

Quantitative Finance – Mini Projects

Executive Highlights

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Mini Project 1 – High- & Low-Risk Portfolio

Goal: Build two equal-weight baskets (defensive vs. aggressive) to contrast risk–return trade-offs.

Method in 3 bullets

- 5-year β via yfinance daily returns; 52-wk momentum screen.
- 2×5-asset portfolios, 20 % weight each.
- Benchmark S&P 500 for covariance.

Key outcome

- Low-Risk: $\bar{\beta} = 0.23$, 7.3 % return; High-Risk: $\bar{\beta} = 2.11$, 11.8 % return.

Take-away: clear visual of volatility-upside trade-off and value of diversification.

Mini Project 2 – Normality of ETF Returns

Goal: Test whether daily log-returns of SPY, QQQ, IWM, TLT, GLD are Gaussian.

Method

- 2010–2025 sample; Shapiro–Wilk, AD, JB, KS tests.
- 252-day rolling windows and 1 % Winsorising.

Findings

- All ETFs reject $N(\mu, \sigma^2)$ over full period; only 1–2 % of calm windows pass.
- Fat tails survive light trimming and equal-weight aggregation.

Implication: heavy-tailed models or vol-scaling required for realistic VaR/ES.

Mini Project 3 – Black–Scholes Sensitivities

Goal: Visualise how call/put price and Δ vary with spot S_0 and time T .

Set-up

- $S_0 = 100$, $K = 110$, $\sigma = 30\%$, $r = 0$, $T \in [1/12, 5]$ yrs.
- Vectorised Python for C , P , Δ ; 70-point grids.

Highlights

- Time-value decays non-linearly as $T \rightarrow 0$.
- Δ : S-curve ($0 \rightarrow 1$ for calls, $-1 \rightarrow 0$ for puts); steepest at-the-money.

Skill gain: reusable option-pricing snippets and clearer intuition for Greeks.

Mini Project 4 – Δ - & σ -Hedging

Goal: Quantify residual P&L of daily Δ -hedging under stochastic volatility (Heston, GARCH); test vega-neutral overlay.

Method

- 1 yr European call, $S_0 = K = 100$, 1 000–30 000 MC paths.
- Daily re-hedge; second option for σ -hedge.

Results

- Heston: fat left tail (–6 %) and $\sigma_{P\&L} \approx 2.0$.
- GARCH: much tighter, $\sigma_{P\&L} \approx 0.19$.
- Vega-neutral hedge cuts risk 75 %.

Lesson: residual risk scales with *vega* \times *vol-of-vol*; hedging vega is powerful but cost-sensitive.

Across four projects, we:

- built reproducible data pipelines
- challenged textbook assumptions
- deepened intuition for Greeks
- quantified the limits of real-world hedging

These tools now form a toolkit for everything from portfolio design to exotic option pricing.

Thank You!