Quant Finance Bootcamp

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Portfolio Construction: High vs. Low Risk

- **Objective:** Optimize two portfolios (High-risk & Low-risk) for maximum Sharpe ratio
- **Data:** 2 years of US equities, weekly log returns
- **Constraints:** Beta, volatility, max drawdown

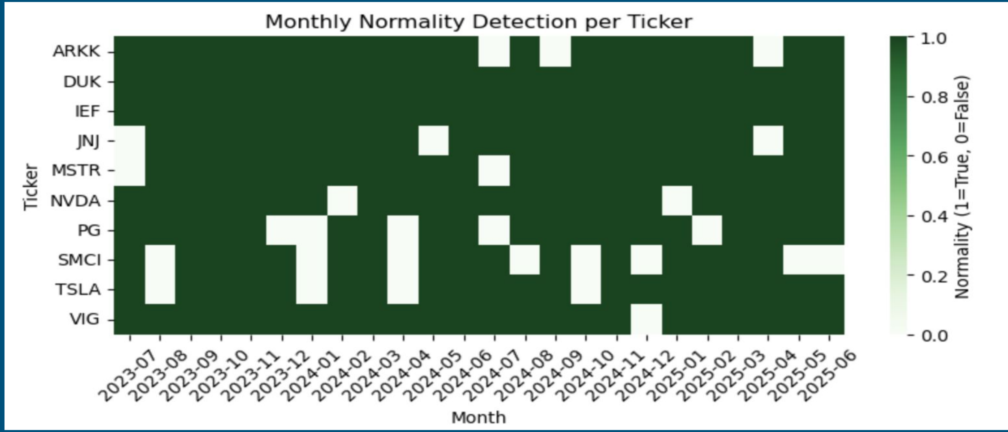
Portfolio	Equal-Weight Sharpe	Optimized Sharpe	β	Volatility σ	Max DD	Annualized return
High-Risk	0.87	1.05	2.10	59%	-59%	44.3%
Low-Risk	0.31	0.47	0.33	10.6%	-9.8%	5.02%

Table 1: Portfolios ouctome

Key Insight: Data-driven, constraint-based optimization outperforms naïve allocations

Empirical Testing: Are Log Returns Normal?

- **Tested 20 stocks with 3 statistical tests**
- **Result:** Most failed normality (fat tails, skew)
- **But:** “Local normality” appears in stable regimes or after outlier removal



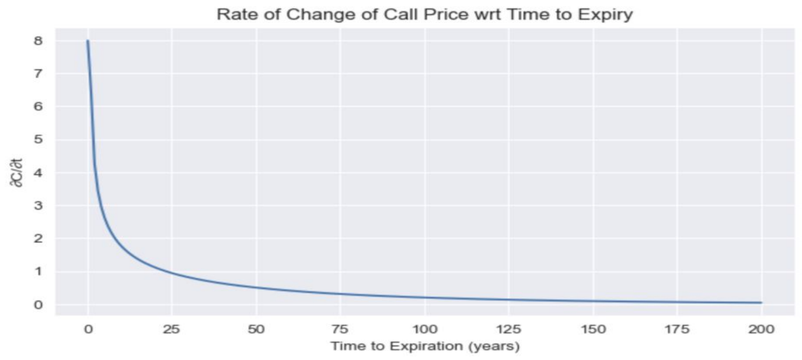
Key Insight:Statistical assumptions must be tested—not assumed.

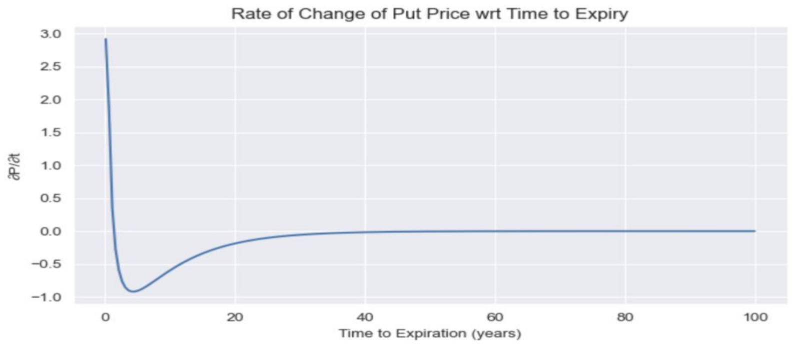
Table 2: Normality Test Results

Ticker	Shapiro-Wilk (p)	Jarque-Bera (p)	Anderson-Darling (stat)	Normality
NVDA	0.0	0.0	3.1279	Not Normal
TSLA	0.0	0.0	3.8157	Not Normal
ARKK	0.0	0.0	1.2209	Not Normal
MSTR	0.0	0.0	4.3422	Not Normal
SMCI	0.0	0.0	8.7245	Not Normal
JNJ	0.0	0.0	4.6774	Not Normal
PG	0.0	0.0	4.6009	Not Normal
DUK	0.0655	0.0072	0.4123	Normal
VIG	0.0	0.0	5.6943	Not Normal
IEF	0.3937	0.5287	0.3114	Normal

Option Greeks: Time & Price Sensitivities

- **Analyzed**: How option values respond to time to expiry (theta) & underlying price (delta)
- **Findings:**
  - Theta spikes near expiry—time decay risk
  - Delta is S-shaped—max hedging sensitivity at-the-money





Key Insight: Quantitative Greeks are vital for risk management and hedging.

Hedging Performance Under Stochastic Volatility

- **Compared:** Delta vs. Vega hedging (Black-Scholes, Heston, GARCH)
- **Findings:**
  - Delta hedging fails under GARCH (heavy losses, high dispersion)
  - Vega hedging gives highest Sharpe—but with severe tail risk

Strategy	Mean	Std Dev	Sharpe	VaR 5%	CVaR 5%	KS p-value
Delta + Constant σ	0.003	0.426	0.007	-0.665	-1.007	0.0049
Delta + Heston σ	-0.095	1.093	-0.087	-2.087	-2.654	0.4036
Delta + GARCH σ	-55.858	4.807	-11.621	-63.773	-65.939	0.2602
Vega + Constant σ	-1.497	0.551	-2.718	-2.508	-2.752	0.1833
Vega + Heston σ	-2.706	1.485	-1.822	-4.766	-5.157	0.0000
Vega + GARCH σ	15.971	19.672	0.812	-20.169	-45.205	0.0000

Table 3: Advanced Risk and Performance Statistics for Each Strategy

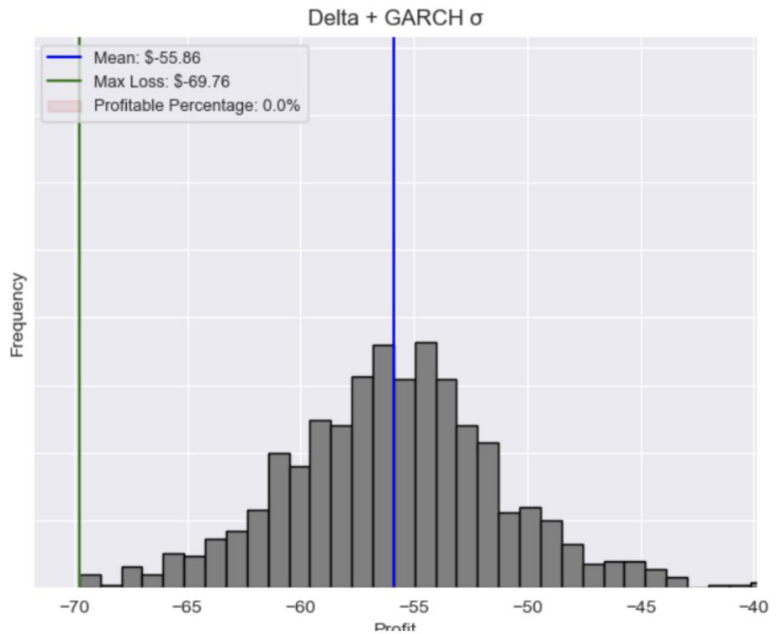


Figure 4: Delta + GARCH σ

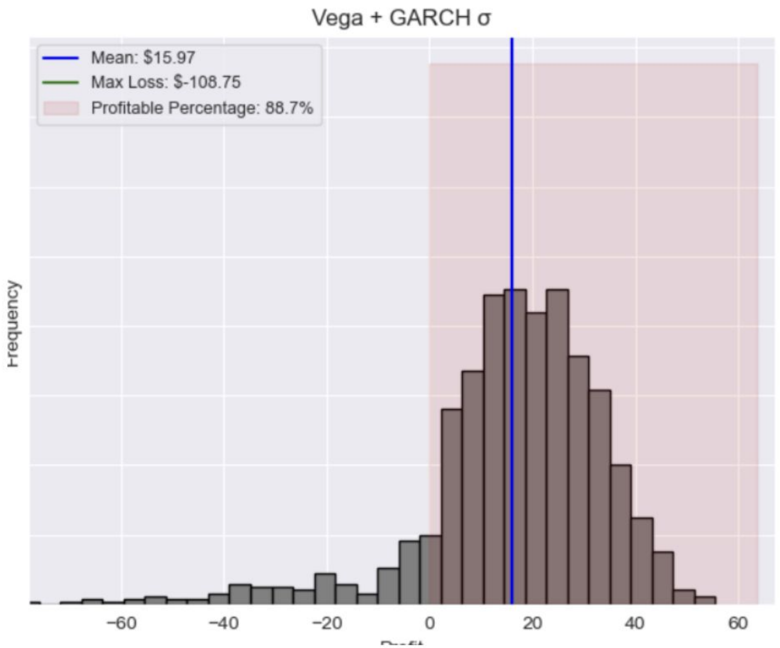


Figure 5: Vega + GARCH σ

Key Insight: Matching your hedging strategy to real-world volatility is crucial.

Conclusion & Key Takeaways

- Data-driven portfolio design beats intuition
- Always test your statistical/modeling assumptions
- Deep knowledge of Greeks is essential for managing risk
- Hedging strategies must be robust to changing market regimes

Thank you!