Option Pricing & Risk

Black-Scholes baseline · Greeks · Simple hedging recommendation

Analysis run date: 2026-01-09

TEAM - GAMMA (IIIT ALLAHABAD)

Executive Summary

Pricing Conclusion

The 645 call appears **not expensive** relative to realised volatility. Black-Scholes price ($14.16) exceeds market price ($12.95), whilst implied volatility (34.01%) sits below historical volatility (37.41%).

Key Risks

- Delta magnitude: 0.5306 per share (53% directional exposure)
- Theta decay: $131.13 per contract daily (significant near expiry)
- Vega sensitivity: $35.5883 per volatility point per contract

Recommended Action

Implement delta-hedge by shorting 53 shares per contract. Monitor implied volatility daily and maintain hedge through expiry. Consider position unwind if implied vol reprices materially higher.

Values from analysis (run date: 2026-01-09)

Data & Key Inputs

Core parameters for the META 645 call option analysis, derived from market data and historical volatility calculations over 12 months of daily returns.

Parameter	Value	Unit
Ticker	META	—
Spot Price (S_0)	646.06	USD
Strike Price (K)	645.0	USD
Expiry Date	2026-01-16	(7 days)
Option Type	Call	—
Market Mid Price	12.95	USD per share
Black-Scholes Price	14.1582	USD per share
Implied Volatility	34.0148%	Annualised
Historical Volatility	37.41%	Annualised (12M)
Risk-Free Rate	4.5%	Assumed
Contract Multiplier	100	Shares

Values from analysis (run date: 2026-01-09) | Data source: yfinance

Pricing Results & Interpretation

Model vs Market Comparison

Pricing Method	Price (USD)
Black-Scholes (Historical Vol)	14.16
Market Mid Price	12.95
Difference	+1.21

Key Insight: The model price exceeds market price by $1.21 per share, suggesting the option trades at a discount to theoretical value when using realised volatility.

Why Model > Market?

Volatility gap: Historical volatility (37.41%) exceeds implied volatility (34.01%) by 3.4 percentage points

Market perception: Options market pricing in lower future volatility than recent realised levels

Technical factors: Bid-ask spreads, liquidity conditions, and early exercise considerations may compress market price

This divergence suggests the market perceives META volatility declining from historical levels, creating potential value for volatility buyers.

Values from analysis (run date: 2026-01-09)

Greeks: Definitions & Values

The Greeks measure how option prices respond to changes in underlying factors. These sensitivities are critical for risk management and hedging strategies.

Delta (Δ)

Definition: Rate of change in option price relative to $1 move in underlying stock. Represents directional exposure and hedge ratio.

Per Share: 0.5306

Per Contract: 53.06

Theta (Θ)

Definition: Rate of option value decay per day due to passage of time. Measures time-decay risk, especially critical near expiry.

Per Share: −1.3113 USD/day

Per Contract: −131.13 USD/day

Vega (v)

Definition: Change in option price for a 1 percentage point change in implied volatility. Measures sensitivity to volatility shifts.

Per Share: .355883 USD per vol-point

Per Contract: 35.5883 USD per vol-point

Values from analysis (run date: 2026-01-09) | Greeks calculated using Black-Scholes model

***Black–Scholes (European), no discrete dividends considered, risk-free rate assumed = 4.5%**, vega displayed as *per 1 vol-point (1%)*. **Black–Scholes (European), no discrete dividends considered, risk-free rate assumed = 4.5%**, vega displayed as *per 1 vol-point (1%)*.

Simple Numerical Examples

Translating Greeks into practical profit and loss scenarios helps visualise risk exposures. These examples use the exact Greek values from our analysis.

Stock Moves Up $1

Delta Effect: Per share: +$0.5306

Per contract: **+$53.06**

A $1 increase in META stock price increases the call option value by approximately 53 cents per share.

One Day Passes (No Move)

Theta Effect: Per share: −$1.3113

Per contract: **−$131.13**

Time decay erodes $131.13 per contract daily, representing significant value loss near expiry.

Volatility Increases 1 Point

Vega Effect: Per share: +.$355883

Per contract: **+$35.5883**

A 1 percentage point rise in implied volatility (e.g., 34% to 35%) adds $35.5883 per contract.

> **Critical Observation:** Theta is large in absolute terms relative to the option premium ($12.95 per share). This indicates meaningful time decay risk with only 7 days remaining until expiry. Daily monitoring is essential.

Values from analysis (run date: 2026-01-09)

Primary Risks

Directional Risk (Delta)

Magnitude: 0.5306 per share represents 53% directional exposure to META stock movements. Each $1 move in the underlying translates to $53.06 P&L per contract.

Sign: Positive delta means long exposure — profits from upward moves, losses from downward moves.

Volatility Risk (Vega)

Magnitude: $3,558.83 per volatility point per contract shows extreme sensitivity to implied volatility changes. Near-term options exhibit amplified Vega due to event risk.

Current gap: Implied vol (34.01%) below historical (37.41%) creates upside if volatility reprices higher.

Time Decay Risk (Theta)

Magnitude: −$131.13 per contract per day represents substantial erosion with only 7 days to expiry. This accelerates as expiration approaches.

Impact: Without favourable stock or volatility moves, the position loses over 10% of its value ($131/$1,295) daily.

Operational Risks

Liquidity: Bid-ask spreads may widen near expiry

Early exercise: American-style calls may be exercised early

Event risk: Corporate announcements in next 7 days could trigger sharp moves

Recommended monitoring frequency: Daily for Delta and Theta; Event-driven for Vega

Hedging Strategy

A delta-neutral hedge eliminates directional risk whilst maintaining exposure to volatility and time decay. This strategy is appropriate for managing the 645 call position.

01

Calculate Hedge Ratio

Delta = 0.5306 per share means each call contract has exposure equivalent to owning 53.06 shares of META stock. Round to nearest whole share for execution.

02

Execute Delta Hedge

Action: Short 53 shares of META per long call contract held.

Mechanism: This creates offsetting directional exposure, neutralising Delta to approximately zero.

03

Rebalance Regularly

Frequency: Daily or event-driven (earnings, guidance, material news).

Trigger: When delta drift exceeds 10 shares from target hedge ratio.

04

Consider Transaction Costs

Account for brokerage fees, bid-ask spreads, and market impact when rebalancing. Frequent adjustments increase costs but improve hedge effectiveness.

Alternative: Vega Control

For traders concerned about volatility risk, consider a **vertical call spread** by selling a higher-strike call. This reduces Vega exposure whilst capping upside potential.

Example: Sell the 650 call against the long 645 call to create a bull call spread with defined risk and reduced volatility sensitivity.

Hedge execution: Use limit orders to minimise slippage; monitor for overnight gap risk

Monitoring & Triggers

Establish clear thresholds and monitoring protocols to manage the position effectively through expiry. Daily oversight is essential given the short time horizon.

Volatility Monitoring

Threshold: If implied volatility moves ±5 percentage points versus historical volatility, reassess position.

Current levels: Implied 34.01% vs Historical 37.41%

Action: Material vol repricing may warrant position adjustment or unwind.

Delta Drift Management

Threshold: If delta drift exceeds 10 shares from target hedge (53 shares), rebalance the hedge.

Frequency: Check delta daily at market close and after significant intraday moves (>2%).

Action: Adjust short stock position to restore delta neutrality.

Expiry Proximity

Threshold: When days to expiry ≤ 3, tighten monitoring and consider position unwind.

Rationale: Gamma risk accelerates, theta decay intensifies, and liquidity may deteriorate in final days.

Action: Evaluate whether to hold through expiry or close position early.

Event Risk Surveillance

Monitor: Corporate events in next 7 days including earnings releases, guidance updates, regulatory filings, or material announcements.

Action: Increase hedge ratio or reduce position size ahead of high-impact events.

Recommended Monitoring Cadence:

- Daily pre-market: Review overnight news and volatility surface changes
- Daily close: Calculate delta drift and assess rebalancing needs
- Event-driven: Immediate review upon material corporate announcements
- Weekend: Comprehensive position review and week-ahead event calendar check

Set alerts for implied vol moves >3 points and META stock moves >3%

Final Recommendation & Next Steps

Recommendation

Hold the long 645 call but implement a delta-hedge of −53 shares per contract and monitor implied volatility daily. Do not add size unless implied volatility reprices materially higher than realised volatility. The option appears fairly valued to cheap on a volatility basis, but significant theta decay and short time horizon warrant active risk management.

Immediate (Today)

Execute delta-hedge by shorting 53 META shares per call contract. Confirm hedge execution and document entry prices for P&L tracking.

1

2

Daily (Through Expiry)

Monitor implied volatility versus historical volatility (target: 34% vs 37%). Check delta drift and rebalance if exceeds 10-share threshold. Review corporate event calendar.

Pre-Earnings (If Applicable)

Re-evaluate position 24-48 hours before any earnings announcement. Consider reducing exposure or tightening hedge if event falls within expiry window.

3

4

3 Days to Expiry

Conduct comprehensive position review. Decide whether to hold through expiry or unwind early based on P&L, volatility levels, and liquidity conditions.

Supporting Documentation

This analysis was produced using **META_option_analysis.py** with data sourced from yfinance. Calculations employ standard Black-Scholes methodology with 12-month historical volatility estimation.

Available files:

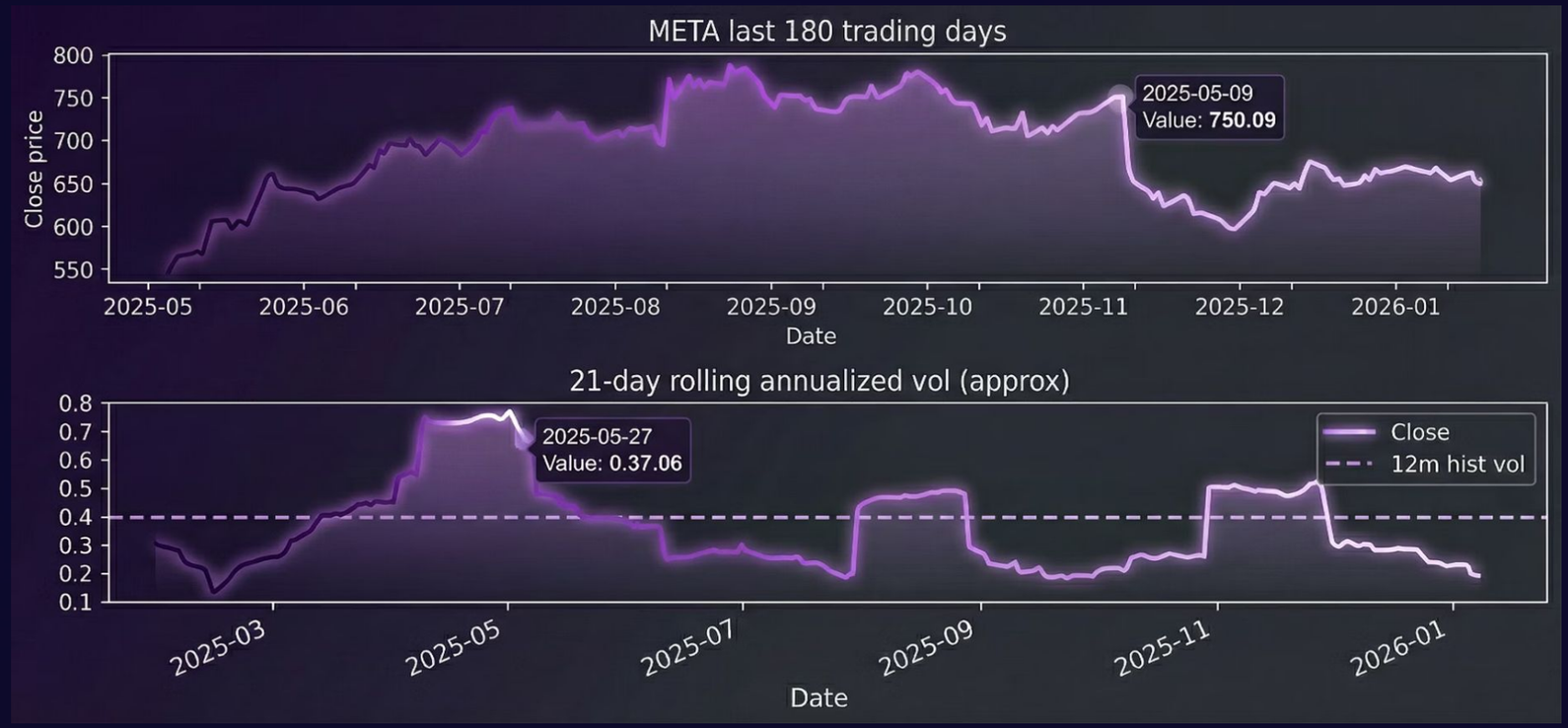
- meta_option_summary.csv (detailed parameters)
- meta_price_history.png (historical price chart)
- meta_volatility.png (volatility surface)
- meta_one_page_memo.md (technical memo)

Values from analysis (run date: 2026-01-09) | Contact trading desk for execution support

Appendix

Supporting Materials

Resources



Top panel — Price (Last 180 trading days)

- META rallied from mid-2025 then corrected sharply in late Q4
- Price trend shows event-driven volatility episodes

Current levels near **$646** after mean reversion

Bottom panel — Rolling Annualized Volatility (21-day)

Volatility spiked to **~0.74 annualized** during mid-2025 events

Mean reverted toward **~0.37**, aligned with 12-month realized vol

- Lower vol into expiry has direct impact on option pricing (Vega + BS fair value)

All analysis code, raw data, and supporting documentation used in this presentation are openly available for review and further exploration in our dedicated GitHub repository.

https://github.com/chandraxshu/Introductory-Options-Hackathon

Thank you for your time and attention. We appreciate your consideration and welcome any further questions .