DAFI REPORT

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Overview

- Introduction
- Methodology
- Regression: Linear and Lasso
- Factor Model Comparison
- Portfolio Construction
- Portfolio Evaluation
- Cross - Portfolio Analysis

INTRODUCTION

Introduction

- The Fama-French Five-Factor Model has been highly influential in asset pricing and risk management.

- Recent advancements in financial research have introduced new factors, such as industry-specific factors, momentum (MOM), short-term and long-term reversal factors.

- This project evaluates whether these new factors (check their significance through lasso regression) outperform the traditional Fama-French factors by analyzing their risk metrics both in-sample and out-of-sample. The analysis is based on the variance-covariance matrices, ex-ante and ex-post betas, and key risk metrics such as volatility, Value-at-Risk (VaR), and Expected Shortfall (ES).

- We then create six different portfolio strategies and evaluate the performance with proper metrics.

METHODOLOGY

Methodology

In the following slide, we will explain which have been the different steps that we initially took in order to realize our report

01

The first essential step to realize this project has been the collection of the data. We have decided to take in consideration the S&P 500 index.

02

We downloaded all the useful information directly from the Kenneth R. French Data Library website. We were able to find all the csv files for the different factors.

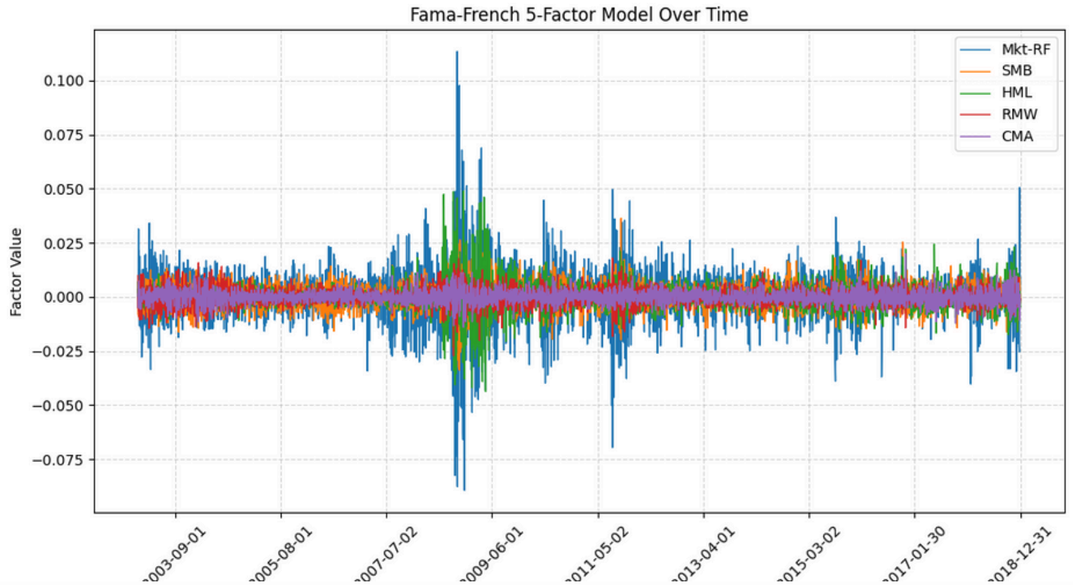
03

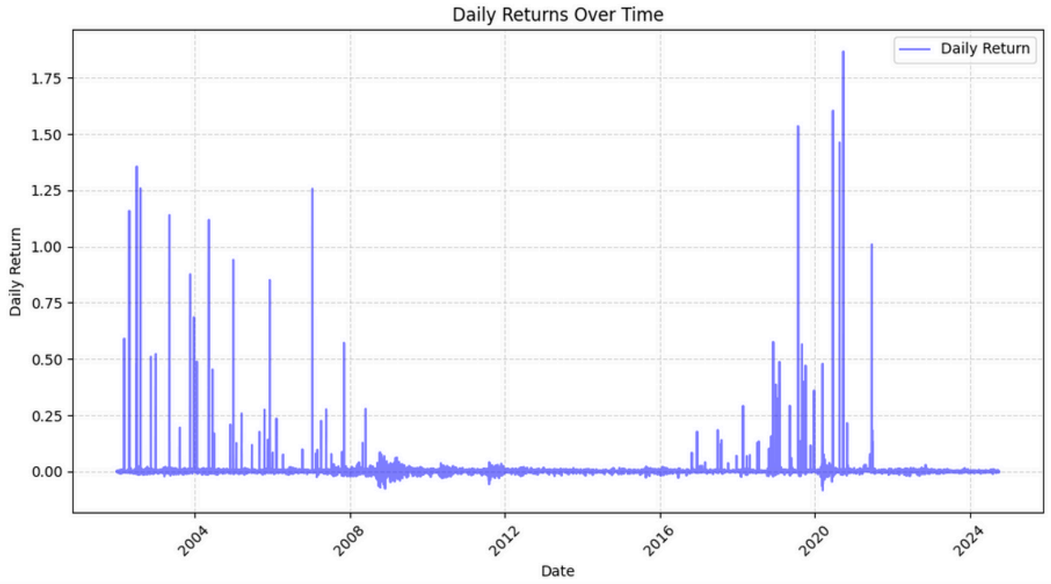
We imported the data on pycharm using different functions able to perform different tasks. For the industry factors, since on the website there were only the portfolios, we have create them by doing the pca and preserving the first five components

04

To have a better understanding of the data we were working with, we performed some initial exploratory data analysis.

Graphs





	Mkt-RF	SMB	HML	RMW	CMA
count	4176.000000	4176.000000	4176.000000	4176.000000	4176.000000
mean	0.000366	0.000075	0.000007	0.000079	0.000023
std	0.011342	0.005485	0.006132	0.003797	0.002913
min	-0.089500	-0.033900	-0.043800	-0.027200	-0.014100
25%	-0.004000	-0.003100	-0.002600	-0.002000	-0.001625
50%	0.000400	0.000000	0.000000	0.000000	0.000000
75%	0.005300	0.003200	0.002400	0.002100	0.001600
max	0.113500	0.045100	0.048900	0.017900	0.019900

REGRESSION: LINEAR AND LASSO

```
Lasso Regression Results (Selected Features Only, Sorted by Absolute Value):
              Feature  Lasso Coefficient Selected
8   Industry_Factor_1           0.005598      Yes
0             Mkt-RF            0.003459      Yes
3                RMW           -0.000567      Yes
9   Industry_Factor_2           -0.000472      Yes
5                MOM           -0.000395      Yes
```

The Lasso Regression

Lasso regression (Least Absolute Shrinkage and Selection Operator) is a type of linear regression that includes L1 regularization, which helps in feature selection by shrinking some coefficients to zero. The lasso regression has been useful in selecting the most relevant factors among the full set of factors (the five Fama French factors, momentum, industry and short/long term reversal factor).

The factors that we have used after the lasso:

- Mkt - RF (market)
- RMW (profitability)
- Industry Factor 1
- Industry Factor 2
- MOM (momentum)

Linear Regression

- We performed linear regression on the two different datasets (Dataset1 and Dataset3), and analyzed the mean squared error (MSE) to evaluate how well the factors estimated the daily return of the S&P 500
- The results indicated strong predictive performance, as the MSE for Dataset3 was significantly lower than that of Dataset1 (0.0000018385 vs. 0.0003476591)
- Dataset3 was also able to explain better the training data given the higher R^2

```
Sum of Residuals: -0.32923256284704566

Residual Analysis:
            Actual   Predicted    Residual
count  806.000000  806.000000  806.000000
mean     0.000228    0.000637   -0.000408
std      0.009075    0.009055    0.001294
min     -0.048460   -0.041389   -0.013035
25%     -0.003536   -0.003248   -0.001111
50%      0.000554    0.000883   -0.000389
75%      0.004594    0.004906    0.000278
max      0.062105    0.059667    0.007247
```

```
Mean Squared Error: 0.0000018385
```

```
Mean Squared Error: 0.0003476591
```

FACTOR MODEL COMPARISON

Introduction

- Objective: Compare the explanatory power of the Fama-French model vs. factors identified using Lasso regression

- Key Metrics Analyzed:
  - Variance-Covariance Matrices
  - Beta Sensitivity (Ex-Ante vs. Ex-Post)
  - Portfolio Volatility
  - Value at Risk (VaR) & Expected Shortfall (ES)
  - Correlation Analysis

Variance - Covariance Matrix

CORRELATION ANALISYS

Fama-French:

- Highest variance in Market Factor (0.000129)
- Lower covariance among factors

New Factors:

- Industry Factor 1 exhibits highest variance (0.000589)
- Unique covariance structure capturing different risk dynamics

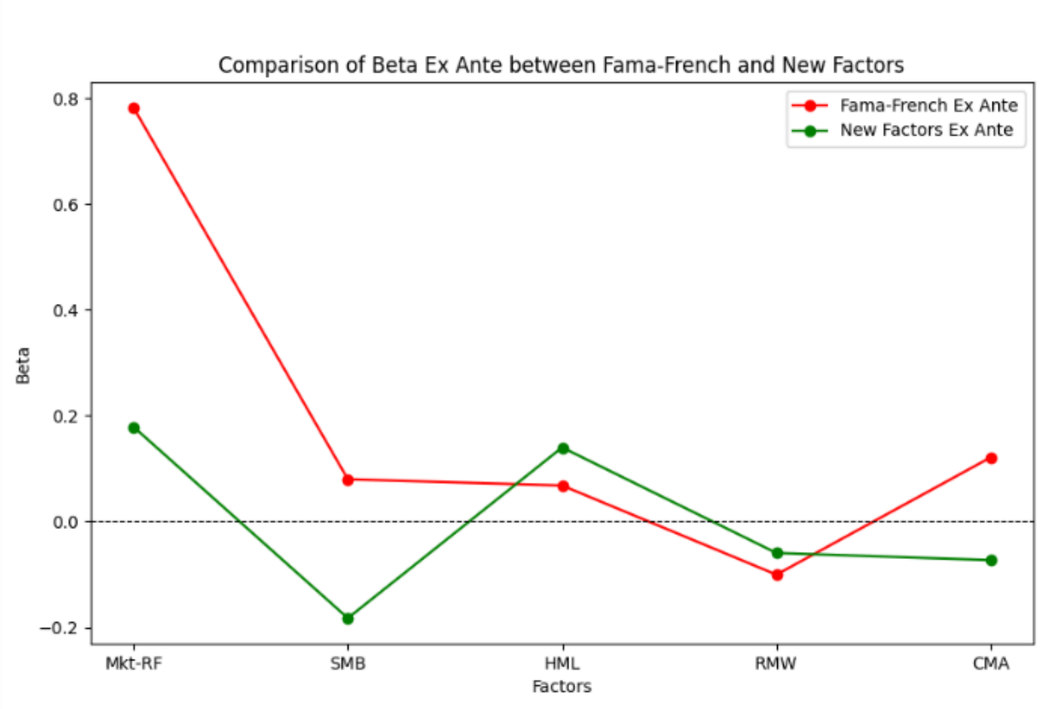
Var-Covar Matrix Fama-French:

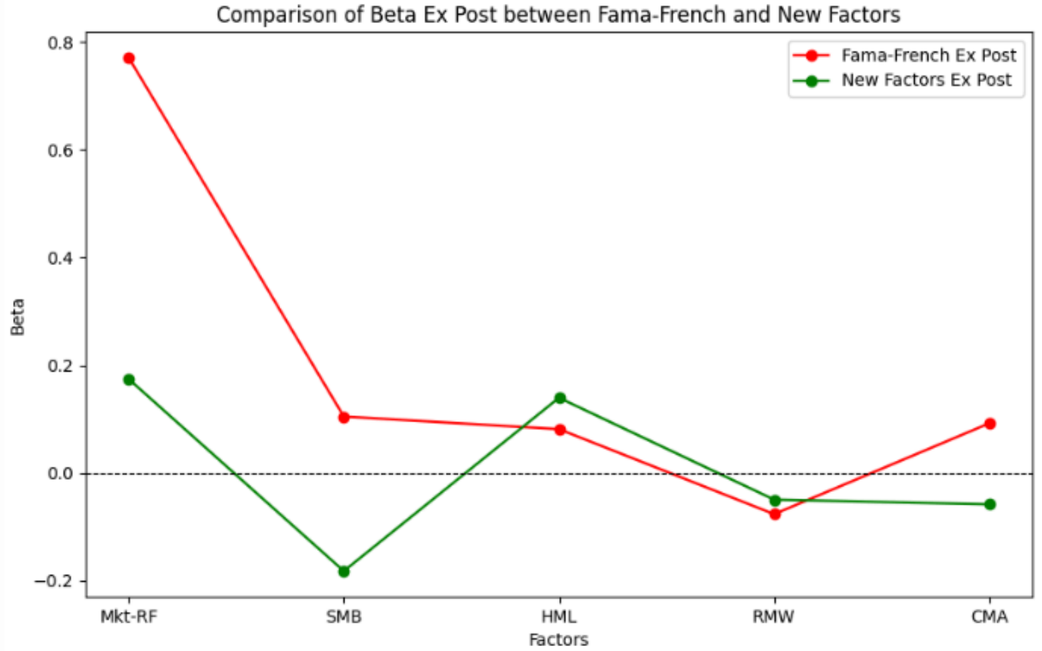
	Mkt-RF	SMB	HML	RMW	CMA
Mkt-RF	0.000129	1.551181e-05	0.000022	-0.000017	-2.765129e-06
SMB	0.000016	3.008155e-05	0.000003	-0.000006	9.052417e-07
HML	0.000022	3.014770e-06	0.000038	-0.000008	4.644790e-06
RMW	-0.000017	-6.308389e-06	-0.000008	0.000014	-1.820044e-06
CMA	-0.000003	9.052417e-07	0.000005	-0.000002	8.487828e-06

Var-Covar Matrix New Factors:

	Mkt-RF	RMW	Industry_Factor_1	Industry_Factor_2	MOM
Mkt-RF	0.000133	-0.000017	0.000589	0.000055	-0.000032
RMW	-0.000017	0.000015	-0.000071	-0.000002	0.000008
Industry_Factor_1	0.000589	-0.000071	0.002714	0.000360	-0.000150
Industry_Factor_2	0.000055	-0.000002	0.000360	0.000330	-0.000008
MOM	-0.000032	0.000008	-0.000150	-0.000008	0.000082

Beta Sensitivity





BETA SENSITIVITY

- Fama-French Model: Ex-Ante Beta (Mkt-RF): 0.7818 → Ex-Post: 0.7711
- New Factors Model: Ex-Ante Beta (Mkt-RF): 0.1787→ Ex-Post: 0.1742
- More dynamic factor loadings in New Factors' Dataset

Risk Metrics

RISK METRICS

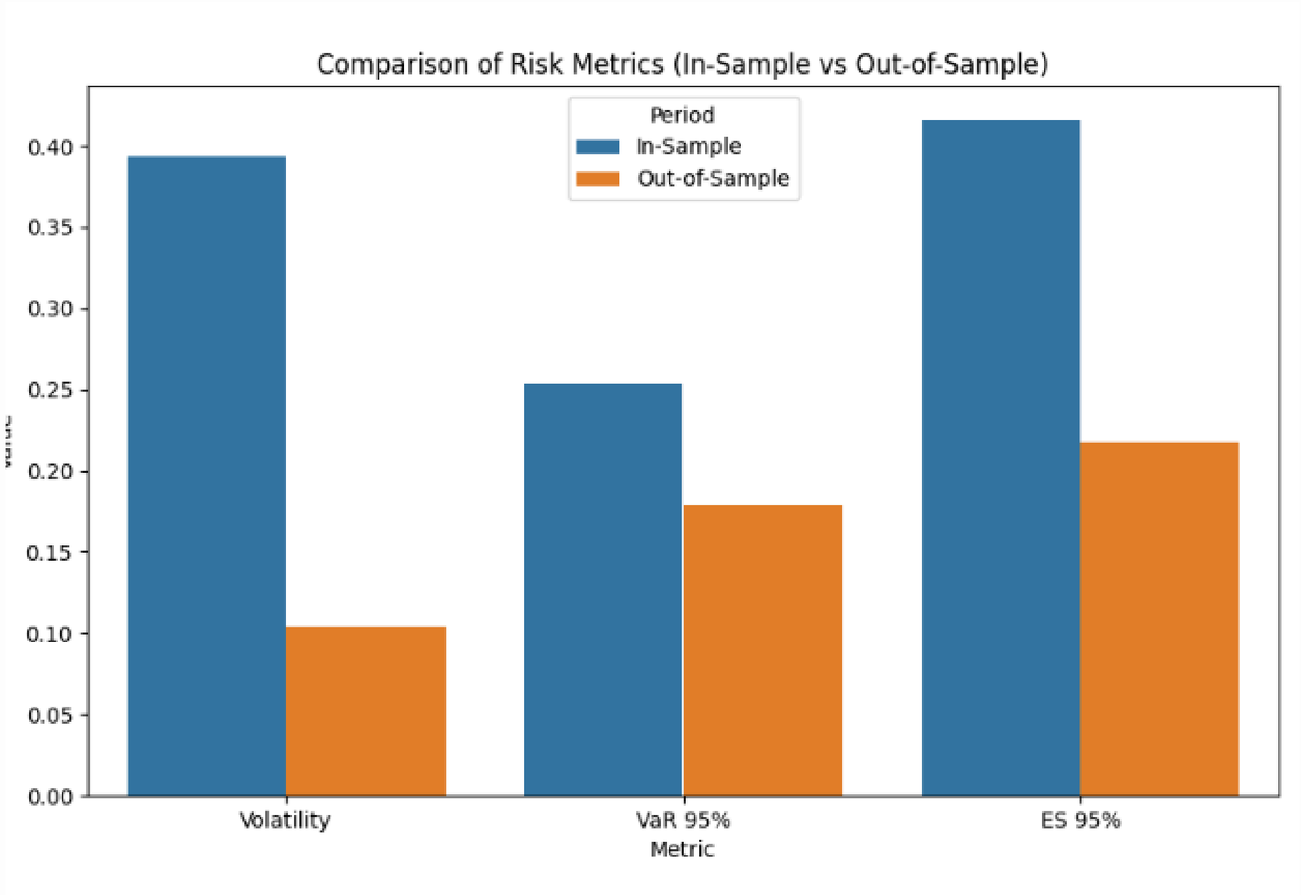
In-Sample:

- Volatility: 0.3933
- VaR 95%: 0.2539
- Expected Shortfall (ES): 0.4162

Out-of-Sample:

- Volatility: 0.1393
- VaR 95%: 0.1785
- Expected Shortfall (ES): 0.2176

- Key Insight: Stability maintained in out-of-sample data



Conclusions

COMPARATIVE ANALISYS

Fama-French vs. New Factors:

- Similar risk profiles
- Industry_Factor_1 and MOM provide additional explanatory power
- Lower covariances reduce multicollinearity

In-Sample vs. Out-of-Sample:

- Reduction in volatility → Generalization to new data
- Lower VaR and ES → Predictive power retained

CONCLUSIONS

- New factors align with traditional Fama-French risk measures
- No significant increase in risk, but improved explanatory power
- Potential for further research in different market conditions

PORTFOLIO ANALYSIS

Portfolio Construction

Equal-Weight Portfolio

- assigns identical weights
- simple but effective
- avoids concentration risk

Equal-Weight Dynamic Portfolio

- starts with equal weights
- adjusts weight dynamically
- ensure balanced portfolio

Minimum Variance Portfolio

- minimizes the volatility
- optimizes weights through covariance matrix estimation

Mean-Variance Portfolio

- maximizes expected returns for a given risk level
- or minimizes risk

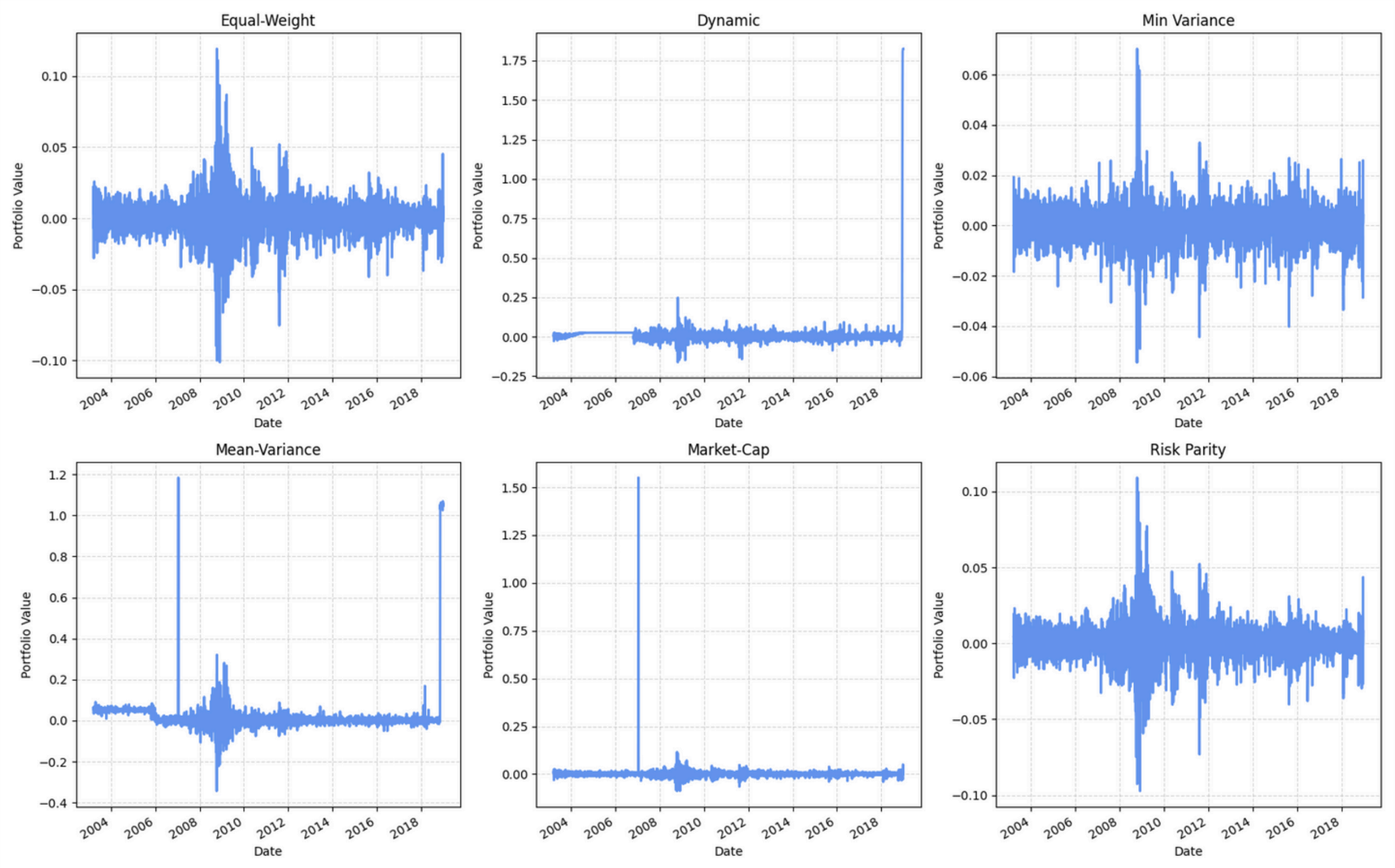
Market-Cap Weighted Portfolio

- assigns weights based on market capitalization
- larger companies dominate

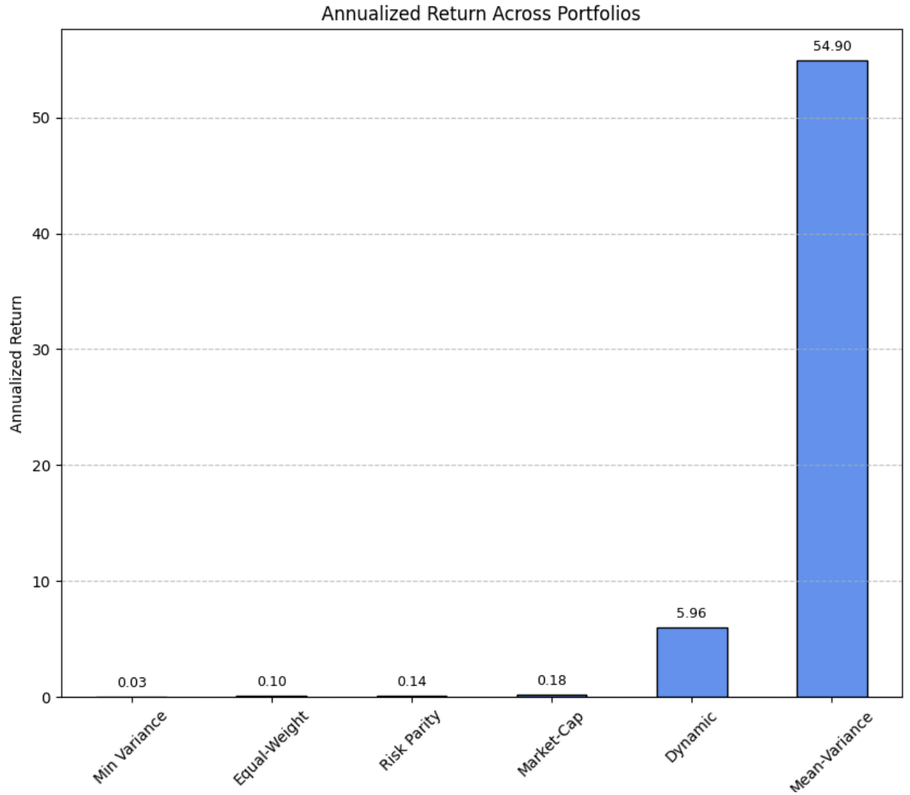
Risk Parity Portfolio

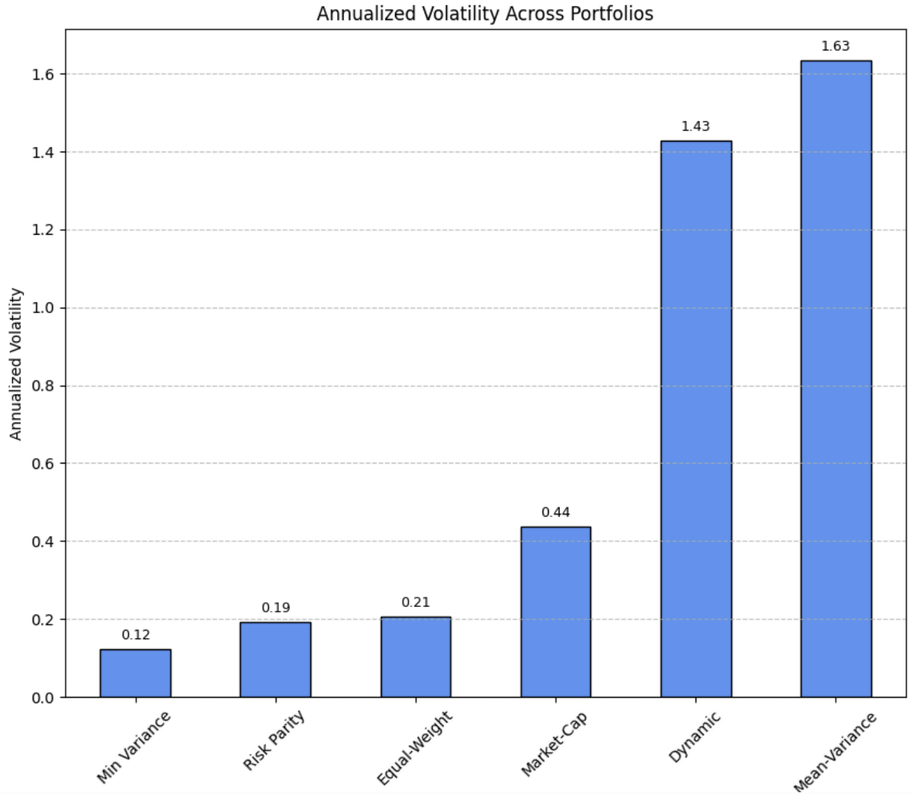
- equalizes risk contributions
- assigns lower weights to highly volatile assets

Portfolio Evaluation



Annualized Return and Annualized Volatility

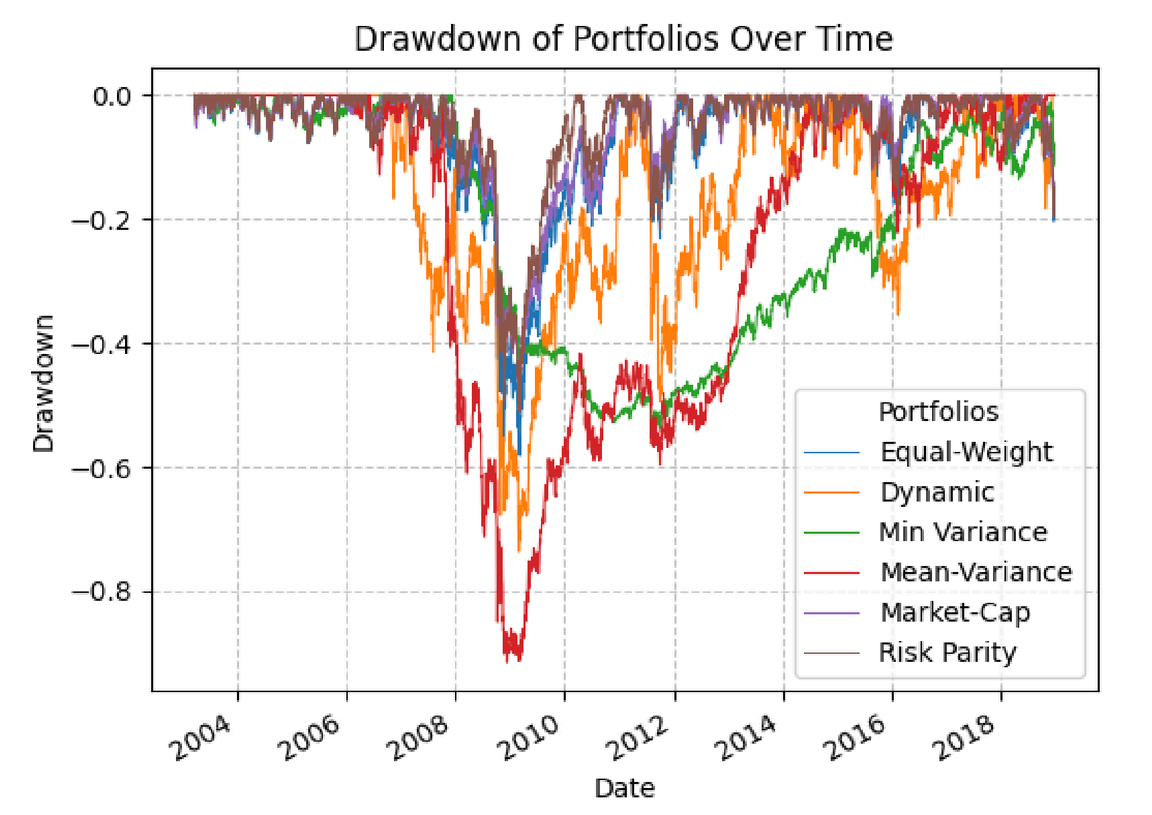


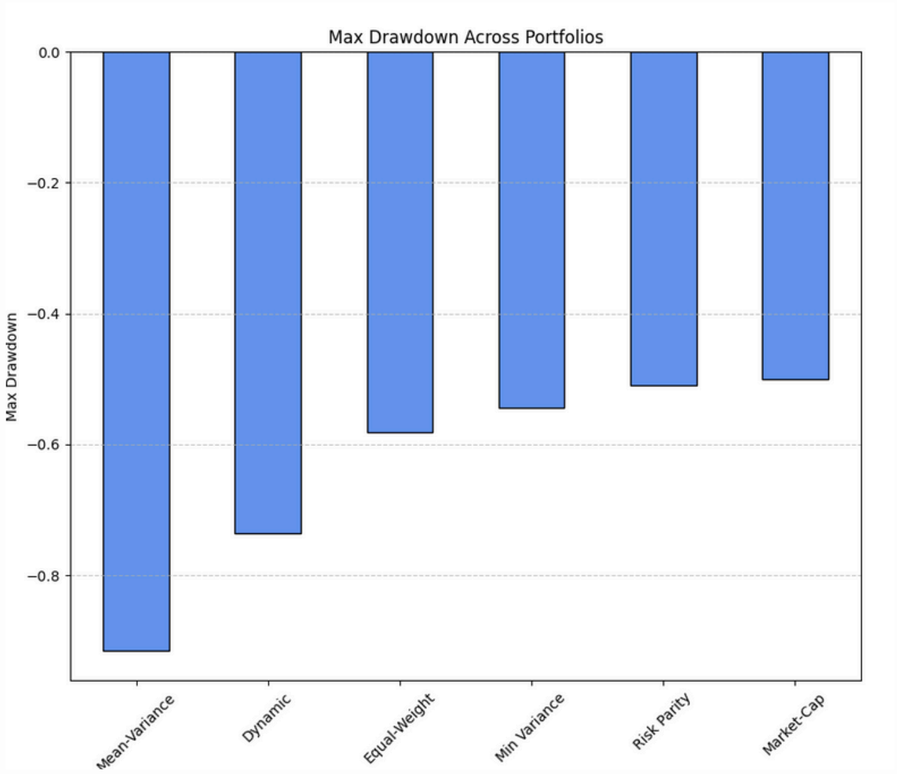


$$ATR = \left(\frac{cumulative\ return_{end}}{cumulative\ return_{start}} \right)^{ann\ const/nr\ days} - 1$$

$$AV = \sigma_{returns} \times \sqrt{ann\ const}$$

Drawdown and Max Drawdown

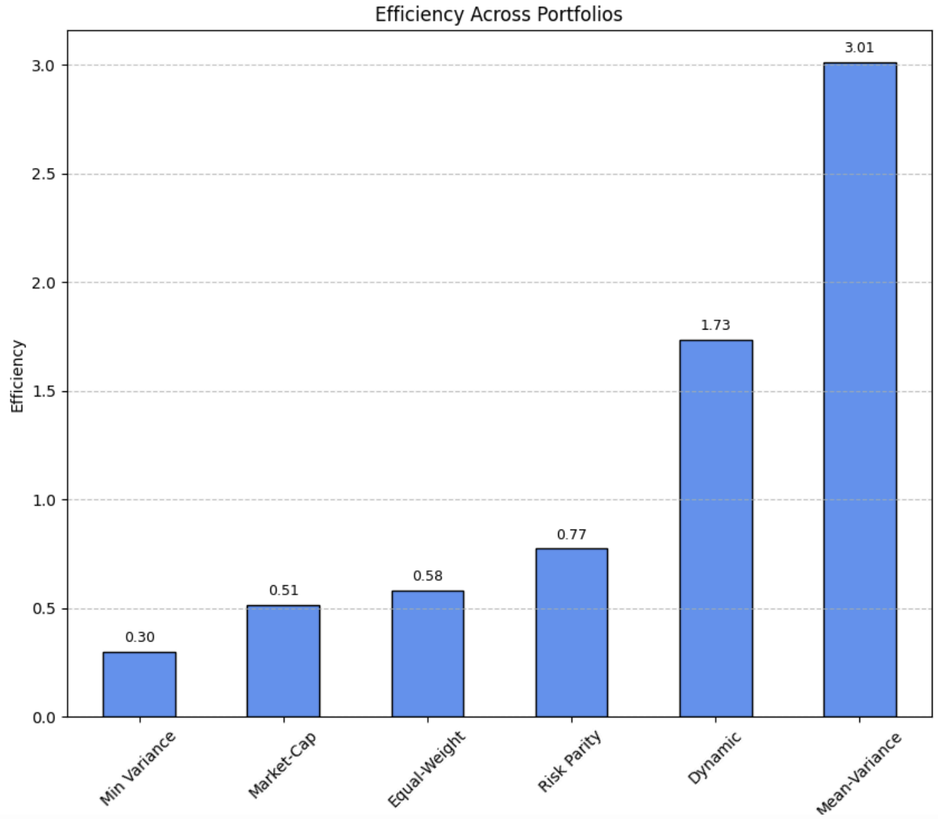


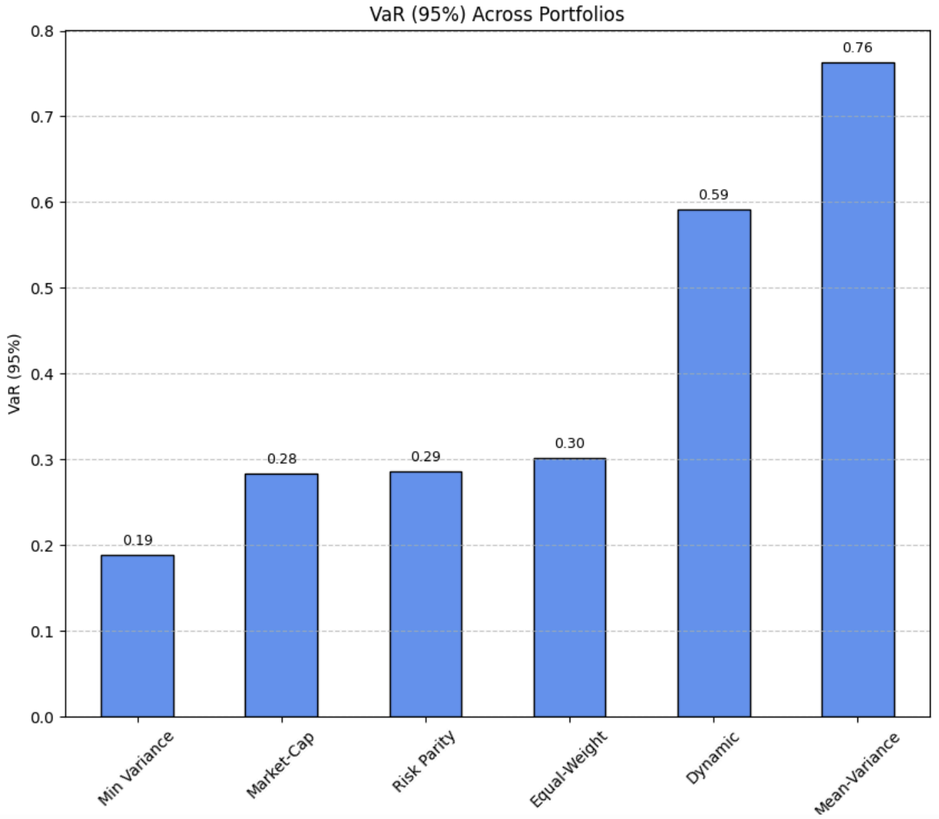


$$Drawdown = \frac{cumulative\ return}{cumulative\ return_{max}} - 1$$

$$Maximum\ drawdown = min\ (drawdown)$$

Efficiency and Value at Risk



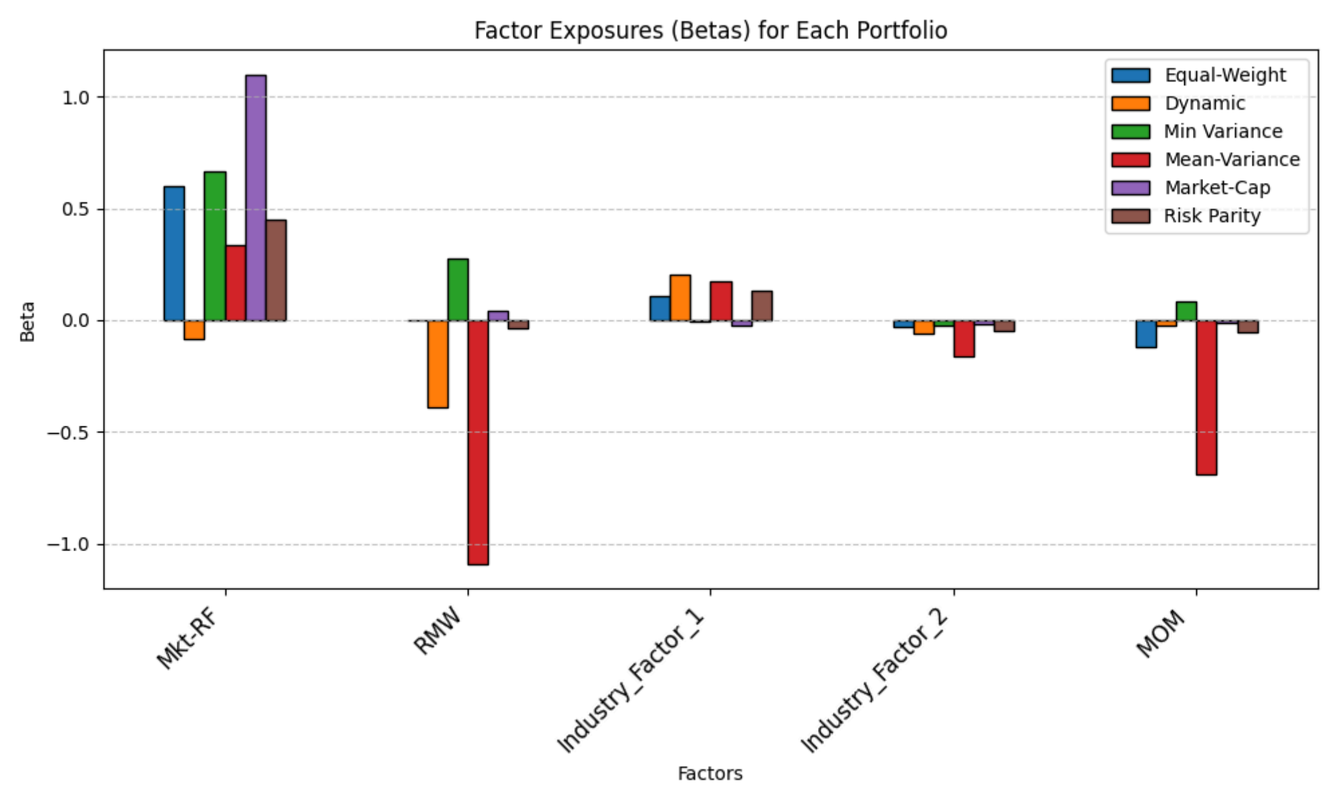


$$Efficiency = \frac{\mu_{returns} \times ann\ const}{AV}$$

$$VAR\ (95\%) = -\ Percentile(returns,\ 5\%) \times \sqrt{ann\ const}$$

CROSS-PORTFOLIO ANALYSIS

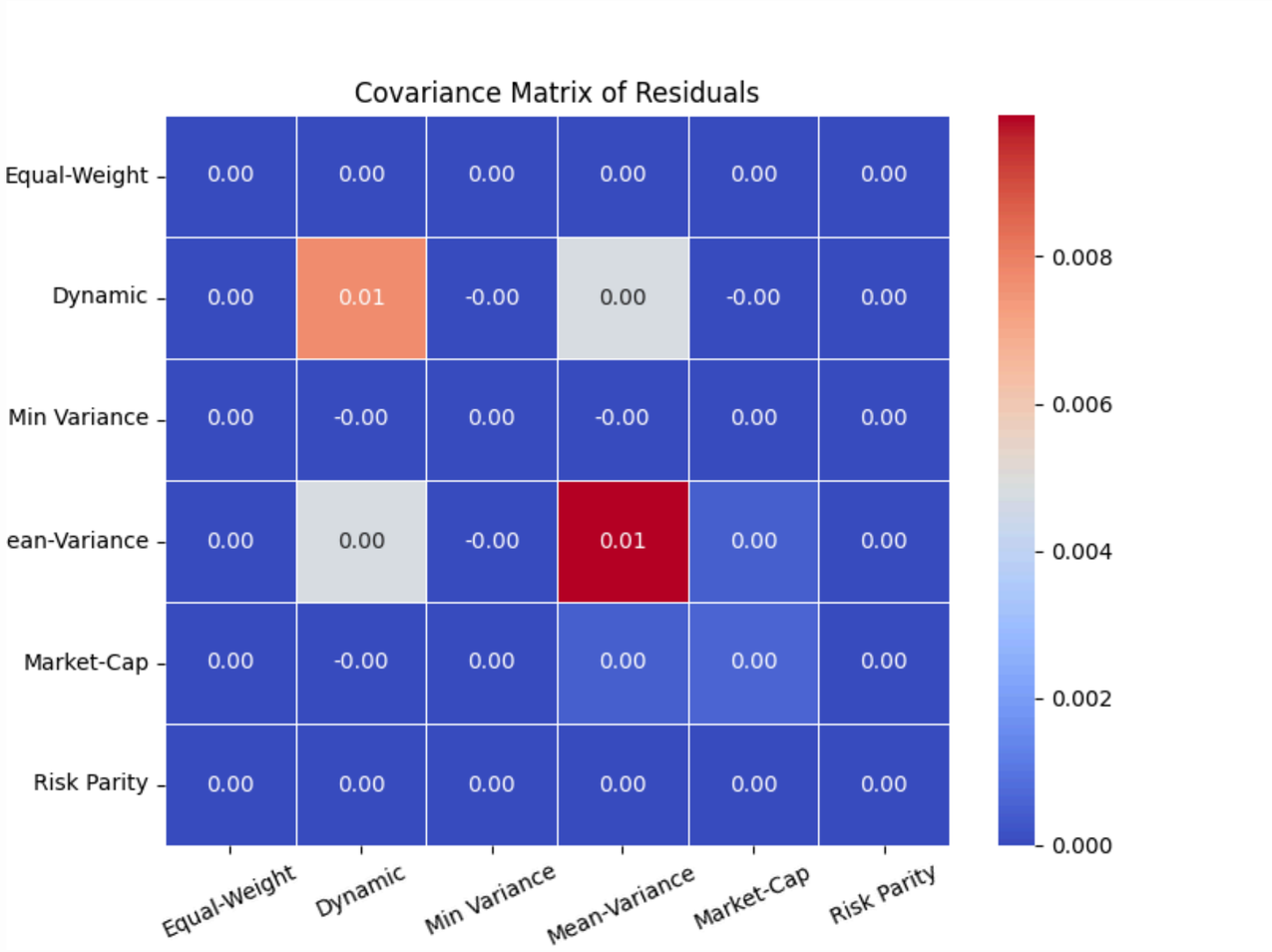
Factor Regression and Sensitivity



- the **factors** capture the systematic risk exposure or portfolios
- the **betas** represent the sensitivity of portfolios to the factors

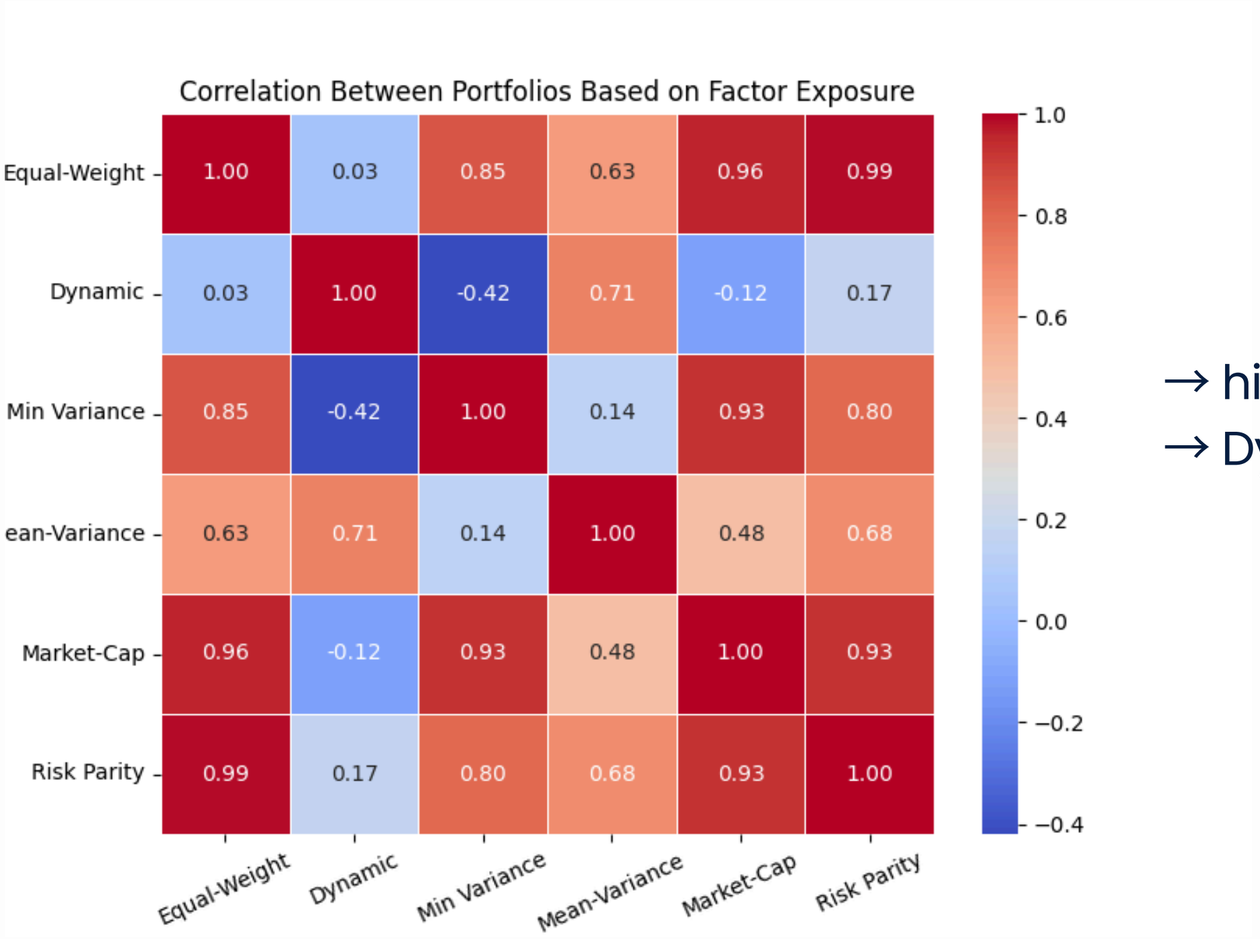
→ strong positive exposure to market factor
→ weak exposure to the other factors

Residual Analysis



→ uncorrelated residuals
→ factors explain perfectly the returns
→ overfitting?

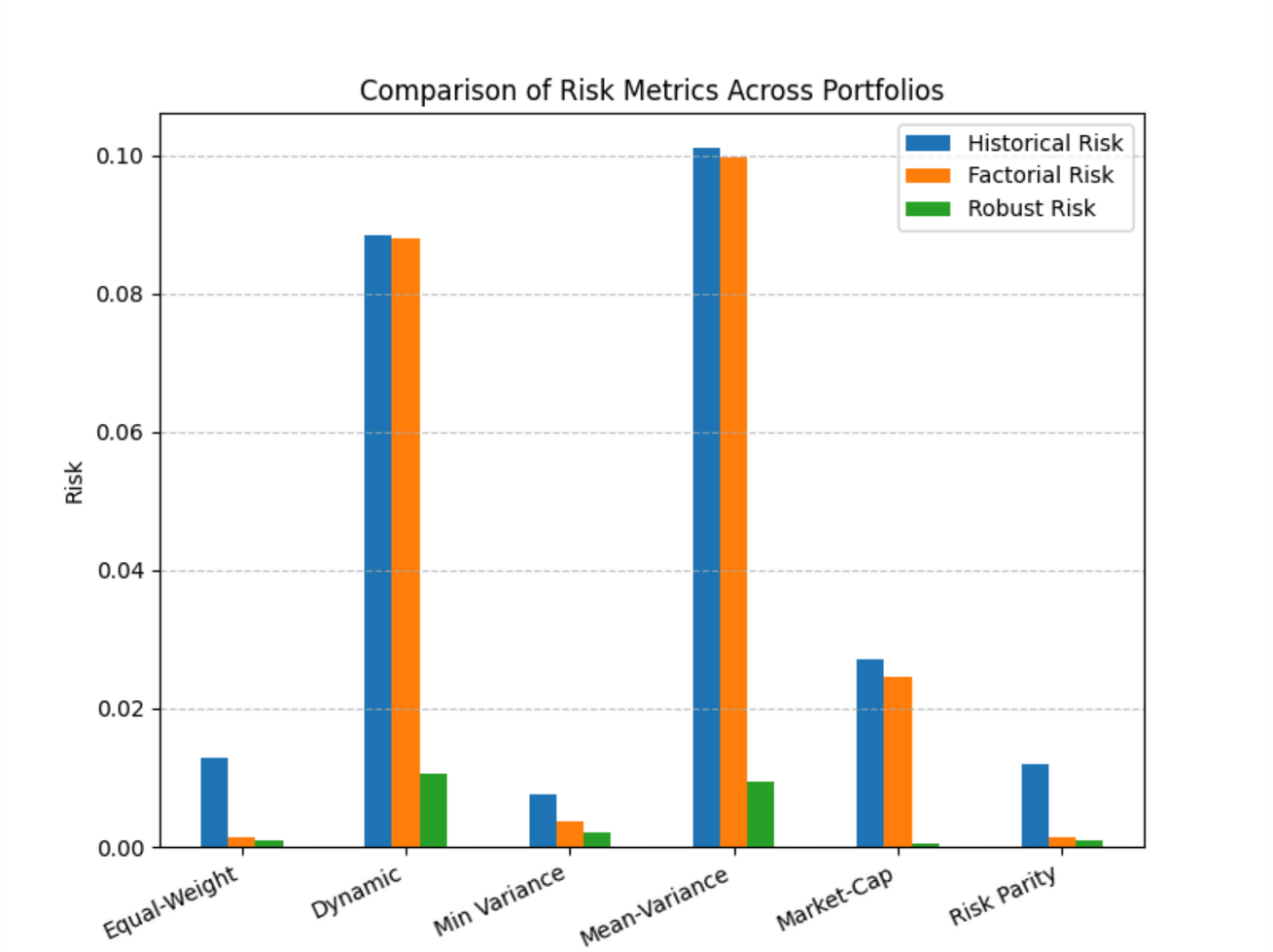
Correlation between portfolios



→ high correlation

→ Dynamic Portfolio has a lower correlation

Risk Metrics



- **Historical risk** = the standard deviation of the portfolio returns
- **Factorial risk** = the standard deviation of the residuals
- **Robust risk** = the Median Absolute Deviation of residuals

THANK YOU!

For your attention