:

- *Contracts*
- Giving the buyer the right to buy or sell
- An underlying asset
  (e.g., 100 shares of specified common stock)
- At a fixed price (i.e., the strike price)
- On or before a given date
  (i.e., the expiration date)

Options
Terminology

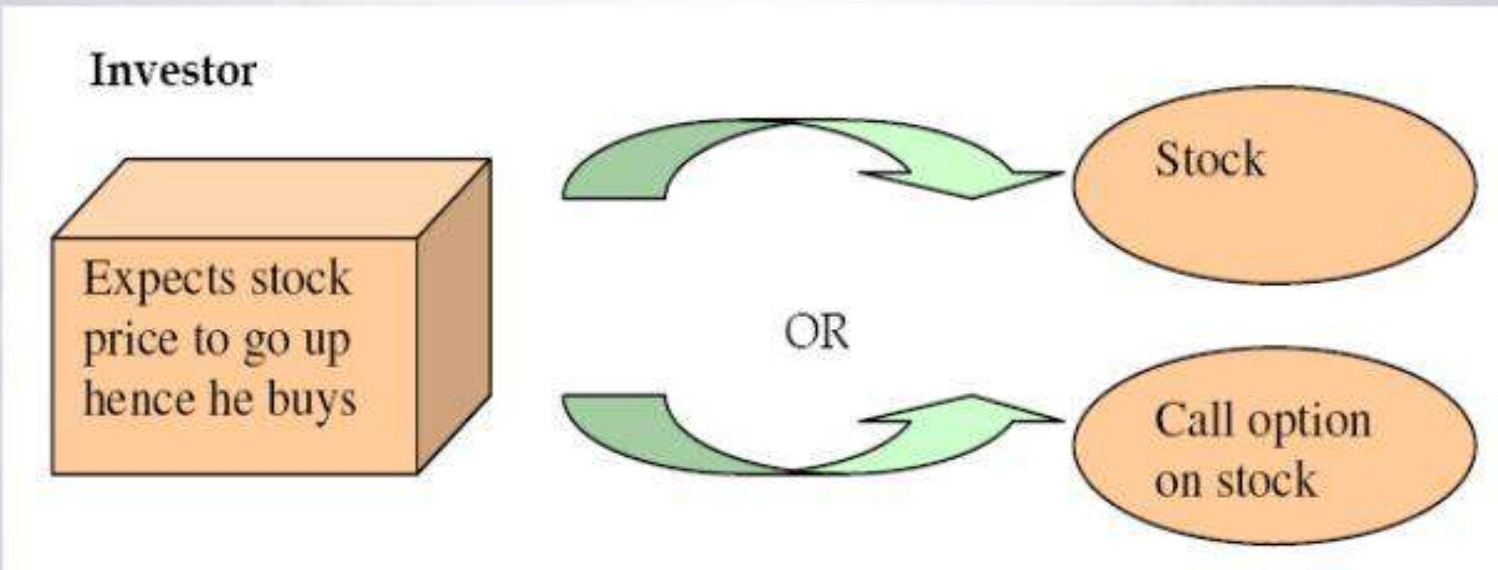
- **Option Holder (Buyer)** – An individual (or firm) who pays the premium to acquire the right.
- **Option Writer (Seller)** – An individual (or firm) who sells the right in exchange for a premium.
- **Premium** – the market value of the option, in effect **the price** of the insurance.
- **Strike Price** – The fixed price specified in an option contract is called the option's strike price or **exercise price**.
- **Expiration Date** – The date after which an option can no longer be exercised is called its expiration date or **maturity date**.

TYPES OF OPTIONS

1. **Call Option:** The investor/ buyer/option holder has the ***right to purchase*** and the option writer/seller has the obligation to sell specified number of securities of the underlying stocks at a specified price prior to the option expiry date.
2. **Put Option:** The owner or buyer has the ***right to sell*** and the writer/ seller has the obligation to buy specified number of the underlying shares at a specified price prior to the expiry date of option.

Call Option Buying

A Call option buyer basically is bullish about the underlying stock.



Call Option Example

CALL OPTION

Current Price = Rs.250

Premium = Rs.25/share

Right to buy 100 Reliance shares at a price of Rs.300 per share after 3 months

Strike Price

Amt to buy Call option = Rs.2500

Expiry date

Suppose after a month, Market price is Rs.400, then the option is exercised i.e. the shares are bought.
Net gain = 40,000-30,000-2500 = Rs.7500

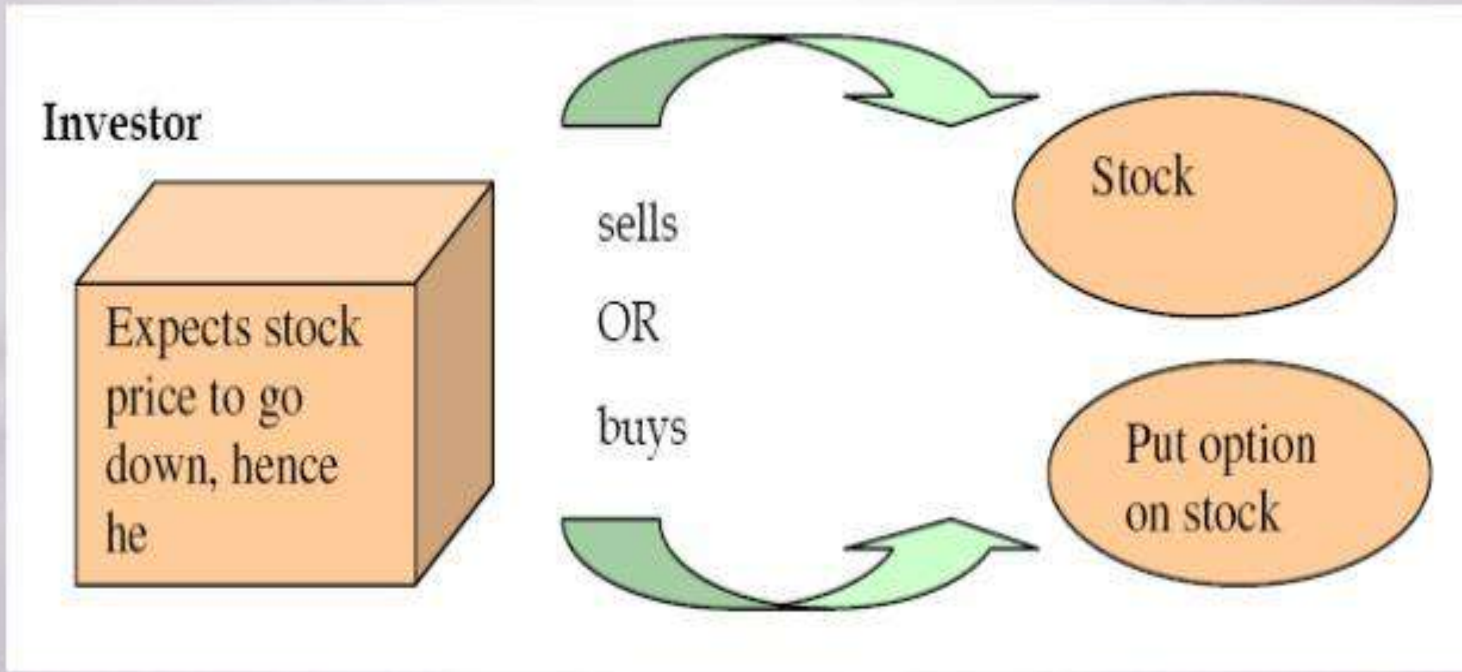
Suppose after a month, market price is Rs.200, then the option is not exercised.
Net Loss = Premium amt
= Rs.2500

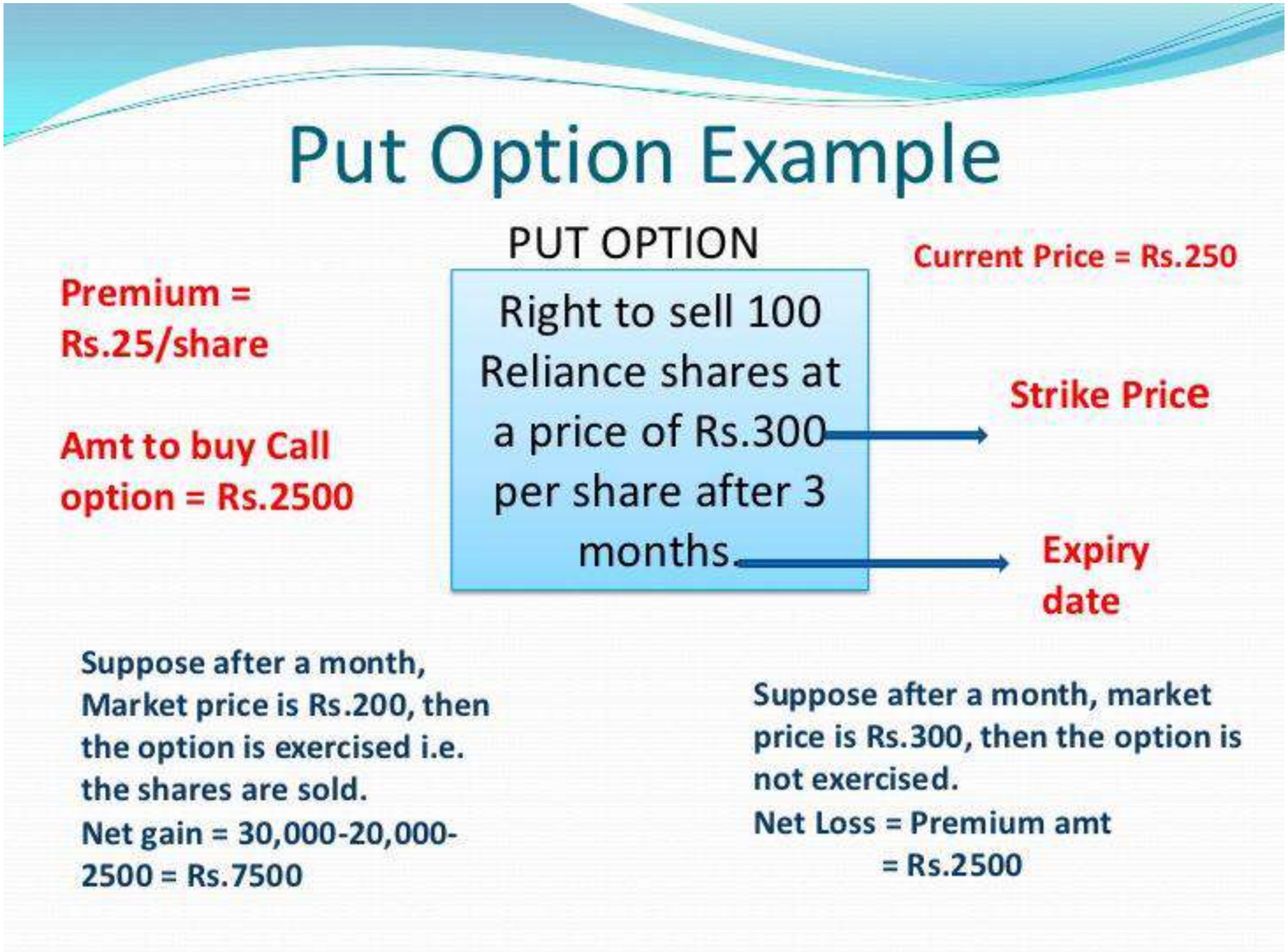
Exercise of calls

Call Option Strike Price - $ 60 3 months Call Price - $ 8	**If strike price (60) < market price of stock**, in this case, the buyer can buy shares at $ 60 by exercising the option, or buy it from market which is quoting the price above $ 60. Obviously it makes sense to exercise the option. **If strike price (60) = market price**, the buyer is indifferent because whether he exercises the option or buys from market, the price is same. **If strike price (60) > market price**, in this case it makes sense to buy the shares from market as market price is lower. Hence simple rules to decide whether call options should be exercised or not are : If Strike Price < Market Price of underlying asset, **Exercise** If Strike Price = Market Price of underlying asset, **Be Indifferent** If Strike Price > market Price of underlying asset, **Do not Exercise**

Put Option buying

- A buyer of put option is bearish on underlying stock.

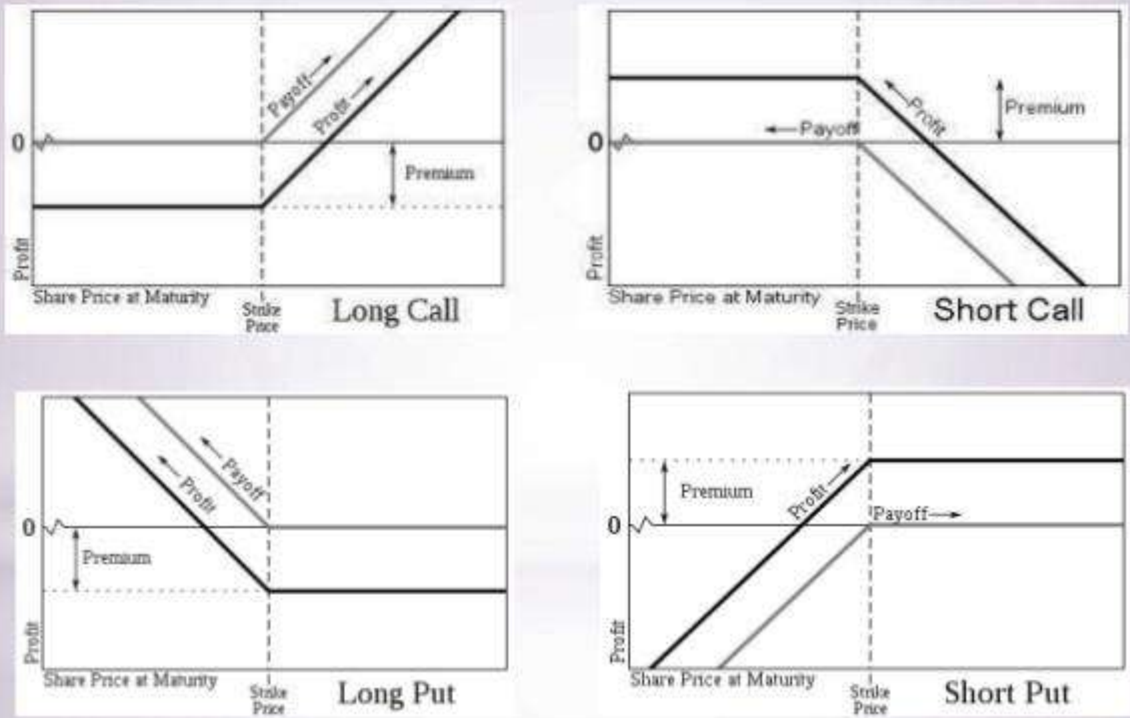



Put Option Example
PUT OPTION
Current Price = Rs.250
Premium = Rs.25/share
Right to sell 100 Reliance shares at a price of Rs.300 per share after 3 months
Strike Price
Amt to buy Call option = Rs.2500
Expiry date
Suppose after a month, Market price is Rs.200, then the option is exercised i.e. the shares are sold.
Net gain = 30,000-20,000-2500 = Rs.7500
Suppose after a month, market price is Rs.300, then the option is not exercised.
Net Loss = Premium amt
= Rs.2500

Exercise of Puts

Put Option Strike Price - $ 60 3 months Put Price - $ 8	**If Strike Price (60) < market price of stock**, in this case, the buyer of put can sell shares at a price higher than $ 60 in the market or sell at $ 60 by exercising the put option. Obviously it makes sense to sell through the market and not to exercise the option. **If Strike Price (60) = market price**, the buyer is indifferent because whether he exercises the option or sells through the market, the price is same. **If Strike Price (60) > market price of stock**, in this case it makes sense to exercise. Because if he sells shares though the market, he will get less than $ 60 while a put exercise gives him $ 60. Hence simple rules to decide whether put options should be exercised or not are : If Strike Price < Market Price of underlying asset, **Do not Exercise** If Strike Price = Market Price of underlying asset, **Be Indifferent** If Strike Price > market Price of underlying asset, **Exercise**

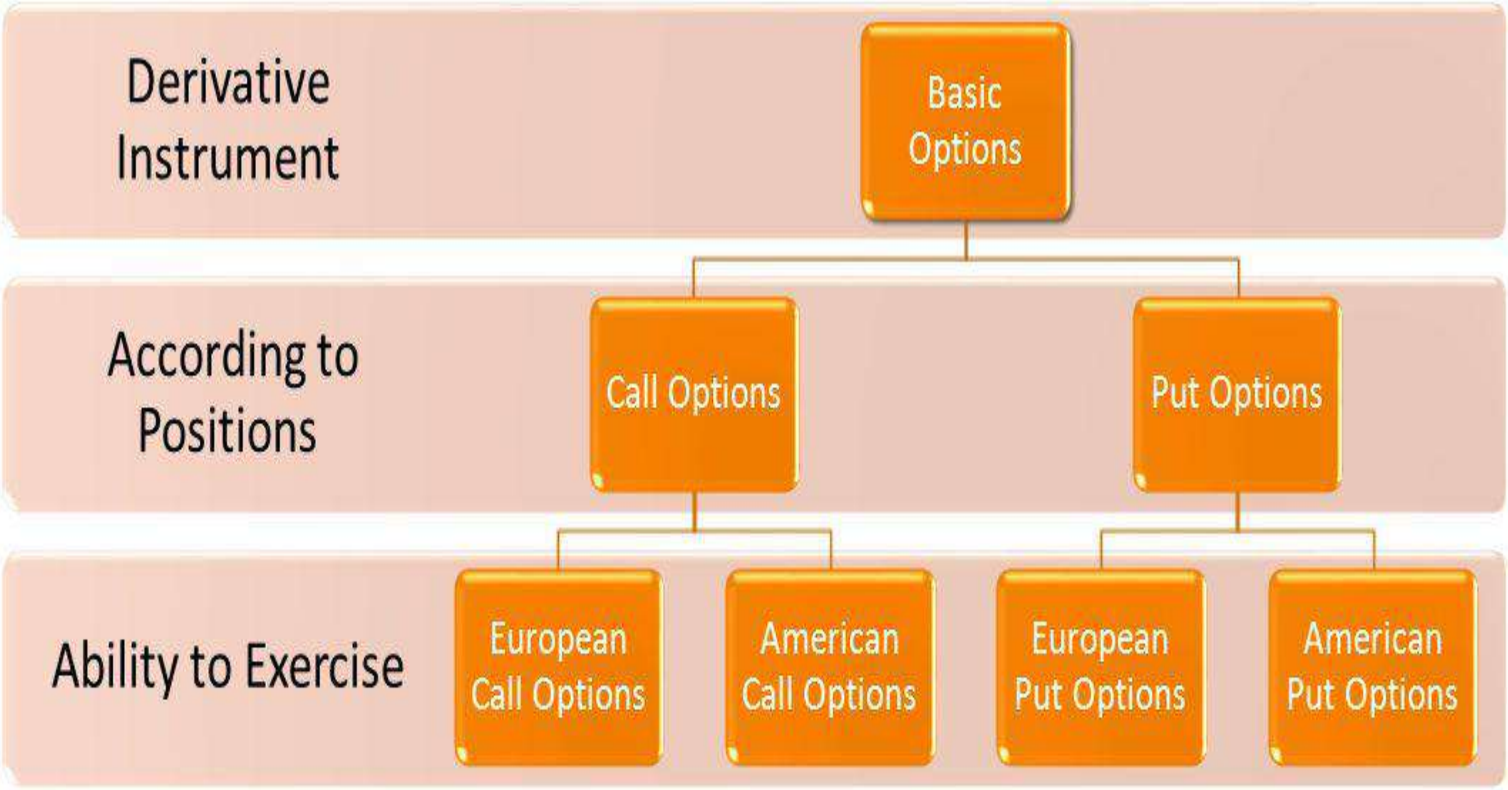
Option Pay Off

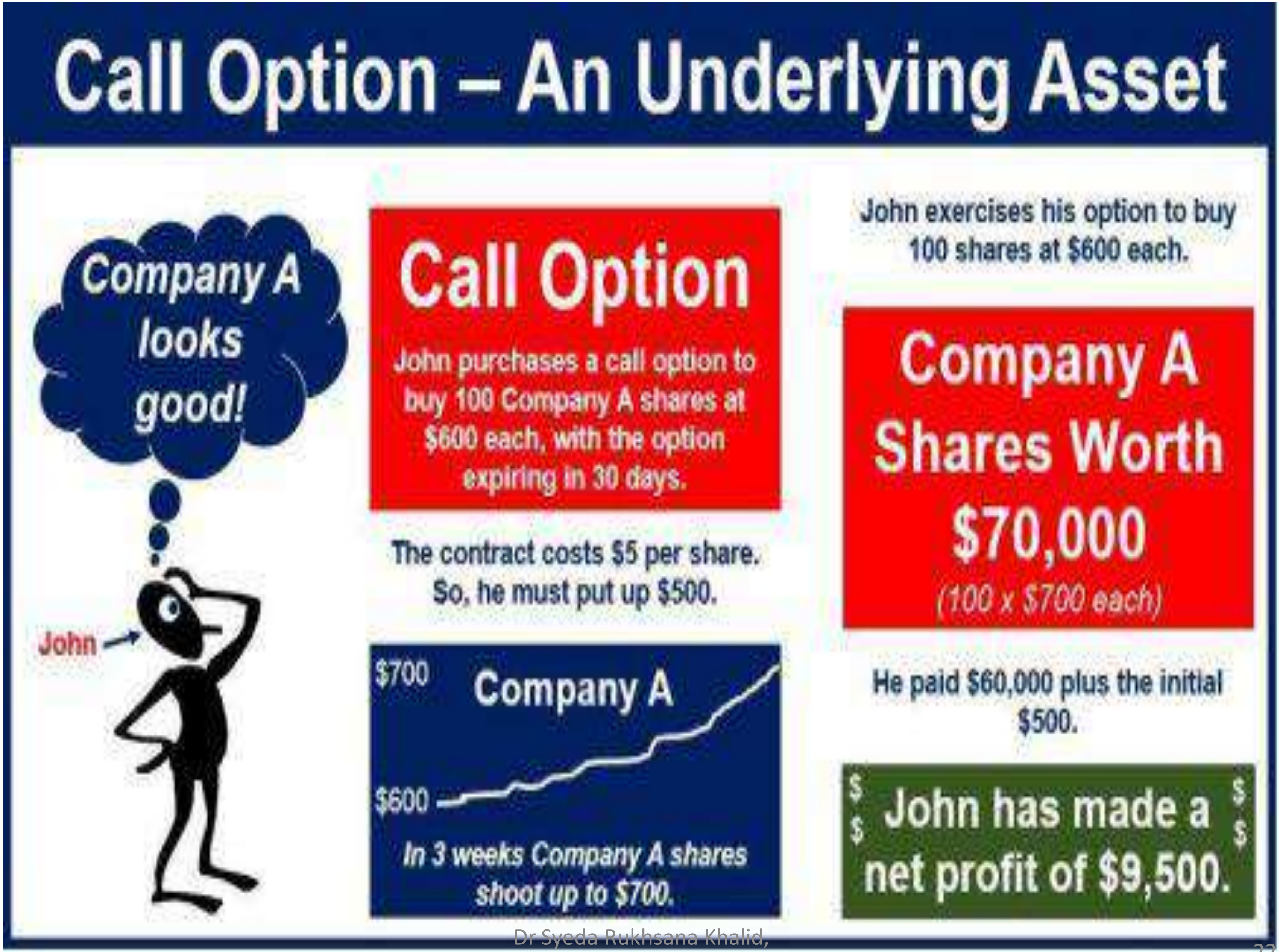


Why it Matters:

- Investors use *options* for two primary reasons:
- To ***speculate*** and to ***hedge*** risk.
- Rational investors realize there is no "sure thing," as every investment incurs at least some risk.
- This risk is what the investor is compensated for when he or she purchases an asset.
- Hedging is like buying insurance. It is protection against unforeseen events, but you hope you never have to use it.
- Should a stock take an unforeseen turn, holding an option opposite of your position will help to limit your losses.

Types of Options




Call Option – An Underlying Asset
Company A looks good!
John
Call Option
John purchases a call option to buy 100 Company A shares at $600 each, with the option expiring in 30 days.
The contract costs $5 per share. So, he must put up $500.
$700
Company A
$600
In 3 weeks Company A shares shoot up to $700.
John exercises his option to buy 100 shares at $600 each.
Company A Shares Worth $70,000
(100 x $700 each)
He paid $60,000 plus the initial $500.
John has made a net profit of $9,500.

STYLES OF OPTIONS

- Options are traded basically in two styles:

a) **American style option:** It can be exercised by the holder of the option ***any time*** between the purchase date and expiration date.

a) **European style option:** It can be exercised ***only on the expiration date*** by the holder of the option. The expiry and the exercise date coincides with each other.

Call Options

- BUYER receives the right to **buy** an underlying security in return for **paying the premium** to the writer
- WRITER **receives the premium** and has an obligation to **deliver** underlying security if the buyer exercises the option.

Put Options

- BUYER receives the right to **sell** an underlying security in return for **paying the premium** to the writer
- WRITER **receives the premium** and has an obligation to **buy** the underlying security if the buyer exercises the option.

Terminology

	Call	Put
Long	• Right to buy • Pay premium • Can Cancel	• Right to sell • Pay premium • Can Cancel
Short	• Obligation to sell • Receive premium	• Obligation to buy • Receive premium

1.3

	TYPES OF OPTIONS CONTRACTS	
	CALLs	**PUTs**
BUYER / HOLDER	**BUY CALL** The right to BUY	**BUY PUT** The right to SELL
SELLER / WRITER	**SELL CALL** The obligation to SELL	**SELL PUT** The obligation to BUY

Option Valuation Basics

- Two components of option value
  - Intrinsic value
  - Time value
- **Intrinsic value** is based on the difference between the exercise price and the current asset value (from the owner's point of view)
  - For calls, max(S-X,0)
  - For puts, max(X-S,0)

  X= exercise price
  S=current asset value
- **Time value** reflects the possibility that the intrinsic value may increase over time
  - Longer time to maturity, the higher the time value

Moneyness of an Option

- In finance, **moneyness** is the ***relative position*** of the current price (or future price) of an underlying asset (e.g., a stock) with respect to the strike price of a derivative, most commonly a call option or a put option.
- Moneyness is firstly a three-fold classification: if the derivative would have positive intrinsic value if it were to expire today, it is said to be **in the money**;
- if it would be worthless if expiring at the current price it is said to be **out of the money**,
- and if the current price and strike price are equal, it is said to be **at the money**.

The Relationship of the Underlying to the Strike Price

	Put	Call
In-the-money option	The price of the underlying is *less* than the strike price of the option	The price of the underlying is *greater* than the strike price of the option
Out-of-the-money option	The price of the underlying is *greater* than the strike price of the option	The price of the underlying is *less* than the strike price of the option
At-the-money option	The price of the underlying is *equal* to the strike price of the option	The price of the underlying is *equal* to the strike price of the option

Note: Underlying refers to the asset (i.e., stock or commodity) upon which an option trades.

Options Terminology (cont.)

- Moneyness: Concept that refers to the potential profit or loss from the exercise of the option. An option maybe in the money, out of the money, or at the money.

	Call Option	Put Option
In the money	Spot price > strike price	Spot price < strike price
At the money	Spot price = strike price	Spot price = strike price
Out of the money	Spot price < strike price	Spot price > strike price

Options Terminology

- Underlying: Specific security or asset.
- Option premium: Price paid.
- Strike price: Pre-decided price.
- Expiration date: Date on which option expires.
- Exercise date: Option is exercised.
- Open interest: Total numbers of option contracts that have not yet been expired.
- Option holder: One who buys option.
- Option writer: One who sells option.

Terminology

- Intrinsic value
  - Value realized if exercised immediately
- Time value
  - Value over level of intrinsic value
- Example
  - Spot price: 53; strike price: 50; Call option price: 5
  - Intrinsic value: 53 – 50 = 3
  - Time value: 5 – 3 = 2

Time Value

- The time value is the excess of actual value over intrinsic value.
- The value attached to the chances that strike price will be moved in times to come before expiry is called the time value of an option.
- Time value of an option = Actual Price –Intrinsic Value
- Time value cannot be negative. At best/worst it can have zero value.
- Time value of the option is greatest for ATM options. The entire premium paid for ATM options is attributable to the time value as the intrinsic value of the option is zero.

Option Pricing Models

→Black Scholes Model

→Binomial Model

OPTION PRICING MODELS are mathematical models used for the purpose of valuing the options. Most prevalent and widely acknowledged option's pricing models are Binomial (Two period or Multi-period) and Black and Scholes Model.

OPTION

An option creates a right (not an obligation) to buy or sell a certain asset at a predetermined price, on or before a predetermined date.

OPTION PRICING MODELS

Binomial Model

Two-Period

$$p = \frac{e^{\frac{rt}{n}} - d}{u - d}$$

Multi-Period

Black and Scholes Model

Call Option Premium = $SN(d_1) - N(d_2).Ee^{-rt}$

$$d_1 = \frac{\ln(S/E) + (r + \sigma^2/2)t}{\sigma\sqrt{t}} \qquad d_2 = d_1 - \sigma\sqrt{t}$$

Black-Scholes Model Assumptions

How to Improve the BS assumptions

- Constant volatility
- price changes smoothly
- constant short-term interest rate
- No trading cost
- No taxes
- No dividends
- Option be exercised at maturity
- No takeover events over the option life

BINOMIAL MODEL

- A binomial model is an option pricing model that is easily understandable and less complex when compared to black and Scholes model or a Monte Carlo simulation.
- **As per the binomial option pricing model, the price of an option is equal to the difference between the present value of the stock (as computed through a binomial tree) and the spot price.**

ASSUMPTIONS IN BINOMIAL MODEL

- Based on the Efficient Markets Hypothesis.
- There exist only ***two possible prices*** for the forthcoming period, hence the name binomial.
- The two prices are the ones realized on an ***uptick*** or ***downtick.***
- No arbitrage is possible.
- The rate of interest remains unchanged throughout the period under consideration.
- The investors are risk neutral.
- There does not exist any transaction cost.

TWO-PERIOD BINOMIAL MODEL

- There exists an asset with a spot price of S_0. Now, in one years time, the price of this asset will either increase by **u%(uptick)** or fall by **d% (downtick).**
- The probability of uptick is indicated by **"p"** and that of downtick by **"1-p".**

Basics of the Binomial Option Pricing Model

- With binomial option price models, the assumptions are that there are two possible outcomes, hence the binomial part of the model.
- With a pricing model, the two outcomes are a move up, or a move down.
- The major advantage to a binomial option pricing model is that they're mathematically simple. Yet these models can become complex in a multi-period model.

KEY TAKEAWAYS

- The binomial option pricing model values options using an iterative approach.
- With the model, there are two possible outcomes with each iteration—a move up or a move down.
- It reduces possibilities of price changes, while removing the possibility for arbitrage.
- The model is mathematically simple

Formula keys:

- **e^$^{(rt/n)}$** = Risk Free Rate, e= exponential, σ = Standard deviation, √t/n= time period

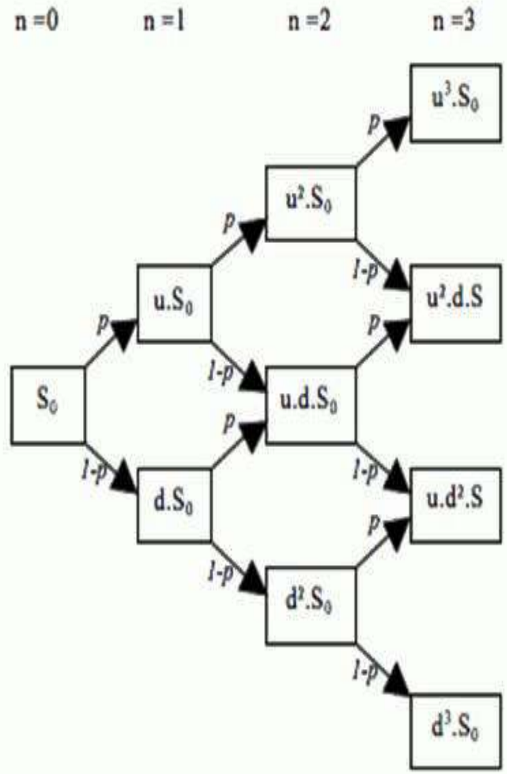
Let us construct a binomial option pricing model

- The current spot price of the asset (S_0) = \$100, RFR= 10%, and Standard Deviation σ = 20%

Therefore,

- Uptick = e0.0.20√1 = **1.2214**
  Downtick = 1/u = 1/1.2214 = **0.8187**
- Therefore, probability of uptick (p) = (1+10%)-0.8187/1.2214-0.8187 =0.698 or **0.7**
- Therefore probability of downtick (1-p) = 1-0.7=**0.3**
- The first branch of the binomial tree will look like this. The prices at either end of the node indicate the two possible and only outcomes given the set of assumptions.

Binomial options pricing model



$$p = \frac{e^{rt/n} - d}{u - d}$$

$$u = e^{\sigma \sqrt{t/n}}$$

$$d = e^{-\sigma \sqrt{t/n}}$$

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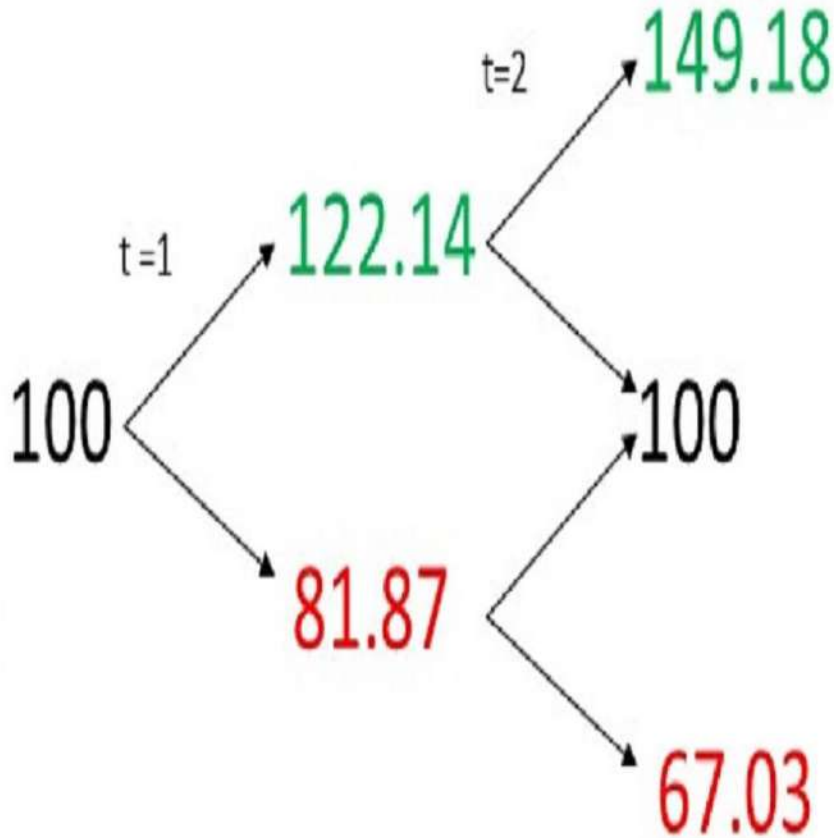

	Probability	Product (Node Value * Probablity)
149.18	*0.7*0.7*	73.0982
100	*(0.7*0.3)+(0.3*0.7)*	42
67.03	*(0.3*0.3)*	6.03

Total = 121.1282

$$p = \frac{e^{\frac{rt}{n}} - d}{u - d}$$

Where

$u = e^{\sigma\sqrt{(t/n)}}$, $d = e^{-\sigma\sqrt{(t/n)}}$

Example of Binomial Option Pricing Model

A simplified example of a binomial tree has only one step.

Assume there is a stock that is priced at $100 per share. In one month, the price of this stock will go up by $10 or go down by $10, creating this situation:

- **Stock price** = $100
- **Stock price in one month (up state)** = $110
- **Stock price in one month (down state)** = $90

Next, assume there is a call option available on this stock that expires in one month and has a strike price of $100.

In the up state, this call option is worth $10, and in the down state, it is worth $0.

The binomial model can calculate what the price of the call option should be today.

- For simplification purposes, assume that an investor purchases one-half share of stock and writes or sells one call option.
- The total investment today is the price of half a share less the price of the option, and the possible payoffs at the end of the month are:
- **Cost today** = $50 - option price
- **Portfolio value** (up state) = $55 - max ($110 - $100, 0) = $45
- **Portfolio value** (down state) = $45 - max($90 - $100, 0) = $45

- The portfolio payoff is equal no matter how the stock price moves. Given this outcome, assuming no arbitrage opportunities, an investor should earn the risk-free rate over the course of the month.
- The cost today must be equal to the payoff discounted at the risk-free rate for one month.
- The equation to solve is thus:

Option price = \$50 - \$45 x e ^ (-risk-free rate x T), where e is the mathematical constant 2.7183.

Assuming the risk-free rate is 3% per year, and T equals 0.0833 (one divided by 12), then the price of the call option today is \$5.11.

- Due to its simple and iterative structure, the binomial option pricing model presents certain unique advantages.
- For example, since it provides a stream of valuations for a derivative for each node in a span of time, it is useful for valuing derivatives such as American options – which can be executed anytime between the purchase date and expiration date. It is also much simpler than other pricing models such as the Black-Scholes model.

BLACK AND SCHOLES OPTION PRICING MODEL

- This model is particularly used to value European options that are held to maturity.
- This formula was derived by ***Fischer Black*** and ***Myron Scholes*** who went on to win the Nobel Prize for this discovery.
- Before the discovery of this formula, options trading was considered as a gamble having no mathematical or scientific basis.
- It was this formula which explained the rationale behind option trading.

ASSUMPTIONS IN B&S MODEL

CONSTANT VOLATILITY

- This option pricing model assumes the volatility (amplitude of movement in stock prices) to be constant through the life of the option.
- While in the short term the volatility may oscillate around a small range, in the long run, it is highly unlikely for the volatility to remain constant.
- This is also a limitation of the B&S model.
- Since it does not account for the movement in one of the most significant variables of the B&S model.

CONSTANT RISK-FREE INTEREST RATE

- Like the volatility, the B&S option pricing model also assumes a constant risk-free interest rate.

- Constant implies the same rate for borrowing and lending which is highly improbable in practice.
- However, the magnitude of the impact of this assumption is not as large as that of assuming constant volatility.
- This is because the two rates differ only by a few basis points.
- Moreover, the interest is not subject to widespread changes in the long run.

RANDOM WALK

- This price of the underlying asset is assumed to be moving in accordance with the random walk theory.

The random walk theory states that at any given moment, the price of an asset may move up or down with equal probability.

- Implicitly, the price of underlying at time (t+1) is completely independent of its price at time (t).

NORMALLY DISTRIBUTED RETURNS

- The returns on the underlying risky asset are said to follow a normal distribution.
- A normal distribution is nothing but a bell curve when translated graphically.
- A bell curve in this context represents that the probability of smaller changes in price in the near future is greater than extreme changes in price. Thus, the bell shape of the curve.
- Further, owing to the normal distribution of returns and the undeniable relationship between the returns and prices, the price of underlying tends to be lognormally distributed.

NO DIVIDENDS:

Another assumption is that the underlying stock does not pay dividends during the option's life

In the real world, most companies pay dividends to their share holders.

The basic Black-Scholes model was later adjusted for dividends, so there is a workaround for this.

This assumption relates to the basic Black-Scholes formula.

A common way of adjusting the Black-Scholes model for dividends is to subtract the discounted value of a future dividend from the stock price.

Interest Rates Constant And Known.

The same like with the volatility, interest rates are also assumed to be constant in the Black-Scholes model.

The Black-Scholes model uses the *risk-free* rate to represent this constant and known rate.

EUROPEAN-STYLE OPTIONS.

The Black-Scholes model assumes European-style options which can only be exercised on the expiration date.

No Commissions And Transaction Costs.

The Black-Scholes model assumes that there are no fees for buying and selling options and stocks and no barriers to trading.

Liquidity.

The Black-Scholes model assumes that markets are perfectly liquid and it is possible to purchase or sell any amount of stock or options or their fractions at any given time.

– Alternative formulas expressed based on the corresponding forward price $F_0 = S_0 e^{(r-q)T}$

$$c = e^{-rT}[F_0 N(d_1) - KN(d_2)],$$

$$p = e^{-rT}[KN(-d_2) - F_0 N(-d_1)],$$

where $d_1 = \frac{\ln(F_0/K) + \sigma^2 T/2}{\sigma\sqrt{T}}$

$$d_2 = \frac{\ln(F_0/K) - \sigma^2 T/2}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

- For the above equations to be correct, the maturities of the forward and the option must be the same
- The advantage of the alternative formulas: they avoid the need to estimate q because all the information needed about q is in the observable forward price F_0

Intrinsic Value vs. Time Value

	In the money	Out of the money	At the money
Put/Call	Time-value *decreases* as the option gets deeper in the money; intrinsic value *increases*	Time-value *decreases* as option gets deeper out of the money; intrinsic value is *zero*	Time-value is at a *maximum* when an option is at the money; intrinsic value is *zero*

Note: Intrinsic value arises when an option gets in the money.

Option Pricing & Valuation

	Call	Put
Intrinsic value	$\max(S_T - X, 0)$	$\max(X - S_T, 0)$
in the money	$S_T - X > 0$	$X - S_T > 0$
at the money	$S_T - X = 0$	$X - S_T = 0$
out of the money	$S_T - X < 0$	$X - S_T < 0$
Time Value	C_T – Int. value	P_T – Int. value

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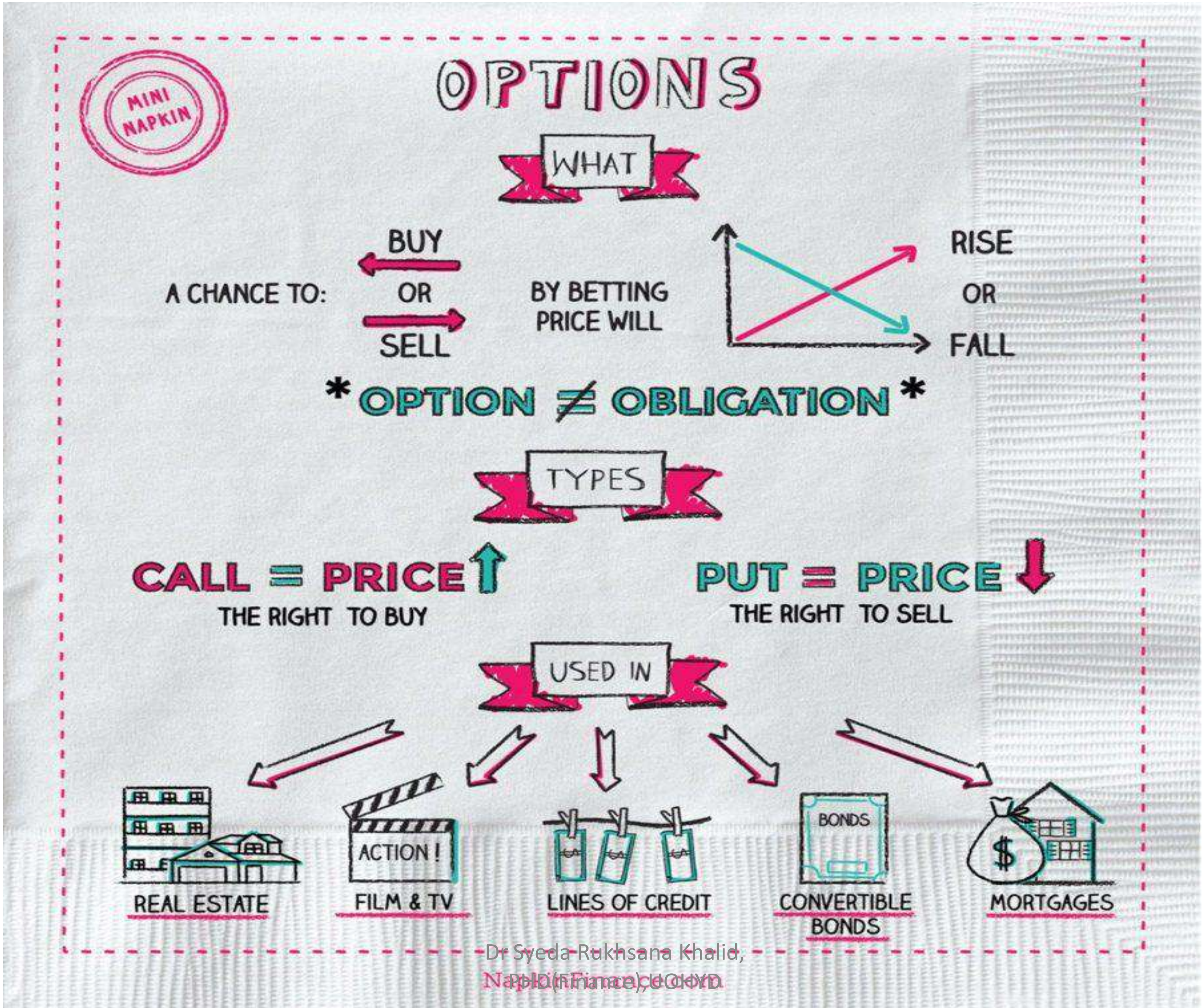
MINI NAPKIN
OPTIONS
WHAT
A CHANCE TO:
BUY
OR
SELL
BY BETTING PRICE WILL
RISE
OR
FALL
* OPTION ≠ OBLIGATION *
TYPES
CALL = PRICE ↑
THE RIGHT TO BUY
PUT = PRICE ↓
THE RIGHT TO SELL
USED IN
REAL ESTATE
ACTION!
FILM & TV
LINES OF CREDIT
BONDS
CONVERTIBLE BONDS
$
MORTGAGES
NapkinFinance.com

Option Type	Description
Call	Gives the options buyer the right, but not the obligation, to purchase the underlying asset at a pre-determined price, by a specified date.
Put	Gives the options buyer the right, but not the obligation, to sell the underlying asset at a pre-determined price, by a specified date.
Over-the-Counter	Individually tailored options traded between two private parties (generally an investor and an investment bank). They are not listed on an exchange.
Vanilla	A normal option with no special features, terms or conditions -- just the right to buy/sell a security during a certain time at a set strike price. European and American style options, which make up the majority of options traded, are considered to be "plain" vanilla options.
European	A "plain" vanilla option that can be exercised *only* on the expiration date.
American	A "plain" vanilla option that can be exercised at *any* time before the expiration date.
Exotic	Any style of option that includes complex structures, terms or conditions, or has a complicated formula to calculate the payoff. It is the opposite of a "plain" vanilla option.

Put-Call Parity

- Is there an arbitrage opportunity?

- $c_0 + X/(1+r)^T = p_0 + S_0$.

- We have:
  - c_0 = price of European call today = $5.
  - X= strike price = $20.
  - r = risk-free rate = 3%.
  - T = time to expiration (# of days to expiration/365) = 1.
  - p_0 = price of European put today = $5.
  - S_0 = price of underlying stock today = $23.

- Plugging in the numbers, left side: $5 + $20/(1.03) = $24.4175. Right side: $5 + $23 = $28.

$$C + Xe^{-rT} = P + S$$

where :

C = *call premium*

Xe^{-rt} = *present value of the strike*

P = *put premium*

S = *the current price of the underline*

The Essentials of Options Trading

Options contracts offer the buyer the right, but not the obligation, to buy (call option) or sell (put option) the underlying asset at an agreed-upon price during a certain period of time or on a specific date.

- Call options allow you to buy shares at a specific time
- Put options allow selling of shares at a specific time

- Differ from stocks in that they do not represent ownership in a company
- Considered lower-level risk than stocks because you can withdraw at any point

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Option trading strategy
What is American option ?
What is European option ?
Moneyness of the options
In The Money(ITM)
At The Money (ATM)
Out The Money(OTM)
Option Premium
Time Value
Intrinsic Value
The option premium has two components intrinsic value and time value
What you learn ?
✓In long call option buying the loss is limited and profit is unlimited.
✓The maximum loss can be only the premium paid.
Max Loss = Net Premium Paid