Advanced Portfolio Risk Analysis Report

Comprehensive Portfolio Risk Analysis: VaR, CVaR, Drawdown & Stress Testing on AAPL, MSFT, TSLA

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Executive Summary

This project evaluates the risk and return profile of a three-stock portfolio composed of AAPL, MSFT, and TSLA. It uses multiple risk metrics to simulate market behavior under both normal and adverse conditions. Metrics include:

- Value at Risk (VaR)
- Conditional Value at Risk (CVaR)
- Sharpe & Sortino Ratios
- Maximum Drawdown
- Rolling CVaR
- Stress Testing

Dataset Overview

Source: Yahoo Finance (via yfinance)
Period: Jan 2022 – Dec 2024
Tickers: AAPL, MSFT, TSLA
Frequency: Daily
Features: Open, High, Low, Close, Volume

Portfolio Construction

- Portfolio weights: AAPL: 40, MSFT: 30, TSLA: 30
- Equal-weighted portfolio (1/3 in each stock) for stress analysis
- Daily returns computed using closing prices
- Simulated shocks and market behavior using realistic distributions
- Calculated VaR for initial investment of 100,000 rupees

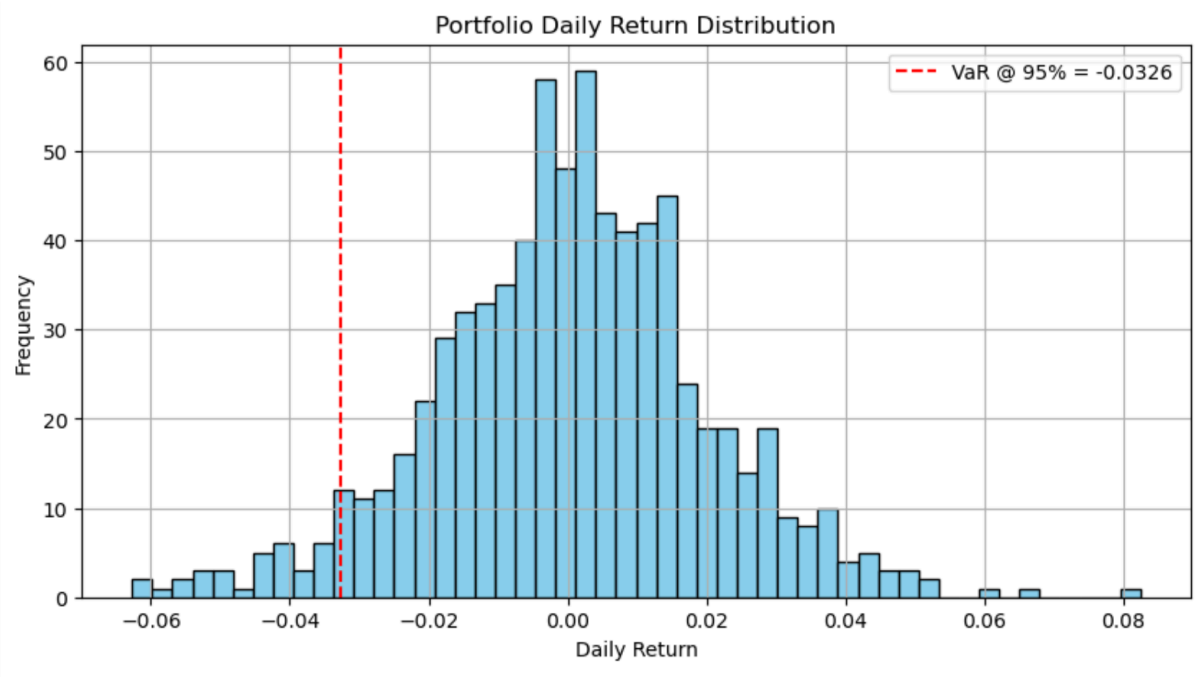
Value at Risk (VaR)

Historical Method:

VaR is calculated as the 5th percentile (for 95% confidence) of past returns.

Formula:

VaR historical = Percentile 5% (Returns) VaR historical = Percentile 5% (Returns)



- **Confidence Level:** 95%
- **Portfolio Size:** ₹100,000
- **Calculated 1-Day VaR:** -3.26%

Interpreted as:
"There is a 95% probability that the portfolio will not incur a loss exceeding ₹3,262 in a single day."

Parametric Method (Variance-Covariance)

Assumes returns are normally distributed. Uses the mean (μ) and standard deviation (σ) of portfolio returns. More efficient but less accurate with non-normal data.

Formula:

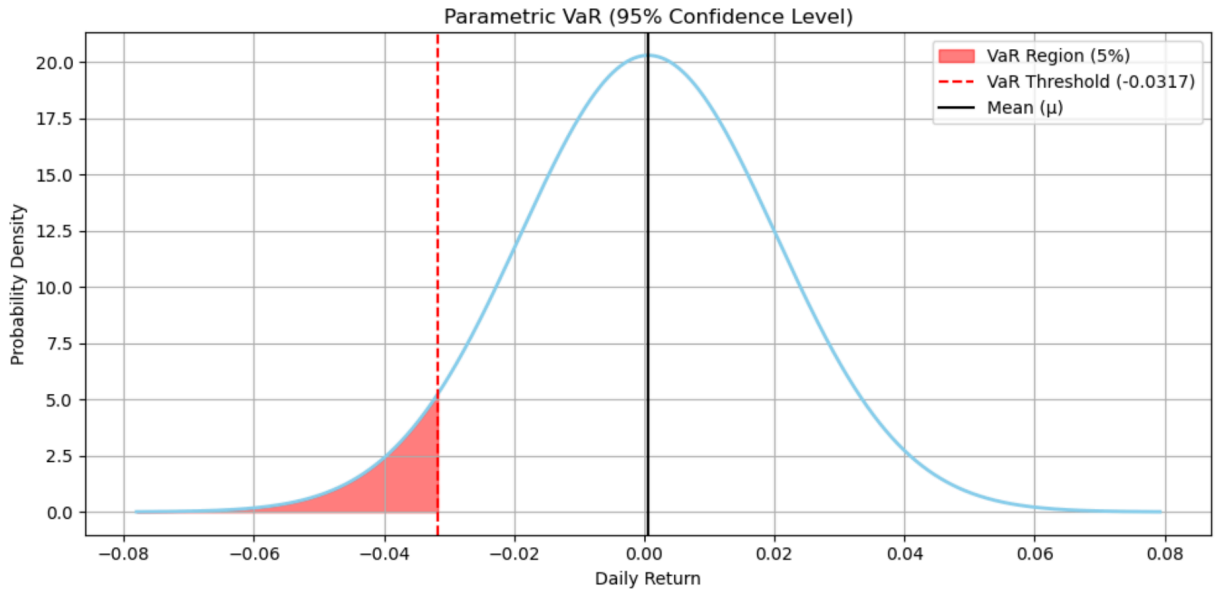
$$\text{VaR parametric} = -(\mu + z \cdot \sigma)$$

Where:

μ μ = mean daily return

σ σ = standard deviation

z z = Z-score (, -1.645 for 95% confidence)



- **Confidence Level:** 95%
- **Portfolio Size:** ₹100,000
- **Calculated 1-Day VaR:** -3.17%

Interpreted as:
"There is a 95% probability that the portfolio will not incur a loss exceeding ₹3,172 in a single day."

Monte Carlo Simulation

Generates thousands of possible future return scenarios based on a normal distribution. Captures uncertainty through simulation .More computational but flexible.

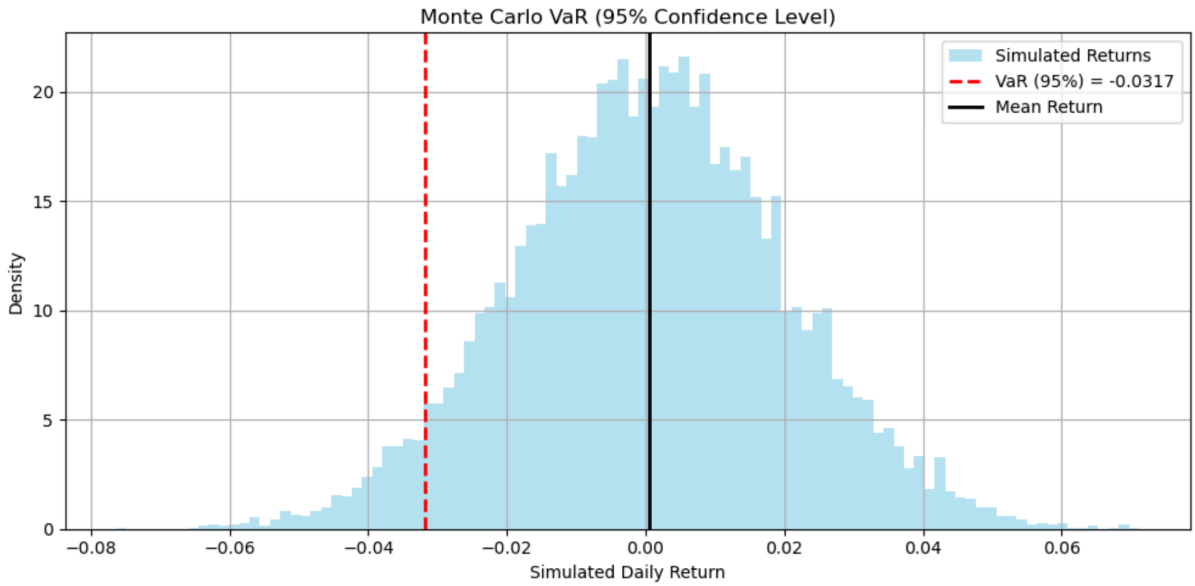
Steps:

Simulate returns using

$N(\mu, \sigma)$ N(μ,σ)

Sort simulations

Take the 5th percentile



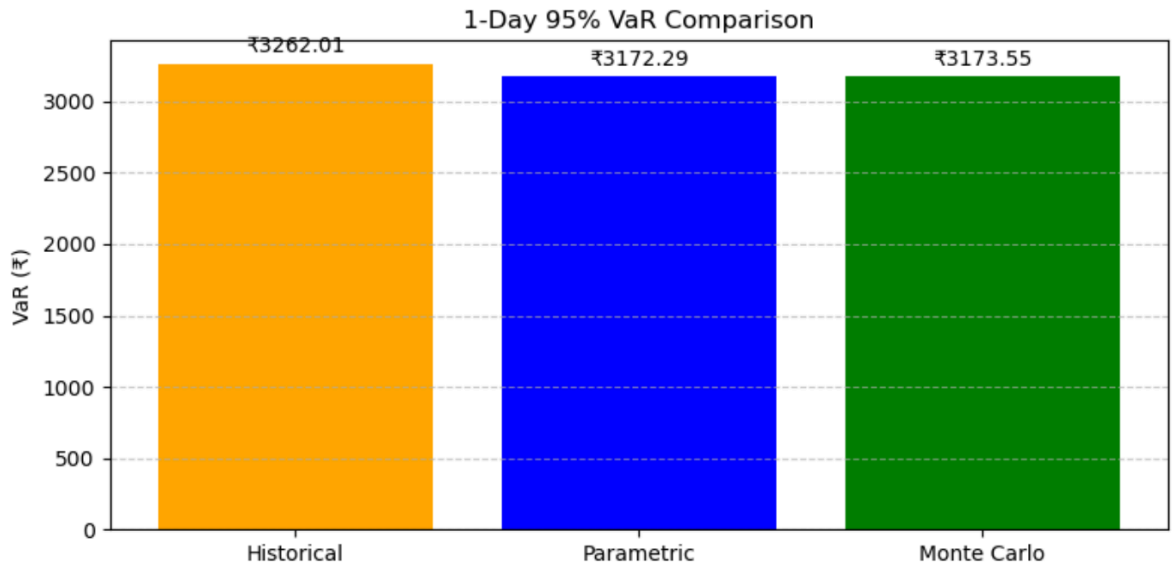
- **Confidence Level:** 95%
- **Portfolio Size:** ₹100,000
- **Calculated 1-Day VaR:** -3.14%

Interpreted as:
"There is a 95% probability that the portfolio will not incur a loss exceeding ₹3,147 in a single day."

Comparison And Summary

1-Day 95% VaR Comparison

Historical Method	₹3,262.01
Parametric Method	₹3,172.29
Monte Carlo Method	₹3,173.55



Summary: Portfolio Risk Assessment using Value at Risk (VaR)

In this project, we analyzed the potential daily risk of a ₹100,000 portfolio invested in AAPL, TSLA, and MSFT using three VaR methodologies:

- **Historical VaR** directly used past returns.
- **Parametric VaR** assumed a normal distribution of returns.
- **Monte Carlo VaR** simulated thousands of possible outcomes.

Conclusion:

All three methods yielded similar risk estimates between ₹3,172 – ₹3,262 for a 1-day, 95% confidence level, implying there is a 5% chance of losing more than ~₹3,200 on a given day.

These results can be used to inform capital allocation, hedging decisions, or broader financial risk management strategies.

Advanced Portfolio Risk Analysis

Conditional VaR (CVaR)

- Calculates expected loss beyond the VaR threshold
- CVaR is more sensitive to tail-end losses
- Rolling 60-day CVaR shows fluctuations in tail risk

Why CVaR?

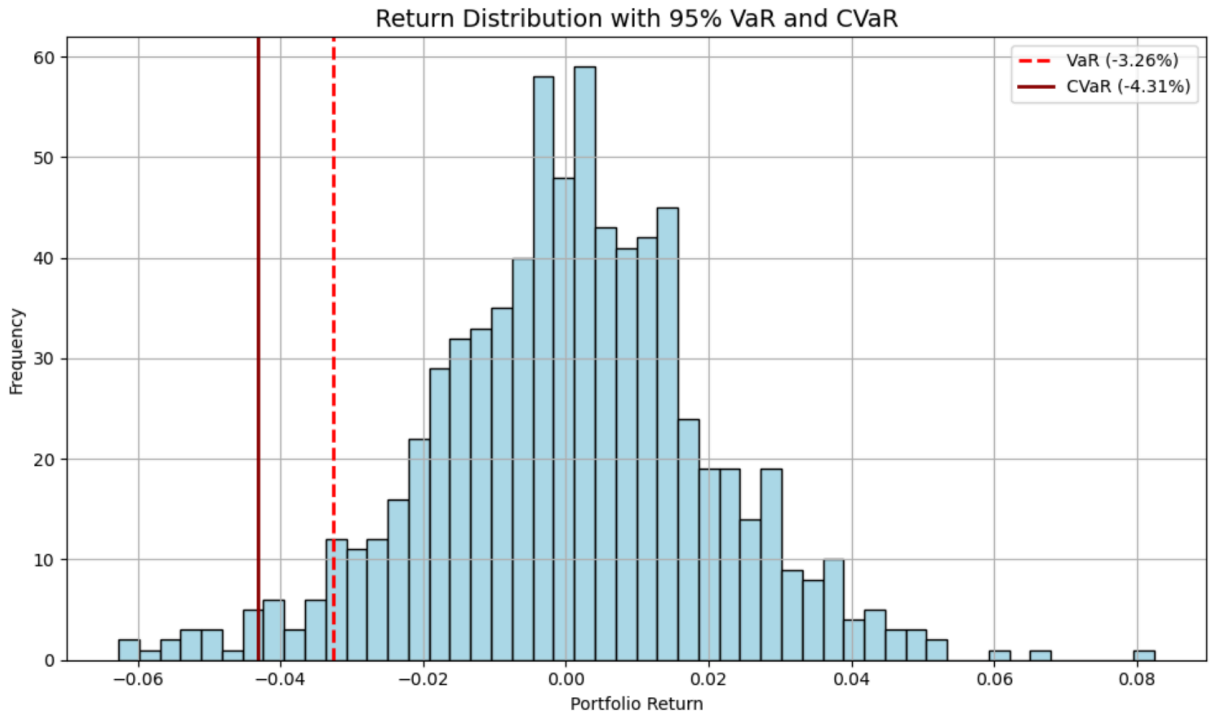
CVaR provides a clearer picture of worst-case losses than VaR by averaging the losses in the worst 5% of scenarios.

$$CVaR_\alpha = E[R \mid R \leq VaR_\alpha]$$

- α be the confidence level (e.g., 95% or 0.95)
- VaR_α be the Value at Risk at confidence level α
- R be the distribution of portfolio returns

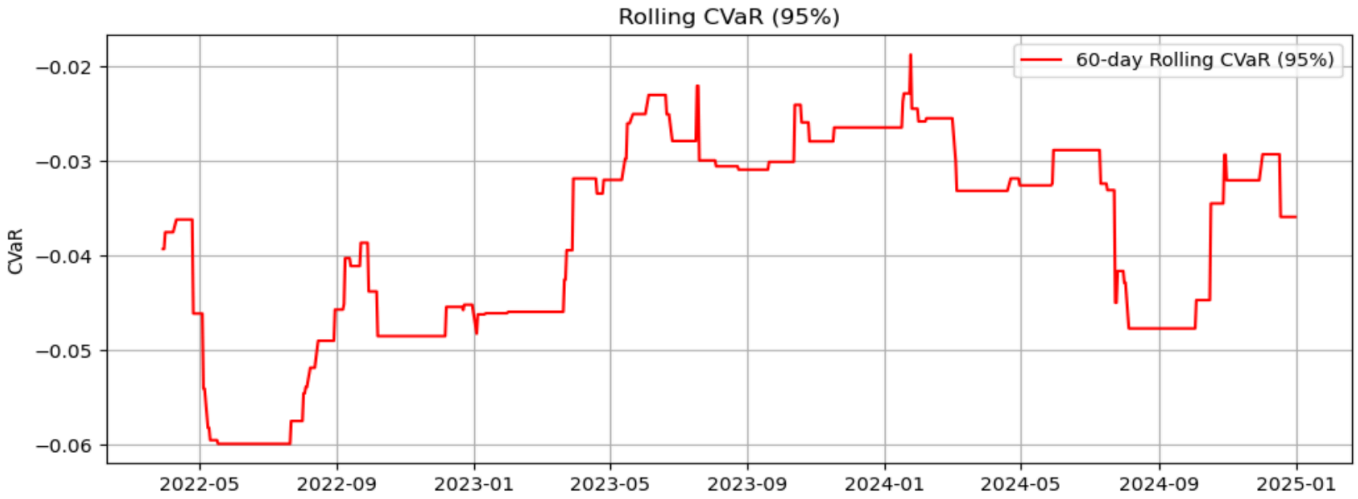
Calculated VaR and CVaR:

95% VaR: -0.0326
95% CVaR: -0.0431



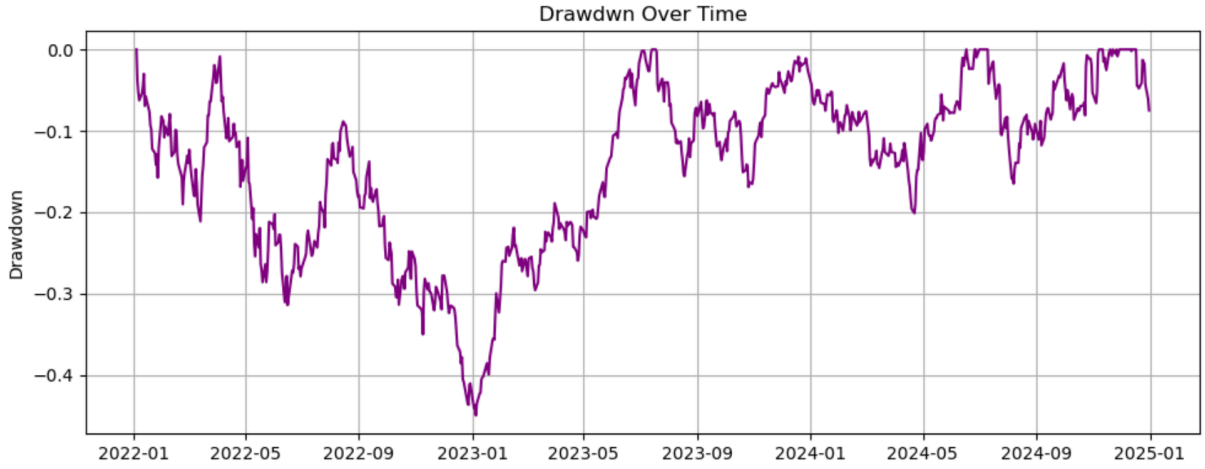
Rolling 60-day CVaR Plot

This tracks the change in portfolio risk over time.



Maximum Drawdown

- Largest drop from peak to trough during the period
- Indicates worst historical loss before recovery



Maximum drawdown: -44.98%

Sharpe & Sortino Ratios

Sharpe Ratio : Measures risk-adjusted return using standard deviation.
Sortino Ratio: Similar, but only considers downside deviation.

Higher values suggest better return per unit of risk.

Metric	Value
Sharpe Ratio	0.0290
Sortino Ratio	0.0447

Interpretation of Sharpe & Sortino Ratios

These values are **very low**, which suggests that:

- **The portfolio's returns are only slightly better than the risk-free rate** (e.g., government bonds).
- But we are taking on significant **volatility** (risk) for that small gain.

Summary Insight

The current portfolio might:

- Be **too volatile** for the small returns it generates
- Or simply be in a **market phase with low returns and high uncertainty**

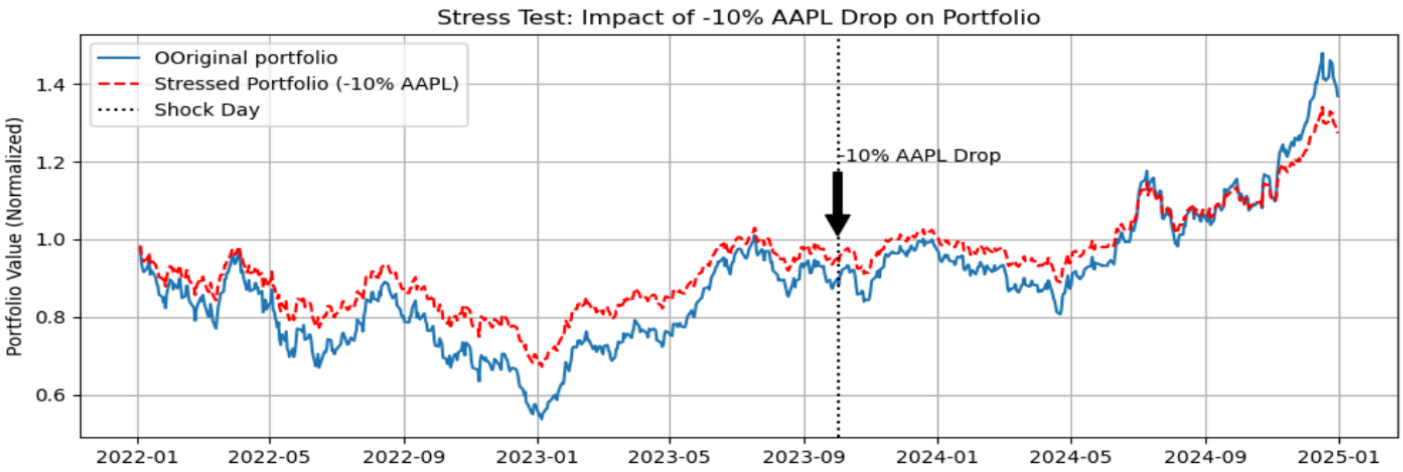
We may want to:

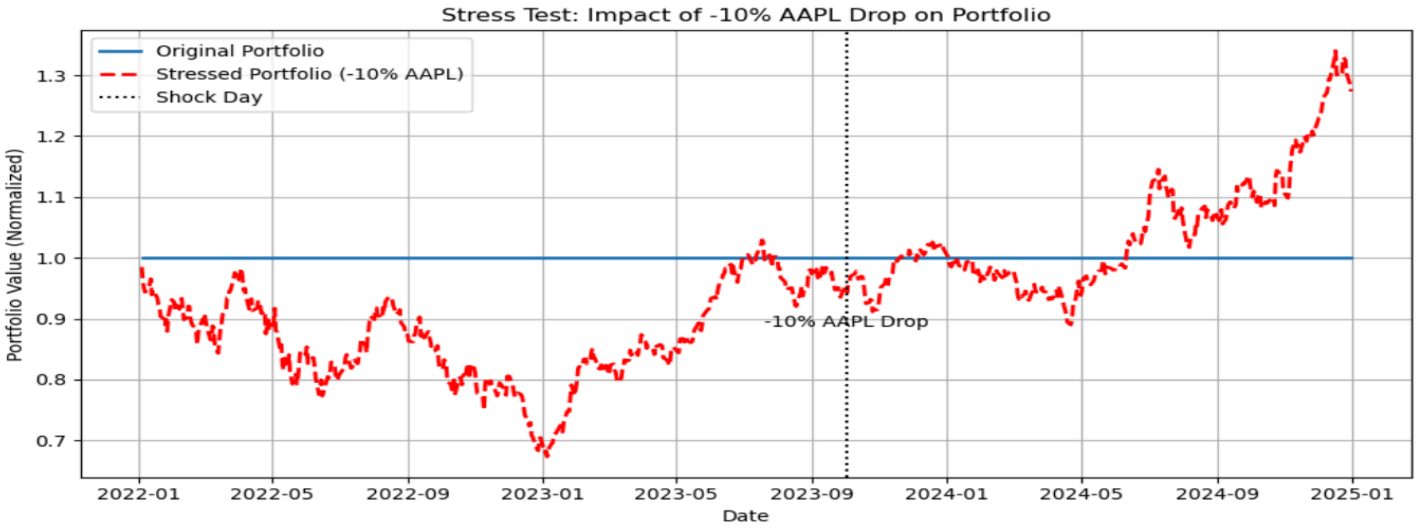
- Rebalance weights
- Optimize asset allocation
- Explore better risk-adjusted return strategies

Stress Testing

Scenario:

- On 2023-10-02 - 10% shock to AAPL
- Analyzed portfolio before and after shock
- Compared shocked vs. unshocked returns





Key Insight:

- One-day shock causes visible but limited impact
- **Limitation:** Real-world shocks often cascade over days. Our model simulates only one isolated event.

Tools Used

- Python (Jupyter Notebooks)
- Libraries: `yfinance`, `pandas`, `numpy`, `matplotlib`, `scipy`, `seaborn`

Conclusion

- The portfolio carries moderate risk and performs reasonably under simulated stress
- Use of multiple methods offers a well-rounded view of market risk
- The project is scalable to other portfolios or stress scenarios

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