FinSearch 2024: OPTION PRICING MODELS AND THEIR ACCURACY

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Midterm Report

Contents

1. What are options?

1.1. Options

1. It is a contract (option agreement between the 2 parties) allowing the recipient (option buyer or holder) the right but not the obligation to transact a known transaction (buy or sell) of a known asset(stocks, exchange-traded funds or indexes) at a known price (strike with extra amount for option price known as premium) in a known pre-defined time frame (options term or duration). The person giving the right is the Option writer, seller or originator.

2. Types of Option: American - options that can be exercised during the entire term, European - can be exercised only at the end of the period. Because the right to exercise early has some value, an American option typically carries a higher premium than an otherwise identical European option

3. Option that involves the right to buy an asset = Call option, Option that consists of the right to sell an asset = Put option

4. Call options and put options form the basis for a wide range of option strategies designed for hedging (Hedging is the purchase of one asset to reduce the risk of loss from another asset and can be used to describe diversifying a portfolio by buying shares in a conservative bond fund to offset potential losses in more volatile stock funds), income, or speculation.

5. Investors use options to hedge or reduce the risk exposure of their portfolios.

6. Ex: Options contracts usually represent 100 shares of the underlying security. So the total cost for the option is (100*cost per contract). Premium is affected by 2 factors, the strike price and contract duration.

7. Options spreads are strategies that use various combinations of buying and selling different options for the desired risk-return profile.

8. At-the-money (ATM) - an option whose strike price is exactly that of where the underlying is trading. ATM options have a delta of 0.50.

9. In-the-money (ITM) - an option with intrinsic value, and a delta greater than 0.50. For a call, the strike price of an ITM option will be below the current price of the underlying; for a put, above the current price.

10. Out-of-the-money (OTM) - an option with only extrinsic (time) value and a delta a less than 0.50. For a call, the strike price of an OTM option will be above the current price of the underlying; for a put, below the current price.

1.2. Types of Options

- Calls
    1. Maximum profit when the price of the asset is highest, calls have a positive delta.
    2. Can speculate on price in a long call as unlimited upside potential but the maximum loss is the premium (price) paid for the option.
- Puts
    1. Long put is a short position in the underlying security, since the put gains value as the underlying asset's price falls (have negative delta).

1.3. Options Risk Metrics: The Greeks

- **Delta** Δ: represents the rate of change between the option's price and a \$1 change in the underlying asset's price. For a call option, it ranges between 0 and 1 and -1 and 0 for a put option.
- **Theta** Θ: represents the rate of change between the option price and time, or time sensitivity - sometimes known as an option's time decay. Options closer to expiration also have accelerating time decay. Long calls and long puts usually have negative Theta. Short calls and short puts, on the other hand, have positive Theta. By comparison, an instrument whose value is not eroded by time, such as a stock, has zero Theta.
- **Gamma** Γ: represents the rate of change between an option's delta and the underlying asset's price. This is called second-order (second-derivative) price sensitivity. Options with longer expirations are less sensitive to delta changes.
- **Vega** V: represents the rate of change between an option's value and the underlying asset's implied volatility. It indicates the amount an option's price changes given a 1% change in implied volatility. Because increased volatility implies that the underlying instrument is more likely to experience extreme values, a rise in volatility correspondingly increases the value of an option.
- **Rho** ρ: represents the rate of change between an option's value and a 1% change in the interest rate.

1.4. Advantages and Disadvantages of Options

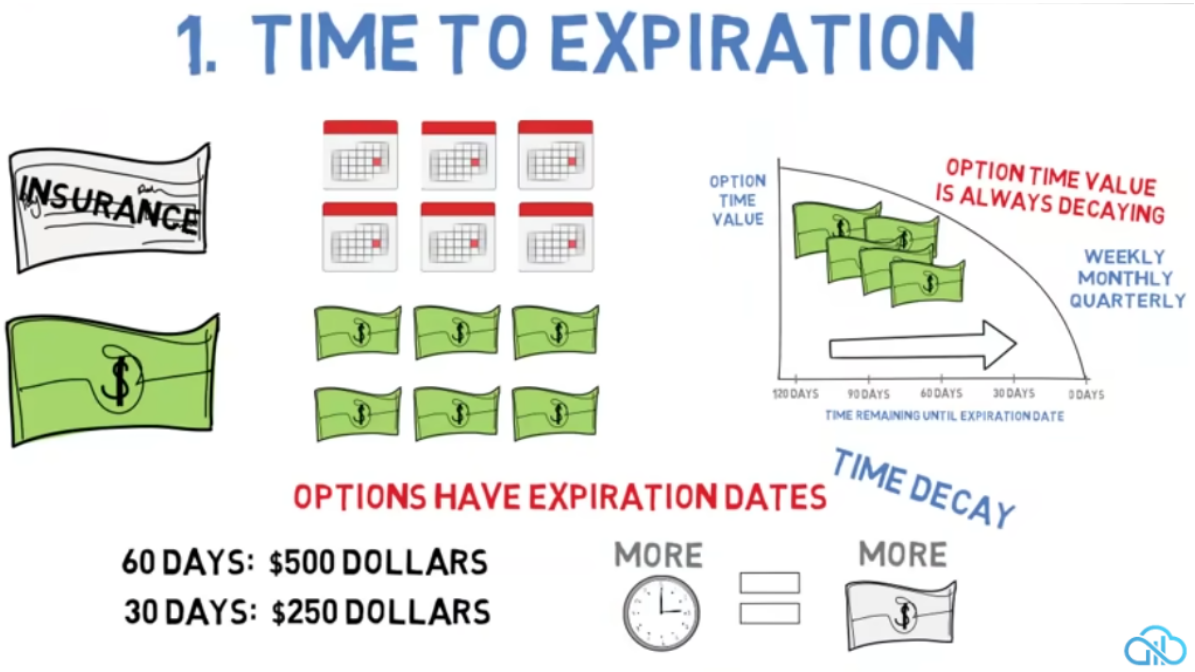
- **Buying Call Options**: Profit on this trade is the market share price minus (the strike share price plus the premium and any brokerage commission to place the orders). The result is multiplied by the number of option contracts purchased, then multiplied by 100—assuming each contract represents 100 shares.

- **Selling Call Options**: Selling call options is known as writing a contract. The writer receives the premium fee if they sell shares from their portfolio holdings at the strike price or can buy the stock at the prevailing market price to sell to the call option buyer. The contract writer incurs a loss on the cost basis of the shares they must use to cover the option order, plus any brokerage order expenses minus the premium.
- **Buying Put Options**: Put options are investments where the buyer believes the underlying stock's market price will fall below the strike price on or before the expiry date.
- **Selling Put Options**: Selling put options is also known as writing a contract. A put option writer believes the underlying stock's price will stay the same or increase over the life of the option, making them bullish on the shares.

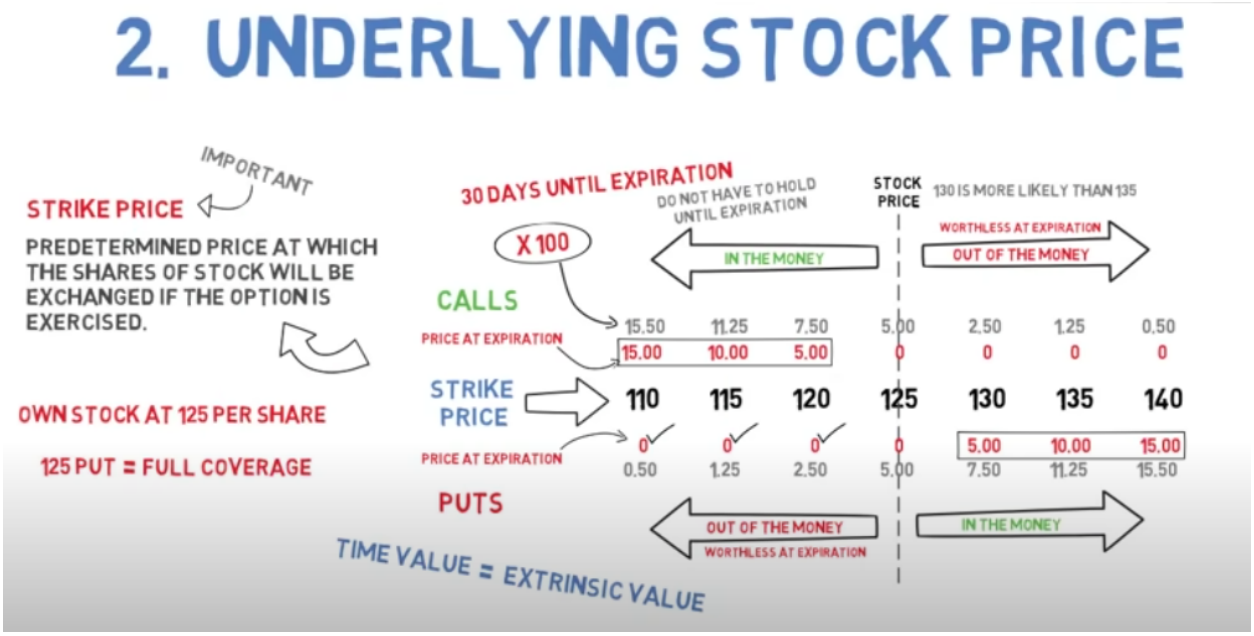
2. How to price options?

Option Prices are based on 3 elements of its underlying stock:

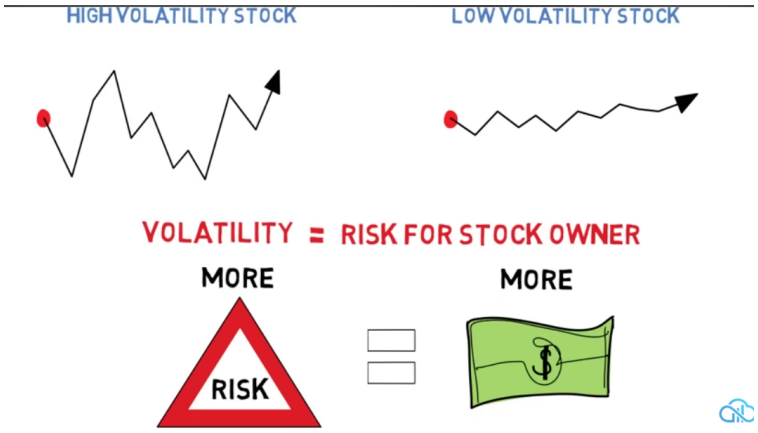
1. **Time to Expiration**: Longer period = Higher cost, As time to expiry decreases, an option's time value will decay. Time decay is exponential ie. as time passes time decay will speed up.



2. **Strike price of underlying asset**: For a call option, any option having a strike above the stock price is "OUT-OF-THE-MONEY" and vice-versa for a put. All OTM options have no worth at expiration where as the ITM options are with the difference between the stock and the strike price as there is no time value(=extrinsic value) left on these options. The further OTM an option is, the cheaper it is as it is less likely to move more outwards from the stock price. If the stock price goes up, the calls will become more expensive and the puts will become cheaper.



3. **Volatility**: It is the magnitude of a stock's price swings. Higher volatility = bigger price swings = more risk for the investor who owns stock (option seller) = options are more expensive. Volatility is more predictable than stock prices.



3. Options profitability

3.1. When Should You Buy Options?

Options are most useful to capitalize on volatile markets. It doesn't matter which direction the market is going; all options traders need is price movement in one direction or the other. Generally, it's best to enter an option position when you expect market volatility to increase and exit an option position when you expect market volatility to decrease. This is because low price movement is not beneficial for an options contract (especially if the option is currently out of the money).

3.2. How Do Call Options Make Money?

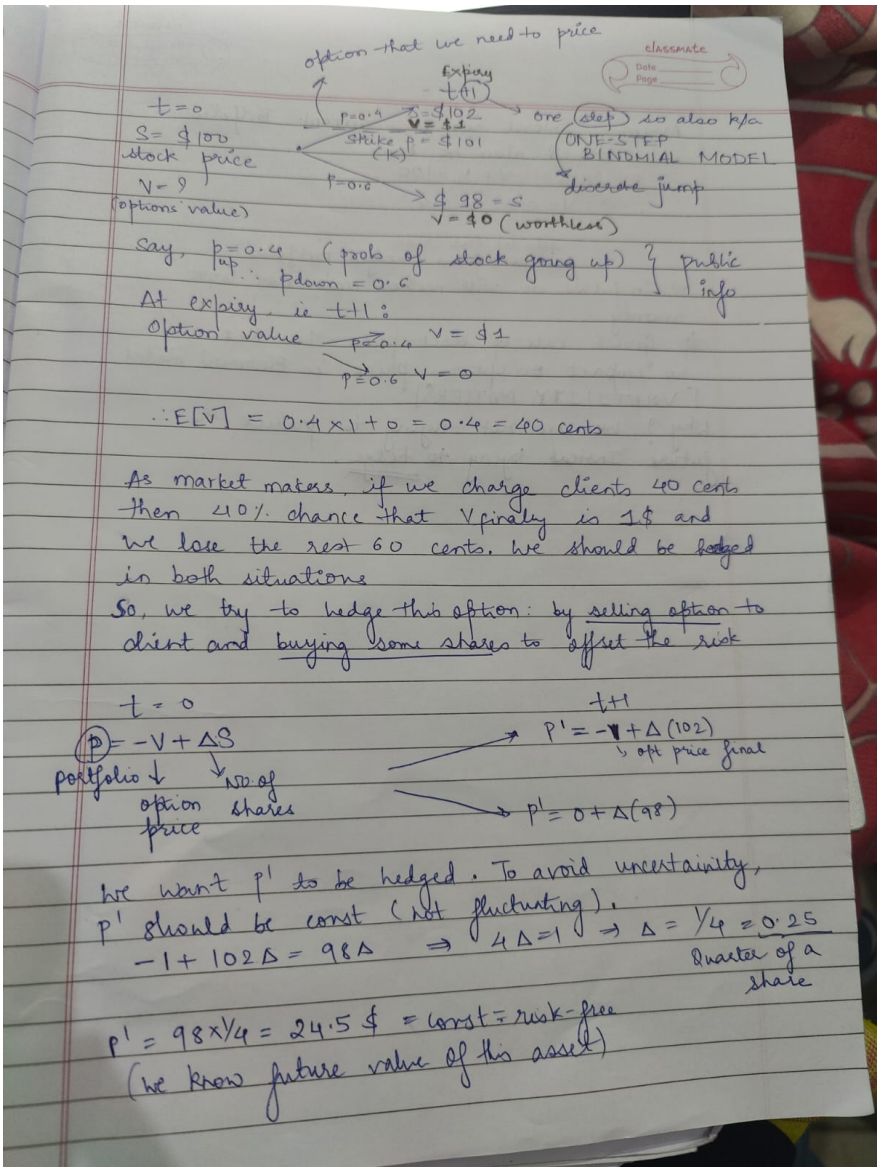
A call option writer makes money from the premium they receive for writing the contract and entering into the position. This premium is the price the buyer paid to agree. A call option buyer makes money if the security price remains above the option's strike price. This gives the call option buyer the right to buy shares at a price lower than the market price.

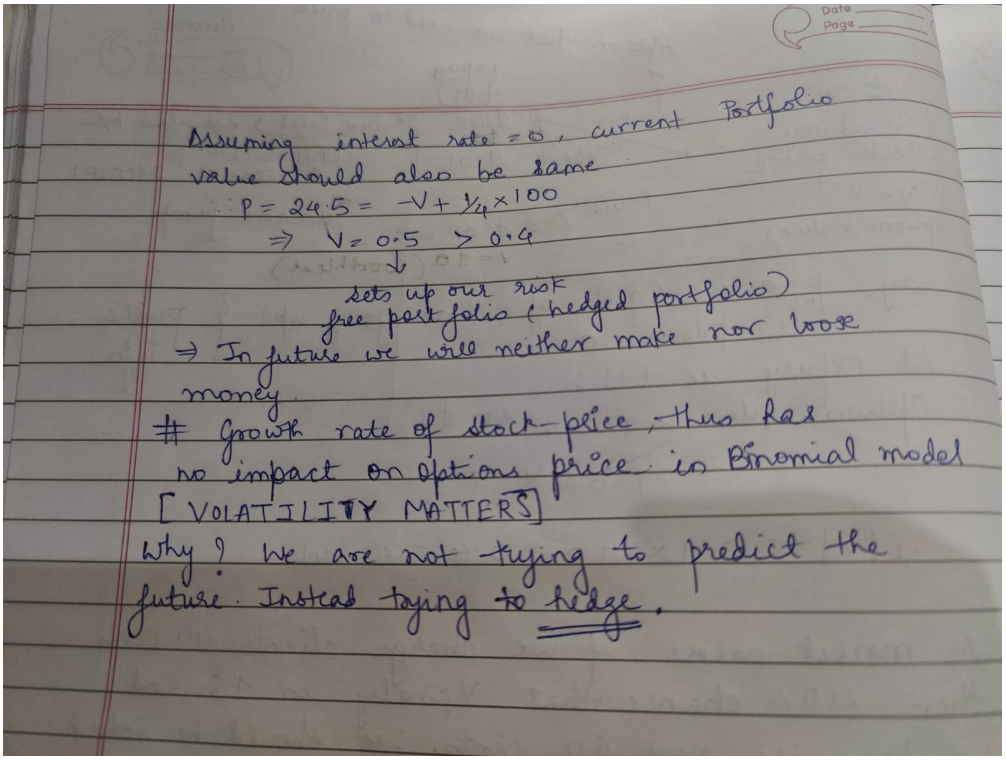
3.3. Can I Sell Options Immediately?

Options contracts can often be bought and sold through a broker on many regulated exchanges during normal market hours. As long as the market is open, you can usually buy an option and sell it the next day (assuming the market is also open the following day).

4. Binomial Option Pricing Model

This model provides a discrete-time framework for valuing options by simulating different paths the underlying asset's price can take, incorporating factors such as volatility, strike price, and time to expiration. The stock predictions are depicted by forming a Binomial tree for branches at every time step. A market maker's motive is to create a hedged portfolio from it. In the Binomial model, the probability of stock prices rising or falling does not affect options price. We hedge the portfolio by selling the option to the client and purchasing some shares to offset the risk of the option.





5. The Black-Scholes Options Pricing model

This model provides a mathematical framework for pricing European-style options based on factors like the underlying asset's price, strike price, time to expiration, risk-free interest rate, and volatility.