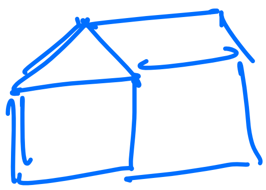
Option Pricing Models

- Call Option
- Put Option

] Arrive at the value of option



↑ fair value of the house

Different Models for Pricing Option

1) Black Scholes Model
2) Binomial Tree Model

} Price d/t option

European Option vs American Option

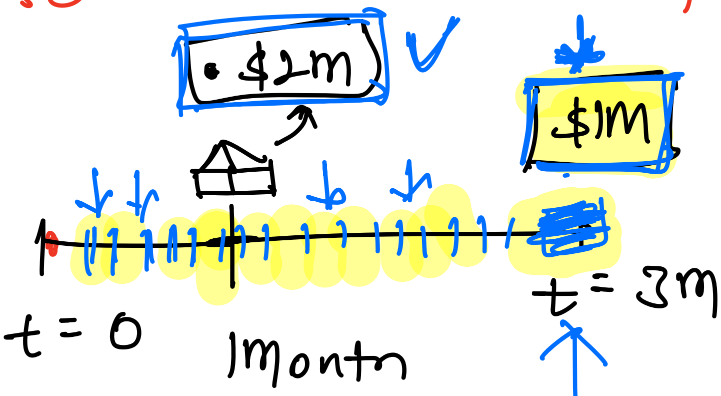
European Option → BS

American Option → BS, BT

- You can exercise the option only at the Maturity

- You can exercise the option anytime during the life of the option.

卖 → sell a house → Put Option



Call → Buy
Put → Sell

Put option
↳ $1m . $\boxed{3m}$

• 1m → $2m =
• 3m → $1m =

• European →
• American →

Buy American ⇒ Advantage over european
↓
flexibility during the life of option

1) **Black Scholes Model**

• It is a mathematical model which is used to price European Option

• The Black Scholes model was developed by Fischer Black.
Myron Scholes

- To price European call option & European put option
  - You can exercise call / put option only at the maturity

Assumption of Black Scholes Model

1) The BS model can only be used for pricing European option.
2) The BS model assumes that there is no dividend being paid out during the life of option.
3) The BS model assumes that stock follow a log normal process or return follows normal distribution.

log Normal → +ve value.

Normal distⁿ → +ve value, -ve value. Return

Return $= \frac{S_t}{S_{t-1}} - 1$ or $\frac{S_t - S_{t-1}}{S_{t-1}}$

① $\frac{S_t}{S_{t-1}} - 1$

② $\ln\left(\frac{S_t}{S_{t-1}}\right)$

+ve or -ve

Up

$S_t = 100$
$S_{t-1} = 95$

$\frac{100-95}{95} = \frac{5}{95}$

+ve

Down

$S_t = 100$
$S_{t-1} = 105$

$\frac{100-105}{105} = \frac{-5}{105}$

= -ve

4) The model assume const risk free rate 'r' & volatility 'σ'.

5) The market is frictionless

- No Transaction Cost
- No arbitrage opportunity
- Trading is continuous.

Formula for Black Scholes Model

$$c = S_0 N(d_1) - K e^{-rT} N(d_2)$$
$$p = K e^{-rT} N(-d_2) - S_0 N(-d_1)$$

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r + \frac{1}{2}\sigma^2\right)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

- S_0 = Current price of underlying stock
- K = strike price
- T = Maturity
- r = risk free interest rate
- σ = Volatility
- $N(.)$ = cumulative distribution fn $\Rightarrow$ standard normal
- $N(d_1)$ = prob that option will be exercised
- $N(d_2)$ = prob that option is in the money.
  $\hookrightarrow (S_T > K)$

$t=0$ $\quad$ $t=3m$

money to grow

↳ 'r' risk free int rate

$\boxed{y\%}$

Moneyness of option

- It is the relationship b/w stock price & strike price

- In the money : Receive the money → Profit
- At the money → No profit No loss
- Out of the money → Paying the money → loss

$$\boxed{c = \max(S_T - K, 0)} \Rightarrow \boxed{S_T - K}$$

	call option	put
In the money	$S_T > K$	$S_T < K$
At the money	$S_T = K$	$S_T = K$
Out of the money	$S_T < K$	$S_T > K$

Sign will change.

$$\boxed{p = \max(K - S_T, 0)}$$

When do we use BS Model

a) To price European call & put option

b) To drive implied volatility of the option.

- Stock price
- Strike price
- Risk free rate 4%
- Time to maturity
- Volatility

Call option price or put option price

Volatility
- Historical volatility
- Implied volatility → $\boxed{\text{forecasted vol}}$
  - ARCH
  - GARCH
  - EWMA

1 yr data
:
:
:

$\boxed{\text{Vol}}$