DRM GROUP PROJECT

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TASK A

To construct a synthetic long call portfolio using Put-Call Parity and compare it with the actual call option

Put–Call Parity

Call = Stock + Put – PV(K)

Synthetic call : = Long Stock + Long Put

Performance Comparison Table

	Metric	Actual Call	Synthetic Call	Winner
0	Total Trades Profitable	167.0000	168.0000	Synthetic
1	Avg. Return per Trade	-1.3422	1.2170	Synthetic
2	Avg. RoC per Trade	0.1975	0.0012	Actual
3	Max Single Trade Profit	135.1500	139.5000	Synthetic
4	Max Single Trade RoC	38.5000	0.0970	Actual
5	Max Single Trade Loss	-53.7000	-46.3000	Synthetic
6	Min Single Trade RoC	-1.0000	-0.0314	Synthetic

Analysis

- Synthetic Call requires higher capital than actual call, hence the RoC is lower for a synthetic call.
- Almost every time the real call profits, the synthetic profits too, and almost every time the real call makes a loss, the synthetic loses too, as seen in the 0^{th} row.
- The average return per trade is positive for the synthetic call, as it involves the security of a stock along with the option trade.
- The average return however turns out to be much smaller for the synthetic call as the risk is minimized since the initial cost is higher.
- This is also observed in the Maximum RoC where the actual call has a higher max RoC than the actual call.
- Similarly, the max loss for actual call is greater as the risk is much higher due to the lower initial capital.
- This can be seen further from the lower min single trade RoC for actual call.

- The maximum profit was observed for actual call on 2024-01-11 as Infosys was near its earnings announcement, this caused both stock price and implied volatility to shoot up, and as call is the right to buy, an increase in stock price is always considered good (intrinsic value), and so is increase in volatility (time value), for the same reason the synthetic call also encountered its maximum profit on 2024-01-03 although it's less dependent on volatility due to the put offset.

- The maximum loss for the actual call occurred on 2022-08-26, because Infosys noticed a decline in its stock price in this period, coupled with low implied volatility, this led to a sharp decline in call premium.

- The maximum loss occurred for synthetic call on 2023-10-03, due to a significant decline in stock price. As synthetic call contains a long stock and long put, most of the payoff sensitivity came from the stock itself. When the stock price fell, the value of the long-stock component dropped, causing it to experience its maximum loss on this date.

TASK B

The BSM model gives the fair value of European call and put options by assuming the underlying follows a lognormal diffusion and constructing a risk-free hedged portfolio that must earn the risk-free rate. This yields a closed-form, no-arbitrage option pricing formula.

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

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

where $$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

Results

1) Delta vs Stock Price

- Delta for call options increases monotonically from 0 → 1 as S rises and the curve is a smooth S-shaped curve.
- At ATM (S ≈ K), Delta ≈ 0.5.
- Higher volatility or time to expiry makes the curve flatter

2) Vega vs Volatility

- Vega is maximum at ATM and declines as volatility increases (for short-dated options).
- The graph reflects $\varphi(d_1)$ PDF decay,as σ increases, sensitivity to volatility gradually falls.
- Longer expiry implies a higher Vega overall (scales with $\sqrt{T}$).

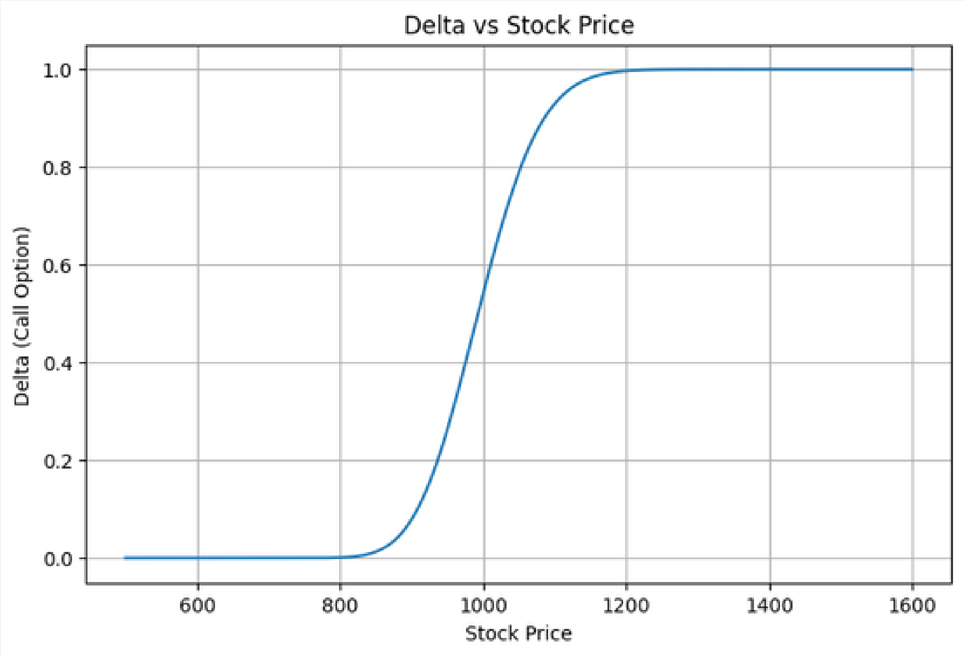
Analysis

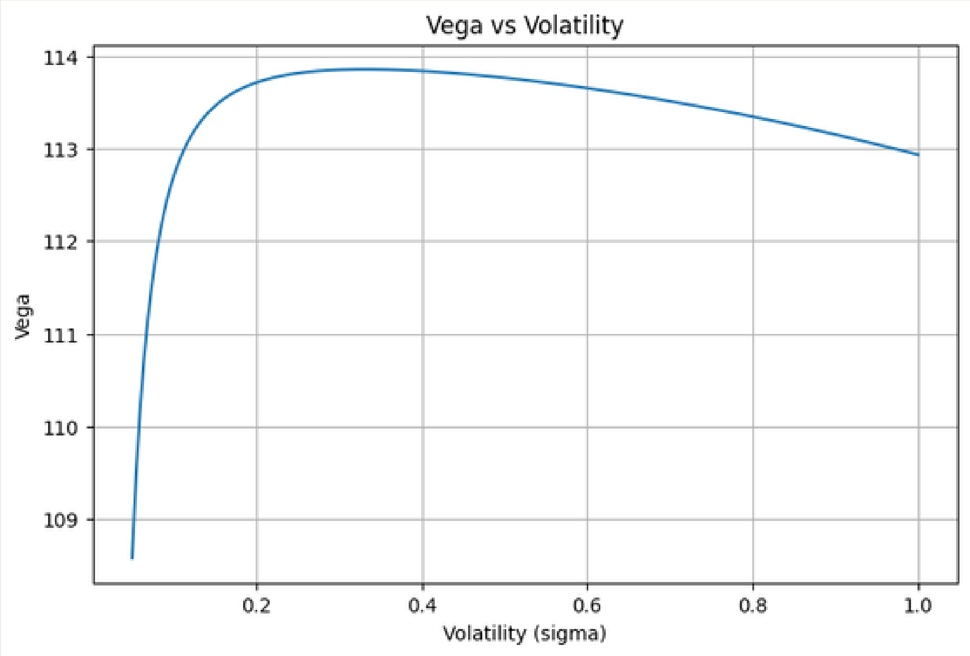
The plots show that an option's sensitivity does not stay constant, it changes depending on market conditions.

The **Delta plot** indicates that price sensitivity is highest near the strike. Around the ATM region, even small moves in the stock lead to large shifts in delta, which explains why most hedging risk is concentrated there. Higher volatility or longer time to expiry spreads this sensitivity across a wider range of stock prices.

The **Vega plot** shows that volatility matters most when the stock is near the strike. As volatility becomes very high, additional increases have less effect on option value, causing vega to decline. Longer-dated options have greater vega, so volatility changes affect them more.

Overall, delta captures price sensitivity and vega captures volatility sensitivity, and each becomes important in different market situations which is why Greeks are essential for managing option risk.





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THANK YOU