

# Quantitative Finance Mini Projects

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2025 Summer Erdos Institute

# Project 1: Risky Portfolio Construction

- Focus on *compensated risks* and long term outcomes
- Invest like someone saving for retirement

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## Low Risk

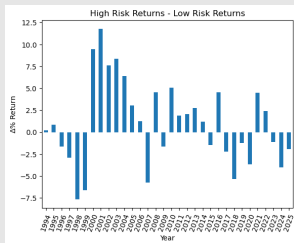
90/10 total mkt  
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## High Risk

90/10 with Fama-French size & value  
factors + Treasury STRIPS

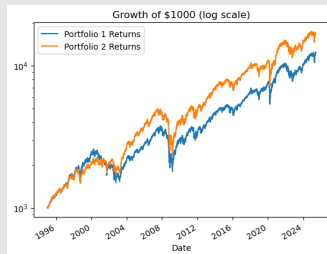
# Results

## Over/Under Performance



- Tracking error introduces behavioral risk

## Backtest



- Low risk  $\sigma = 0.159$
- High risk  $\sigma = 0.155$
- Traditional risk metrics largely unchanged!

# Project 2: Assumptions of Lognormal Returns

- Lognormal daily returns are **very rare** over contiguous periods of time
  - Like a coin flip over rolling 6 month periods
- Hypothesis testing unreliable with large samples

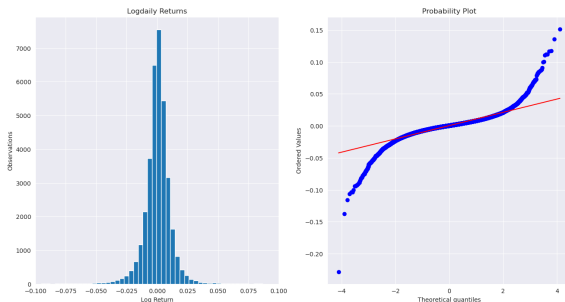


Figure: S&P 500 Log Returns

# Local Behavior of Log Returns

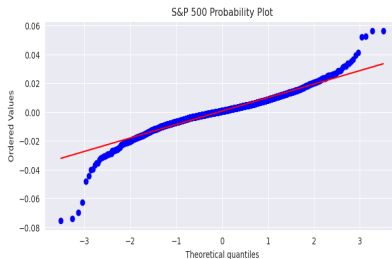
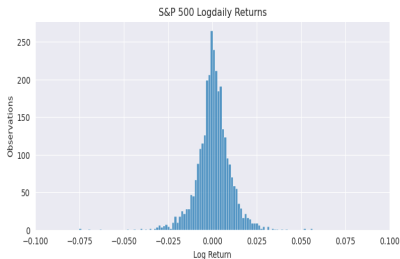


Figure: S&P 500 Log Returns: 1987/12 to 2000/03

# Local Behavior of Individual Stock Log Returns

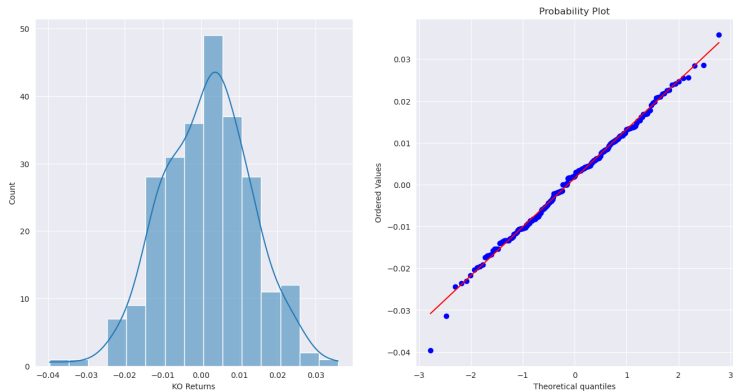


Figure: KO Log Returns: 1995/04 to 1996/04



# Project 3: TTE and Spot Dependence of BS Option Prices

- Discovered **theta decay** and options as **leveraged long/short positions**

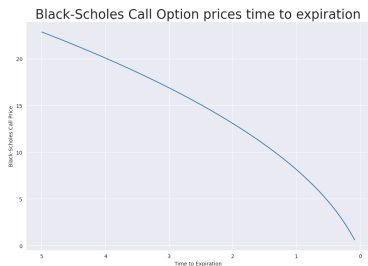


Figure: \$110C @ \$100 spot. Time to Expiration Dependence

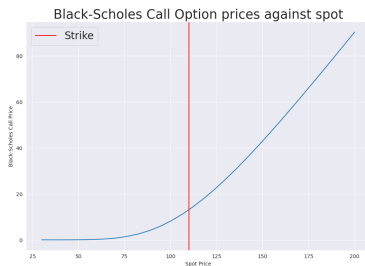


Figure: \$110C @ \$100 spot. Spot Dependence

# Phenomena in Context of Trading Strategies

- Theta decay: a double edged sword
  - Hurts option buyers
  - Helps option sellers
  - Covered calls/puts exploit this theta decay
  - Justifies multi-leg strategies to protect against losses
- Deep ITM options as leveraged positions
  - $|\Delta|$  values close to 1 give near equivalent directional exposure to 100x the underlying
  - Theta decay reduced at long expirys, ergo...
  - Deep ITM LEAPS get best of  $\Delta$  exposure and least theta decay

# Project 4: Effects of Volatility Models on $\Delta$ Hedging

## Main Accomplishment

- Implemented **generic Monte Carlo method** for both options pricing and delta approximation
- Allowed for a fully simulated  $\Delta$  hedging payoff model
- Plug-and-play with various stochastic processes

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## Models tested

Constant volatility, constant elasticity of variance (CEV), Hull-White stochastic vol, GARCH(1,1), SABR

# Some Profit Distributions

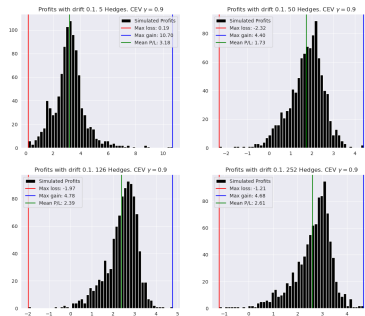


Figure: CEV Profit Distributions

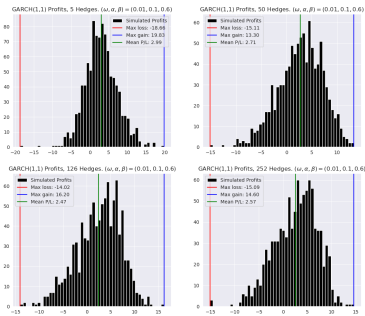


Figure: GARCH(1,1) Profit Distributions

# Conclusion

Thank you for your attention!