END-TERM REPORT

TOPIC: OPTION PRICING MODELS AND THEIR ACCURACY

GROUP: E6

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OPTION GREEKS

INTRODUCTION:

Option's prices are associated with various risks. These risk parameters are described by Greeks. Greeks are used by options traders and portfolio managers to see the variation of their options investment with price and accordingly try to reduce the risk of adverse price movements in assets. There are several Option Greeks, each representing a specific aspect of an option's sensitivity to market conditions, main ones being delta, gamma, theta, vega and rho.

GREEKS:

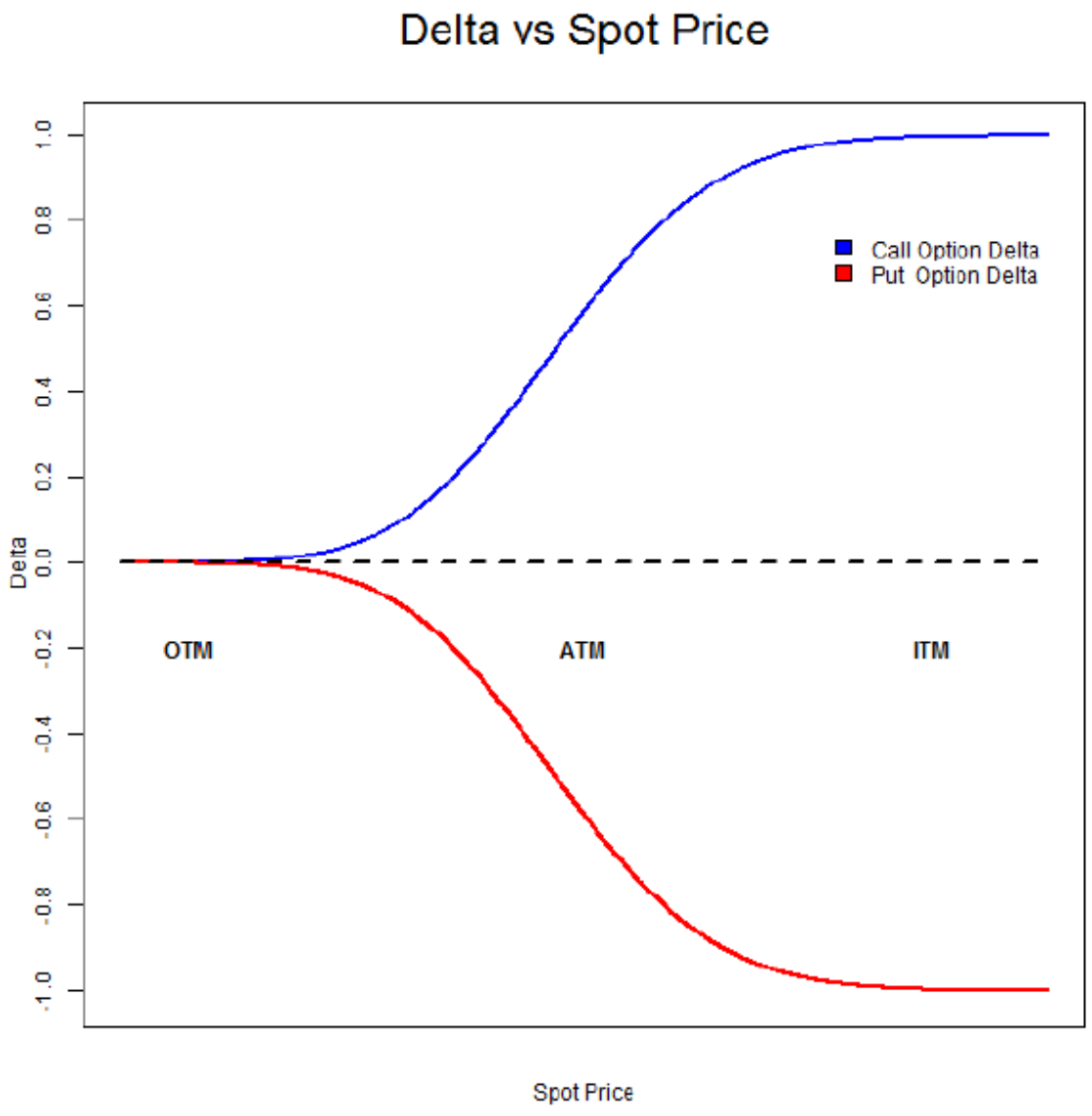
Delta

Delta measures how much an option's price can be expected to move for every $1 change in the price of the underlying security or index. Hence, it represents price sensitivity of the option with respect to the underlying.

For a call option, delta ranges between 0 and 1. We know that options contracts are derivatives because they derive their value from the price of the underlying security or stock thus, the delta cannot exceed 1 otherwise it would be as if the option is gaining more value than the underlying which is not possible. For delta value less than 0 the premiums may become negative which cannot happen so, delta is bounded by 0 and 1. Similarly, put option ranges between -1 and 0. The negative sign is the result of the inverse / opposite relation between underlying security and premiums. Delta is thus used when determining directional risk.

Note that: A call option gives the holder the right, but not the obligation, to buy the underlying security at the strike price on or before expiration. A put gives the holder the right, but not the obligation, to instead sell the underlying stock at the strike price on or before expiration.

For near or at the money options, delta tends to increase closer to expiration. ATM options have a delta of 0.5, ITM option have a delta of close to 1 and OTM options have a delta of close to 0. This shows the tendency of delta to determine probability of being profitable.



Gamma

Gamma is second-order (second-derivative) price sensitivity. It represents the rate of change between an option's delta and the underlying asset's price. It determines how stable an option's delta is. Higher gamma values indicate that delta could change dramatically in response to even small movements in the underlying's price.

As seen in the graph of Delta vs Spot price the delta rapidly changes as it approaches ATM and slowly changes in the case of OTM and ITM. Thus, value of gamma is higher for options that are ATM and lower for options that are ITM or OTM and accelerates in magnitude as expiration approaches.

Gamma can be considered as a measure of the stability of an option's probability. Gamma is the smallest for deep out-of-the-money and deep-in-the-money options and positive for long options and negative for short options.

Note:

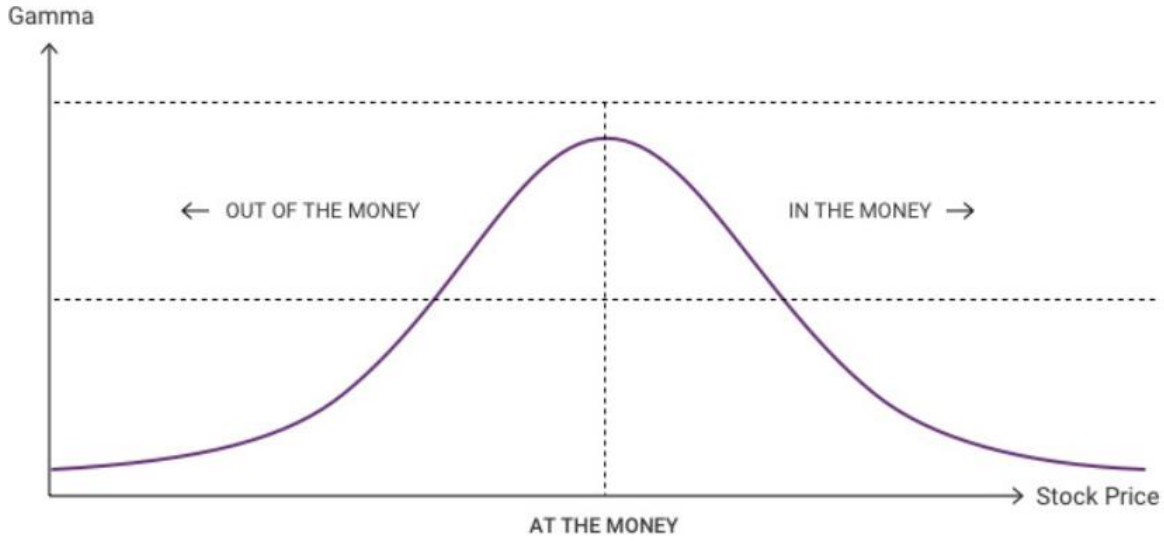
ATM (At the Money): Current underlying price = Strike price

ITM (In the Money): Current underlying price > Strike price (for call options) or Current underlying price < Strike price (for put options)

OTM (Out of the Money): Current underlying price < Strike price (for call options) or Current underlying price > Strike price (for put options)

Deep in-the-money options have a higher intrinsic value and are less affected by changes in the option's extrinsic value (time value and volatility effects).

Deep out-of-the-money options are generally less expensive but also have a lower probability of becoming profitable due to the substantial movement required in the underlying asset's price.

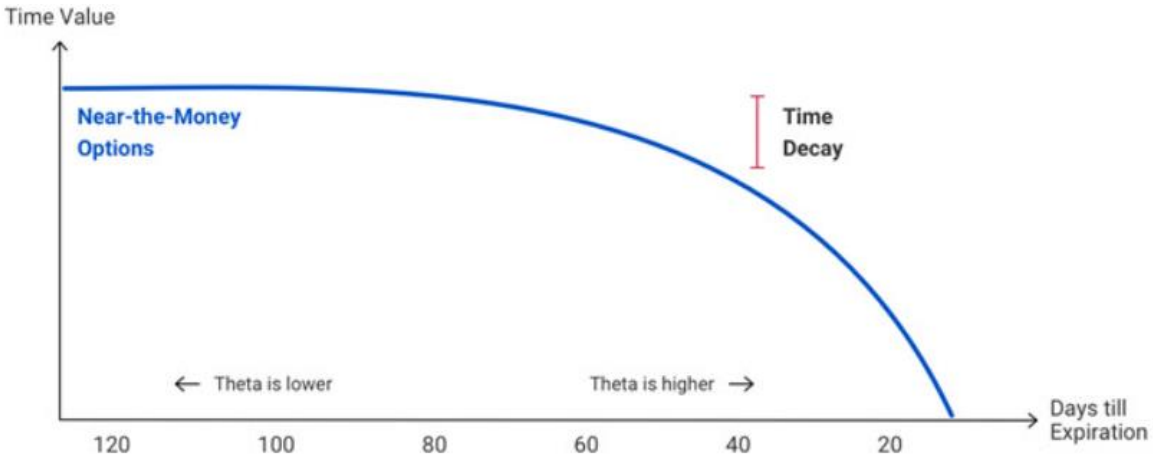


Theta

Theta is also known as an option's time decay. It is rate of change of option prices with time and represents time sensitivity. Theta tells you how much the price of an option would decrease each day as the option nears expiration, given all other factors remain the same.

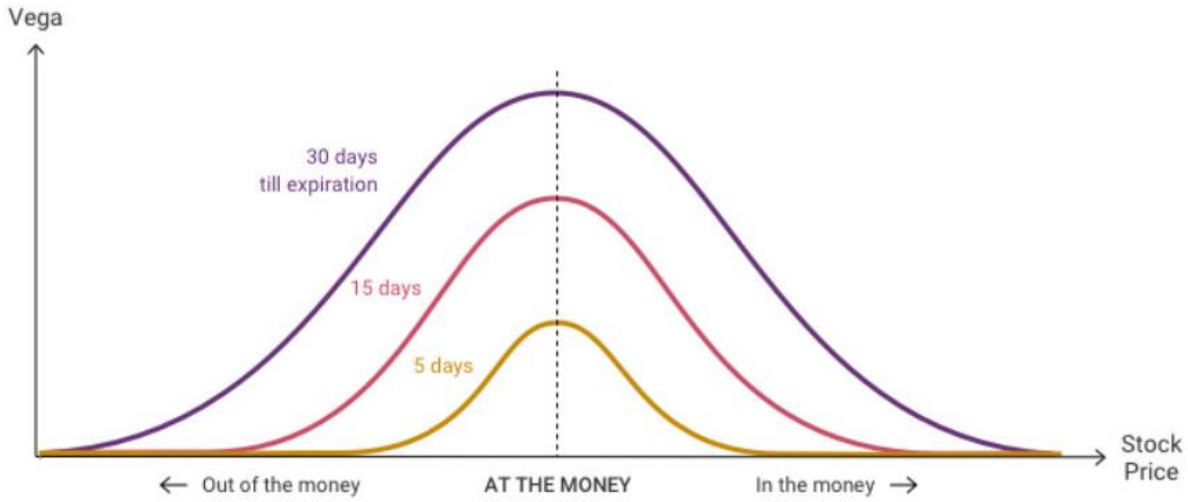
Theta values appear smooth and linear over the long-term, but the slopes become much steeper for at-the-money options as the expiration date grows near. Theta shows that as expiration is approached the chances of earning profit decreases. Theta is generally higher for at-the-money (ATM) options compared to in-the-money (ITM) or out-of-the-money (OTM) options.

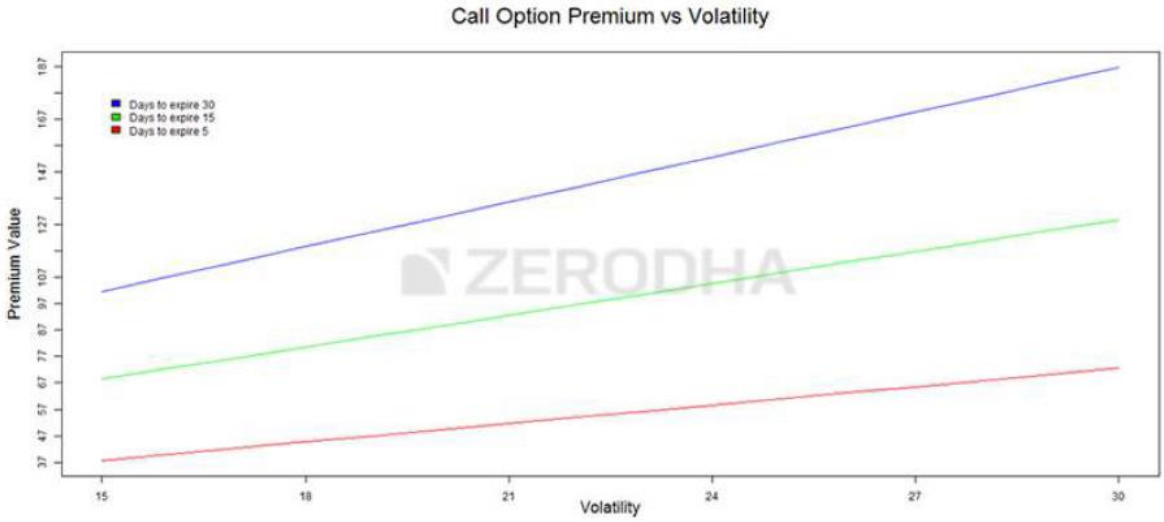
While Theta is primarily related to time decay, changes in implied volatility can also influence an option's value and, consequently, its Theta. Generally, higher volatility tends to increase an option's premium, including its time value. Theta is an essential concept to understand for options traders, as it underscores the importance of time in options pricing.



Vega

Vega measures the rate of change of premium with respect to change in volatility. It is parameter associated with the changes in the implied volatility. Vega is positive for both call and put options, meaning that an increase in implied volatility leads to an increase in the option's premium, and a decrease in implied volatility leads to a decrease in the premium. When the market expects higher volatility, options tend to become more expensive due to the increased uncertainty. Vega tends to be higher for options with longer time to expiration. This is because longer-term options have more time for potential changes in implied volatility to affect the option's value.





Rho

Rho quantifies the change in an option's price in response to changes in the risk-free interest rate. It is particularly relevant for options on assets that are affected by interest rates, such as currencies or bonds. Rho is generally not a huge factor in the price of an option, but should be considered if prevailing interest rates are expected to change.

There are other greeks too but they are second- or third-derivatives of the pricing model and affect things such as the change in delta with a change in volatility. Eg Charm, Vanna, Lambda.

These Greeks help traders and investors make informed decisions about their options positions by understanding how different market variables interact and impact an option's value. Keep in mind that Option Greeks are theoretical models and can provide useful insights, but real-world market behaviour can deviate from these theoretical expectations.

PSYCHOLOGY BEHIND TRADING OPTIONS

- Investing in options is quite risky in nature. Research in neuroscience shows us that the leadup to a win is much more exhilarating than the win itself. The feeling of winning makes you want to indulge in the given activity once again. This is due to the dominance of our reflexive over our reflective brain. Our urges overcome our rational thoughts.

- You may have gained high returns once upon buying a call or put option as a result of which you will have a tendency to buy it again thinking you could profit again. Trading options with such a mindset is a perfect recipe for a P&L disaster. The "Limited Risk and Unlimited Profit Potential" is a silent killer.

- Most option traders take trading options quite lightly. They find it quite amusing to initiate an options trade.

- Leverage in options trading allows you to control a larger position (the underlying asset) with a smaller amount of money (the premium). While your potential loss is limited to the premium paid, the percentage loss can be substantial when compared to the premium.

- You must be well-versed in option trading strategies to manage your risk effectively. However, no strategy is guaranteed to give you returns at all times. It is all in how you implement the strategy.

SOURCE: BEHAVIORAL FINANCE ARTICLE

A very naïve and simple way of looking at option trading would be to:

- Buy a call option when you expect the price of an underlying asset to increase i.e. bullish sentiment.

- Sell a call option when market is flattening or going down.

- Buy a put option when you expect the price of an underlying asset to decrease i.e. bearish sentiment

- Sell a put option when the market if flat or going up.

There is a certain degree of groundwork required before you buy an option. The ground work mainly revolves around assessment of volatility, time to expiry, and of course the directional movement of the market itself.

Market Direction is a generic topic and can be determined by appropriate technical analysis or quantitative analysis.
Irrespective of type of option, Premium linearly increases with increase in volatility. The increase is greater when time to expiry is more as well as seen in the graphs.

The added risk that comes with increased volatility makes option contracts more attractive to traders who are seeking to hedge against potential adverse price movements. As a result, buyers are willing to pay more for options to protect themselves from these increased risks.

Buy options when you expect volatility to increase and short options when you expect the volatility to decrease.

Shorting options requires careful risk management strategies, as a sudden price move against the trader's position can lead to significant losses.

Now, we will look at time of expiry to analyse option prices.

Let us take the spot price of a call option to be equal to 5000.

Now based on the time that the option was issued and when it was traded we should look to buy options with different stock prices.
Let's assume we want to execute the trade 5 days from initiation and we are quite bullish about the market.

We should look to purchase OTM options.

The question is why?

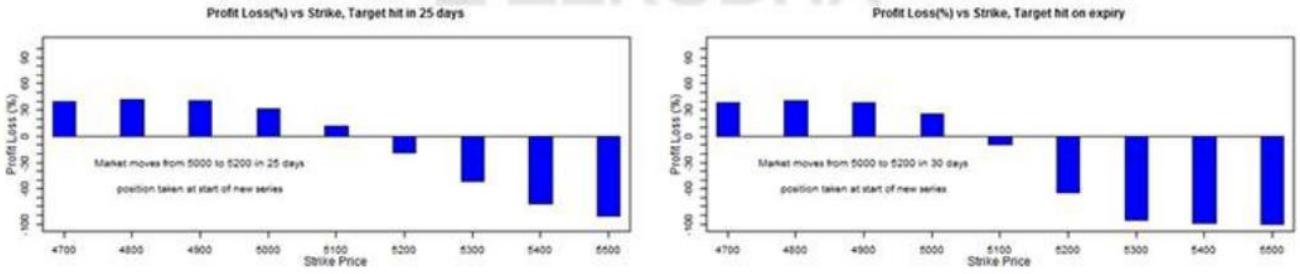
OTM options are generally cheaper than in-the-money (ITM) or at-the-money (ATM) options. This means that you can control a larger position with a smaller upfront investment, potentially magnifying your returns if the trade goes in your favour. So you should look to purchase an option with a strike price above 5000. This is risky in nature but the premium for these OTM options will be lower as well.

OTM options have a lower probability of expiring in-the-money. This means that the market needs to move significantly in your favour for the option to become profitable, which might not happen within a short timeframe. So with high risk comes high reward.
In summary, buying OTM options in a short timeframe can offer the potential for high returns due to their leverage and cost advantages.

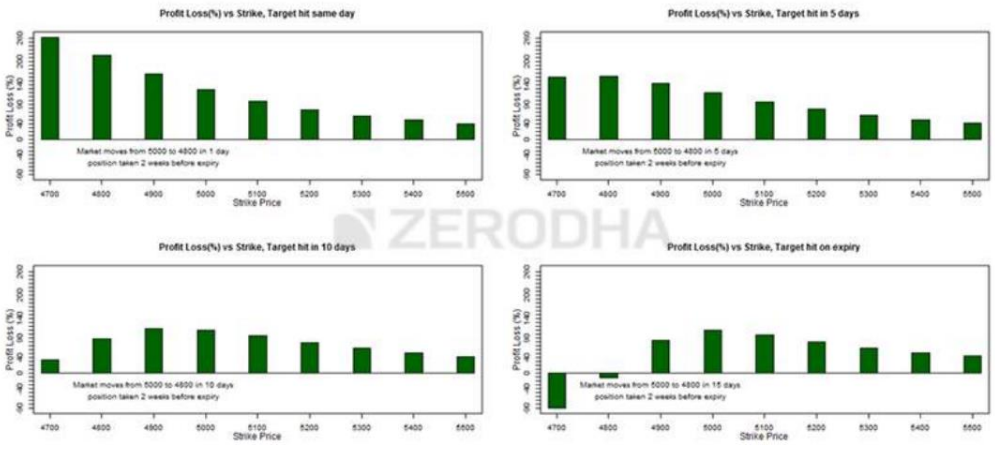
As the timeframe increases it becomes safer to buy ITM options for the following reasons:

- Intrinsic Value: ITM options inherently have intrinsic value because they are already in a profitable position due to the existing price difference between the option's strike price and the spot price of the underlying asset. This means that even if the underlying asset's price doesn't move significantly, the option still holds value.

- Higher Probability of Profit: ITM options have a higher probability of expiring in-the-money compared to out-of-the-money (OTM) options. This is because they are already partially or fully in-the-money. This increased probability can be advantageous over a longer timeframe when there's more time for the underlying asset to move in the expected direction.



Similar conclusions can be drawn for put options as well as seen in the below graphs



OPTION TRADING STRATEGIES

We will look at an option trading strategy now based on our knowledge attained until now.

BULL CALL SPREAD:

- Spread strategies are among the simplest strategies an option trader can implement.

- Spreads are multi leg strategies involving 2 or more options. The Bull Call Spread strategy is ideally implemented when your view of the markets is moderately bullish/bearish.

- To take an example, My view on a particular stock could be moderately bullish under the following conditions:

    - The stock is in a downtrend for a while and has reached a 52 week low. It is approaching the support line and is approaching the 200 day Moving average line as well. Thus, it could be due for a trend reversal with high probability. Under these conditions, I would feel moderately bullish.

- Now when it comes to the bull call spread, We buy one ATM call option in leg1 and sell an OTM call option in leg2. At the same time, we must ensure that the asset remains fixed along with the timeframe for both options.

  After we initiate the trade we are generally in debt with the debt amount being the difference of the premiums of the two options.

Nifty Spot – 7846

ATM – 7800 CE, premium – Rs.79/-

OTM – 7900 CE, premium – Rs.25/-

Here our initial debt would be Rs 54.

Analysing 4 scenarios of strike prices at the time of expiry,

Market Expiry	LS – IV	HS – IV	Net pay off
7700	0	0	(54)
7800	0	0	(54)
7900	100	0	+46
8000	200	100	+46

LS=Lower Strike Payoff
HS=Higher Strike Payoff

The spread is defined as the difference between the higher and the lower strike price.
In the first 2 cases we remain with the debt of Rs 54 as both options expired worthless.
In the 3rd and 4th case we make a total profit of 100 so on the whole our profit is now 100-54=Rs 46.
Thus, both our profit and loss are bounded which gives a trader some clarity on what level of risk he is taking on for what rewards.
To conclude, your risk vs reward depends on your strike price. We can also use more than 1 option for each leg as long as each leg has same number of options per leg.
As usual, do consider Option Greeks as well, particularly theta! The time to expiry is a crucial factor while determining potential market movements. (As highlighted in graphs earlier).

READING AN OPTION PRICING TABLE

INTRODUCTION:

An option pricing table, often referred to as an option chain, is a tabular representation of various options contracts available for a particular stock or underlying asset. This table provides information about call options and put options for specific strike prices and expiration dates.

Here's how to read an option pricing table:

Calls:

This column lists the different call options available for a particular underlying asset. Call options give the holder the right, but not the obligation, to buy the underlying asset at a specified price (strike price) before a certain expiration date.

Puts:

This column lists the different put options available for the underlying asset. Put options give the holder the right, but not the obligation, to sell the underlying asset at a specified price (strike price) before a certain expiration date.

Open Interest (OI):

Open Interest refers to the total number of contracts that are currently open (not yet closed or exercised) for a particular option. It gives an

idea of the liquidity and activity in that option. A higher open interest indicates more trading activity and potential liquidity.

Change in OI:

This column indicates the change in open interest compared to the previous trading session. It reflects the number of new contracts added or contracts that have been closed since the last session. Positive values suggest new interest, while negative values suggest reduced interest.

Volume:

The volume represents the total number of contracts that have been traded during the current trading session. It gives an insight into the level of trading activity for a specific option.

Last Traded Price (LTP):

This is the most recent price at which an option contract was traded. It provides the current market price for buying or selling that option.

Net Change:

Net Change signifies the difference between the LTP of the current session and the LTP of the previous session. It shows whether the option's price has gone up or down since the last trading session.

Bid Quantity and Bid Price:

The Bid Quantity represents the number of contracts buyers are willing to purchase at a specific price (Bid Price). The Bid Price is the highest price a buyer is willing to pay for the option.

Ask Quantity and Ask Price:

The Ask Quantity represents the number of contracts sellers are offering to sell at a specific price (Ask Price). The Ask Price is the lowest price a seller is willing to accept for the option.

Strike Price:

The Strike Price is the predetermined price at which the underlying asset can be bought (for call options) or sold (for put options) if the option is exercised. It helps to determine the level at which an option will become profitable.

IV (Implied Volatility):

Implied Volatility is a measure of how much the market expects the underlying asset to move in the future. Higher implied volatility usually corresponds to higher option prices, and vice versa.

This is how a typical option pricing table or a option chain looks like:

CALLS												PUTS									
Chart	OI	Chng in OI	Volume	IV	LTP	Net Chng	Bid Qty	Bid Price	Ask Price	Ask Qty	Strike Price	Bid Qty	Bid Price	Ask Price	Ask Qty	Net Chng	LTP	IV	Volume	Chng in OI	OI	Chart
	571,350	-44,025	749	-	875.00	28.90	75	866.00	876.90	75	8100.00	75	3.65	3.80	1,650	-0.40	3.65	21.91	7,138	1,650	866,475	
	375	-75	1	-	810.00	-9.00	1,500	774.70	899.90	3,000	8150.00	1,500	2.00	-	-	-	3.80	-	-	-	16,275	
	537,225	-81,600	1,269	-	774.00	26.65	75	770.10	775.40	75	8200.00	75	4.40	4.50	75	-0.60	4.50	20.42	9,788	-65,700	1,840,800	
	2,025	-	-	-	680.30	-	150	695.45	732.75	75	8250.00	1,500	5.00	5.60	75	-0.15	5.50	19.98	790	-7,425	64,575	
	414,750	-8,925	181	-	675.00	22.75	75	670.90	674.65	150	8300.00	375	5.50	5.60	2,175	-1.05	5.60	18.89	14,676	154,875	2,794,950	
	375	-	-	-	614.40	-	150	584.25	652.30	150	8350.00	75	6.00	7.25	75	-0.95	6.95	18.47	1,095	4,800	80,100	
	693,075	-6,600	199	-	577.90	23.80	150	573.45	577.10	75	8400.00	1,200	8.00	8.25	150	-1.60	8.00	17.78	19,112	-20,475	4,299,600	
	3,150	-	-	-	515.05	-	150	491.30	562.10	150	8450.00	75	8.80	10.95	75	-0.80	10.50	17.56	1,206	7,350	170,475	
	1,147,050	-9,525	1,066	-	479.90	21.85	75	478.45	480.95	225	8500.00	5,250	11.55	11.70	75	-2.15	11.60	16.66	39,389	-12,675	5,639,175	
	25,050	-300	4	-	420.00	16.00	150	398.60	487.40	150	8550.00	75	13.30	14.25	150	-2.35	14.15	16.12	2,446	30,600	271,425	
	1,592,325	-34,950	1,695	-	383.60	19.40	150	382.95	384.45	225	8600.00	525	16.55	16.70	75	-3.30	16.70	15.43	65,071	-2,325	6,066,075	
	152,100	-1,575	39	-	343.10	25.30	75	335.40	342.00	150	8650.00	75	20.45	20.90	75	-3.40	20.95	14.99	3,349	-46,425	364,950	
	2,176,200	-99,450	4,579	-	293.65	18.50	75	292.60	295.30	300	8700.00	75	25.10	25.40	750	-5.20	25.40	14.37	92,872	553,650	5,573,850	
	100,725	-975	119	-	249.15	15.65	75	245.00	252.95	75	8750.00	150	31.00	32.35	75	-7.50	31.05	13.76	4,206	17,925	444,825	
	2,628,900	-5,175	16,617	6.98	208.80	13.35	75	210.75	211.95	75	8800.00	600	41.35	41.40	2,025	-7.90	41.35	13.65	109,768	298,875	4,807,950	
	186,600	-6,300	1,928	7.40	167.10	6.85	225	168.70	174.95	375	8850.00	225	52.50	53.25	75	-9.70	52.65	13.32	6,745	14,625	337,950	
	3,471,750	86,175	83,532	8.88	138.40	11.60	600	138.00	139.25	75	8900.00	75	67.50	67.70	75	-11.15	67.45	13.11	131,523	637,050	3,534,450	
	257,775	5,250	6,910	9.21	108.50	11.10	75	107.95	109.05	75	8950.00	75	85.10	87.90	225	-12.60	85.35	12.90	5,977	55,425	179,550	
	5,584,275	39,225	149,409	9.28	81.55	8.45	600	81.55	82.05	450	9000.00	75	107.55	108.00	2,400	-14.65	107.95	12.84	52,687	54,900	1,641,075	
	302,550	7,875	4,986	9.33	59.40	6.95	75	58.45	59.45	75	9050.00	75	130.55	134.35	75	-18.50	130.95	12.41	294	7,650	13,125	
	3,481,650	-206,400	86,239	9.39	42.00	5.35	75	41.85	42.00	900	9100.00	75	164.05	165.85	75	-19.00	164.00	12.75	8,157	39,300	577,275	
	175,275	4,125	3,171	9.04	26.05	1.25	1,725	26.05	28.25	75	9150.00	150	179.60	219.95	150	5.30	200.40	13.14	3	75	75	
	3,017,175	305,400	74,220	9.49	19.00	2.75	150	18.80	18.90	375	9200.00	75	238.35	240.75	75	-19.85	240.15	13.64	2,689	6,525	418,425	
	104,625	19,650	1,640	9.05	10.15	-0.35	75	10.20	12.15	150	9250.00	150	260.15	304.40	150	-69.90	270.10	12.20	1	75	150	
	1,277,100	46,575	26,637	9.60	7.60	0.75	3,000	7.55	7.60	2,925	9300.00	75	324.90	328.70	75	-22.80	327.00	14.98	533	3,675	38,550	
	27,150	12,450	296	9.88	5.15	0.75	75	4.95	7.05	75	9350.00	150	327.50	390.85	1,500	-	-	-	-	-	-	
	523,125	11,175	10,477	10.15	3.45	0.20	2,325	3.40	3.50	2,700	9400.00	75	419.45	442.40	75	-1.10	438.20	20.05	140	225	6,375	
	26,325	900	178	10.69	2.70	0.15	1,800	1.20	2.70	1,800	9450.00	1,650	421.95	490.85	1,500	-	-	-	-	-	-	
	786,825	26,625	5,210	11.05	1.95	0.05	6,225	1.90	2.10	975	9500.00	225	515.15	518.00	300	-20.30	519.05	19.31	532	3,300	761,700	
	1,200	1,200	116	12.00	2.00	-21.15	1,050	0.80	2.15	75	9550.00	150	544.85	590.85	1,500	-	-	-	-	-	-	
	93,300	10,125	469	12.48	1.60	0.10	10,050	1.60	1.65	6,075	9600.00	150	605.65	622.30	225	-24.55	615.00	21.02	15	-525	5,850	

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You may ask why some rows of CALL and PUT options are marked yellow while others are not:

Well the answer lies in something called **in-the-money** options and **out-of-the-money** options. The **in-the-money** options are **marked in yellow** whereas the **out-of-the-money** options are **not marked in any color.**

Let's talk about **in-the-money options (ITM)** and **out-of-the-money options (OTM):**

In-the-Money (ITM) Options:

An option is considered "in-the-money" when it has intrinsic value. This means that the option's strike price is favorable compared to the current market price of the underlying stock.

In the case of call options:

- A call option is in-the-money when the market price of the underlying stock is higher than the option's strike price.

For put options:

- A put option is in-the-money when the market price of the underlying stock is lower than the option's strike price.

Why In-the-Money Options are Highlighted:

The yellow highlighting of in-the-money options in the option chain serves as a visual cue to quickly identify options that have intrinsic value. These options are more likely to have a higher premium due to

their intrinsic value, and they represent a higher likelihood of being exercised.

Out-of-the-Money (OTM) Options:

An option is considered "out-of-the-money" when it doesn't have any intrinsic value. In other words, the option's strike price is not favorable compared to the current market price of the underlying stock.

For call options:

- A call option is out-of-the-money when the market price of the underlying stock is lower than the option's strike price.

For put options:

- A put option is out-of-the-money when the market price of the underlying stock is higher than the option's strike price.

Significance of Out-of-the-Money Options:

Out-of-the-money options are often less expensive than in-the-money options because they don't have intrinsic value. Their premium consists entirely of time value, which reflects the potential for the option to move in-the-money before expiration.

Investors and traders might consider out-of-the-money options when they have a specific market outlook and want to speculate on significant price movements in the underlying stock. These options can offer a leveraged way to gain exposure to the stock's price changes.

However, it's important to note that due to their speculative nature, out-of-the-money options also carry a higher risk of losing the entire premium paid.

We can use the Black Scholes model to simulate option prices using the data from the table which depicts the present options market and compare simulated prices vs the Real Prices present in the LTP column

We can create a Python Script to do so.