Experiential Learning Project Report

Introduction

This project mimics the role of a risk analyst by constructing and analyzing a multi-asset portfolio consisting of:

- Reliance Industries (Large Cap)\
- Balrampur Chini Mills (Small Cap)
- NIFTY 50 Index
- USD/INR Exchange Rate
- Gold Futures (Commodity)

We performed risk estimation using VaR models, volatility forecasting via GARCH, option pricing with Greeks analysis, and implemented a Delta-neutral hedging strategy.

Modeling Process

Step 1: Asset Selection and Data Download

- Selected 5 diverse assets.
- Downloaded 5 years of daily 'Close' price data from Yahoo Finance (2019-04-01 to 2024-04-01).

Step 2: Data Cleaning and Preprocessing

- Forward filled missing values.
- Calculated log returns.
- Visualized returns and computed descriptive statistics (mean, standard deviation, skewness, kurtosis).

Step 3: Volatility Modeling

- Applied GARCH(1,1) model on portfolio returns.
- Forecasted volatility for 30 days.
- Verified residuals using Ljung-Box test (white noise confirmed).

Step 4: Value at Risk (VaR) Estimation

- Calculated 1-day and 10-day VaR using:
- Variance-Covariance Method
- Historical Simulation
- Monte Carlo Simulation
- Confidence Levels: 95% and 99%
- Created VaR comparison table.

Step 5: Backtesting VaR

- Conducted Kupiec and Christoffersen tests.
- Kupiec p-value > 0.05, suggesting model validity.
- Christoffersen Test skipped (fewer than 5 exceptions).
- Ljung-Box test confirmed no autocorrelation in residuals.

Step 6: Option Pricing and Greeks

- Simulated GBM paths for RELIANCE.NS.
- Computed European call/put prices.
- Estimated Greeks (Delta, Gamma, Vega, Theta) using finite difference methods.
- Visualized Greeks across different strikes.

Step 7: Hedging Strategy

- Implemented Delta-neutral hedging.
- Calculated total portfolio Delta and rebalanced stock holdings to achieve Delta-neutrality.

Step 8: Executive Summary

- Summarized key risk findings, hedging results, and provided recommendations.

Interpretations

- Returns Analysis: Portfolio shows moderate mean returns with slightly positive skewness.
- Volatility Forecasting: GARCH successfully captured volatility clustering.
- VaR Models: Historical Simulation captured fat-tails better than Variance-Covariance.
- Backtesting: Kupiec test validated VaR predictions; residuals were clean.
- Greeks: ATM options had highest Gamma and Vega; Delta moved towards 1/0 based on moneyness.
- Hedging: Delta-neutral hedging reduced portfolio's sensitivity to stock movements.

Risks and Limitations

- GARCH assumes stationarity; sudden regime shifts may not be captured.
- VaR models do not predict loss magnitude beyond threshold.
- Data from Yahoo Finance may have inconsistencies.
- Monte Carlo assumes normal distribution; may underestimate tail risks.
- Finite difference method for Greeks is sensitive to epsilon choice.

Suggestions for Improvement

- Try EGARCH/GJR-GARCH models.
- Incorporate Stress Testing.
- Validate data from multiple sources.
- Implement Gamma and Vega hedging alongside Delta hedging.
- Use mean-variance optimization for portfolio weights.

Conclusion

The modeling approach followed a robust risk management framework. Based on backtesting and residual analysis, the risk models were validated. Hedging strategies were successfully implemented to neutralize Delta risks, thus enhancing the risk-adjusted performance of the portfolio.

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