

Portfolio Risk Attribution

1. Introduction: This project conducts a multi-factor risk analysis for a U.S. equity portfolio, utilizing Lasso, Gradient Boosting, and Principal Component Analysis. The objective is to develop predictive models for portfolio returns while identifying and evaluating key risk factors. Additionally, the analysis includes backtesting Value at Risk and decomposing portfolio risk based on the contributions of various model factors.

2. Data Sources

Factor Category	Key Components	Data Sources
Macroeconomic	10Y-2Y Treasury, CPI, GDP Growth, Credit Spread	FRED
Style	Fama-French 5F (Mkt, SMB, HML)	Kenneth French Data Library
Market	S&P500, Gold, Crude Oil	YFinance

3. Methodology

- **Predictive Modeling: Lasso Regression, Gradient Boosting Regression, PCA Regression:**
 - Applied PCA to extract uncorrelated components that summarize key risk exposures.
 - Retained components that explain 90% of the total variance.
 - Interpreted PCA factors to uncover the primary drivers of portfolio risk.
- **Model Evaluation:** Used R^2 , RMSE, MAE, and Q-Q plots to assess model fit and predictive accuracy.
- **Risk Decomposition:** Calculated **Marginal Risk Contribution (MRC)** to measure each factor's contribution to overall portfolio risk, enabling better diversification and exposure management.
- **Backtest VaR and Expected Shortfall (ES):** Used historical data and models, including GARCH, to evaluate portfolio downside risk by calculating Value at Risk (VaR) and Expected Shortfall (ES) during the backtesting period.

4. Results and Findings

- Developed predictive models that provide insights into the key risk factors driving portfolio returns.
- Identified sector-based and factor-based contributions to portfolio risk, offering actionable insights for more informed decision-making.
- The backtesting revealed the portfolio's VaR and ES, offering a clearer picture of potential downside risk and risk mitigation strategies.

5. Future Improvements

- **Rolling Windows:** Implementing rolling windows would allow models to adapt to changing market conditions, improving prediction accuracy over time.
- **Factor Expansion:** Adding global macroeconomic indicators, alternative data (e.g., sentiment analysis, geopolitical events) and other style factors other than Fama-French factors would enhance model predictions.