Multi-Factor Risk Analysis

Overview This project performs a multi-factor risk analysis for a U.S. equity portfolio using Lasso, Random Forest, and PCA models. The goal is to develop predictive models for portfolio returns while identifying and evaluating key risk factors. The analysis includes backtesting VaR and decomposing portfolio risk based on model factors.

Data Sources and Factor Categories

Factor Category	Key Components	Data Sources
Macroeconomic	10Y-2Y Treasury, CPI, GDP Growth	FRED
Style Factors	Fama-French 3F (Mkt, SMB, HML)	Kenneth French Data Library
Sector Factors	GICS Sector Returns	Yfinance
Portfolio Data	Momentum, Volatility, Weights	Internal Portfolio Records

Methodology:
1. **Predictive Modeling:**
   o **Backward Stepwise Regression:**
      ▪ Feature selection based on p-values.
      ▪ Variance Inflation Factor (VIF) screening (threshold < 10) to mitigate multicollinearity.
   o **Lasso Regression**
   o **Random Forest Regression**
   o **PCA Regression:**
      ▪ Principal Component Analysis (PCA) to extract uncorrelated components summarizing key risk exposures.
      ▪ Retained components explain 90% of total variance.
      ▪ Interpretation of PCA factors to uncover major drivers.
2. **Model Evaluation:**
   o R^2, RMSE, MAE, Q-Q plots.
3. **Risk Decomposition:**
   o **Marginal Risk Contribution (MRC):** Measures each factor's contribution to overall portfolio risk, providing insights for better diversification and exposure management.

Key Analysis Components:
- **Regression Modeling:** Estimating portfolio returns based on identified factors.
- **Backtesting & VaR Analysis:** Evaluating model performance using historical data and calculating Value at Risk (VaR) to assess downside risk.
- **Risk Contribution Analysis:** Decomposing portfolio risk to understand exposure by factor.
- **Stress Testing:** Stress-testing models under adverse market conditions (e.g., changes in macroeconomic indicators or sector performance) to evaluate their robustness.