

## Multi-Factor Risk Analysis

**Overview** This project delivers a multi-factor risk analysis for a U.S. equity portfolio using regression and PCA models. The primary goal is to build predictive models for portfolio returns while identifying and assessing influential risk factors. The project combines macroeconomic, style, and sector factors to capture key drivers of risk and return.

### Data Sources and Factor Categories

Factor Category	Key Components	Data Sources
Macroeconomic	10Y 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	Dynamic Weights	Internal Portfolio Records

**Methodological Framework** The project employs two core modeling approaches to analyze portfolio risk:

- Predictive Modeling**
  - Backward Stepwise Regression:**
    - Feature selection based on p-values
    - Variance Inflation Factor (VIF) screening (threshold < 5) to mitigate multicollinearity
    - Residual diagnostics using Q-Q plots and the Durbin-Watson statistic to ensure robust model assumptions
  - PCA Regression:**
    - Principal Component Analysis to extract uncorrelated components that summarize key risk exposures
    - Retained components explain 90% of total variance
    - Interpretation of PCA factors based on loadings to uncover key drivers
- Risk Decomposition**
  - Marginal Risk Contribution (MRC) Calculation:**
    - Measures each factor's contribution to total portfolio risk, offering actionable insights into diversification and exposure management

### Key Analysis Components

- Regression Modeling:** Predictive models are developed to estimate portfolio returns based on identified risk factors.
- Backtesting & VaR Analysis:** Model performance is evaluated using historical data, with Value at Risk (VaR) calculations to assess downside risk.
- Risk Contribution Analysis:** Portfolio risk is decomposed into factor-specific contributions to better understand exposure sources.
- Stress Testing:** The models are stress-tested under adverse market conditions, such as sharp changes in macroeconomic indicators or sector performance, to evaluate their robustness.