LABORATORY OF DATA ANALYTICS FOR INVESTING



Benchmark-Neutral Allocations with Factor Tilts - Research Approach

Giovanni Baldon
Alessio Formosa
Cecilia Paolini
Sophia Ricci

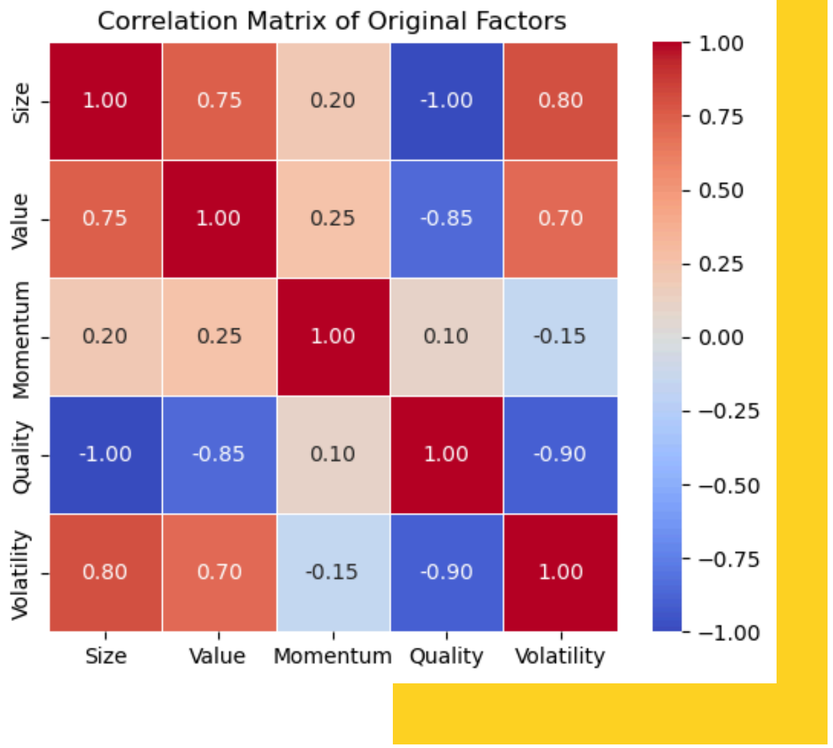
TABLE OF CONTENT

- DATA COLLECTION
- TUCKER FACTORS
- INDICATORS
- CORRELATION TEST
- FACTOR RETURNS
- COVARIANCE MATRICES
- PORTFOLIO

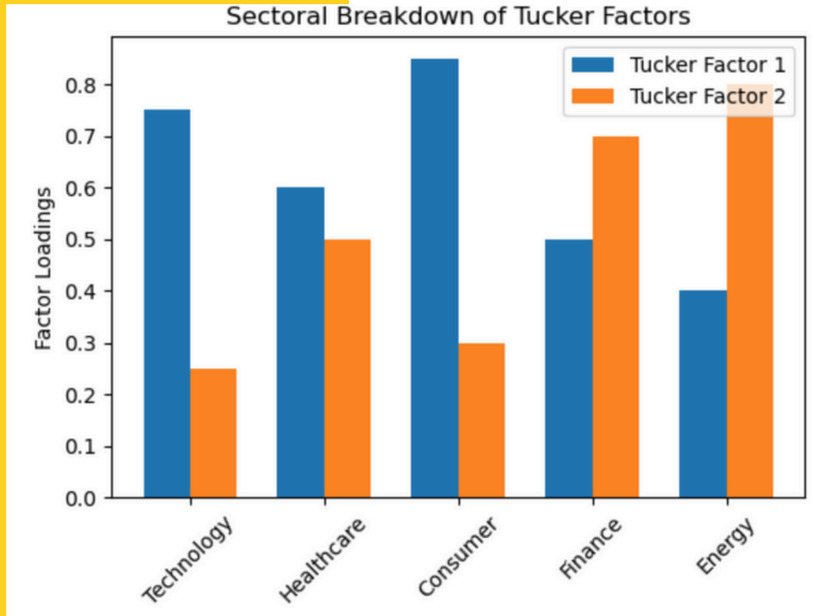
DATA COLLECTION

- ***Data Source***: Stock price and market capitalization data obtained from Yahoo Finance.
- ***Sector Focus***: Technology, healthcare, consumer, finance, and energy sectors.
- ***Stock Selection***: Top 10 largest companies in each sector.
- ***Time Period***: January 2020 – February 2025.
- ***Portfolio Construction***: Sector-based portfolios compared to a capitalization-weighted market benchmark for performance evaluation.
- ***Data Processing***: Utilized the market_data module to extract and structure financial information.
- ***Error Handling***: Implemented robust mechanisms to maintain accuracy and ensure continuity despite missing or delayed data.

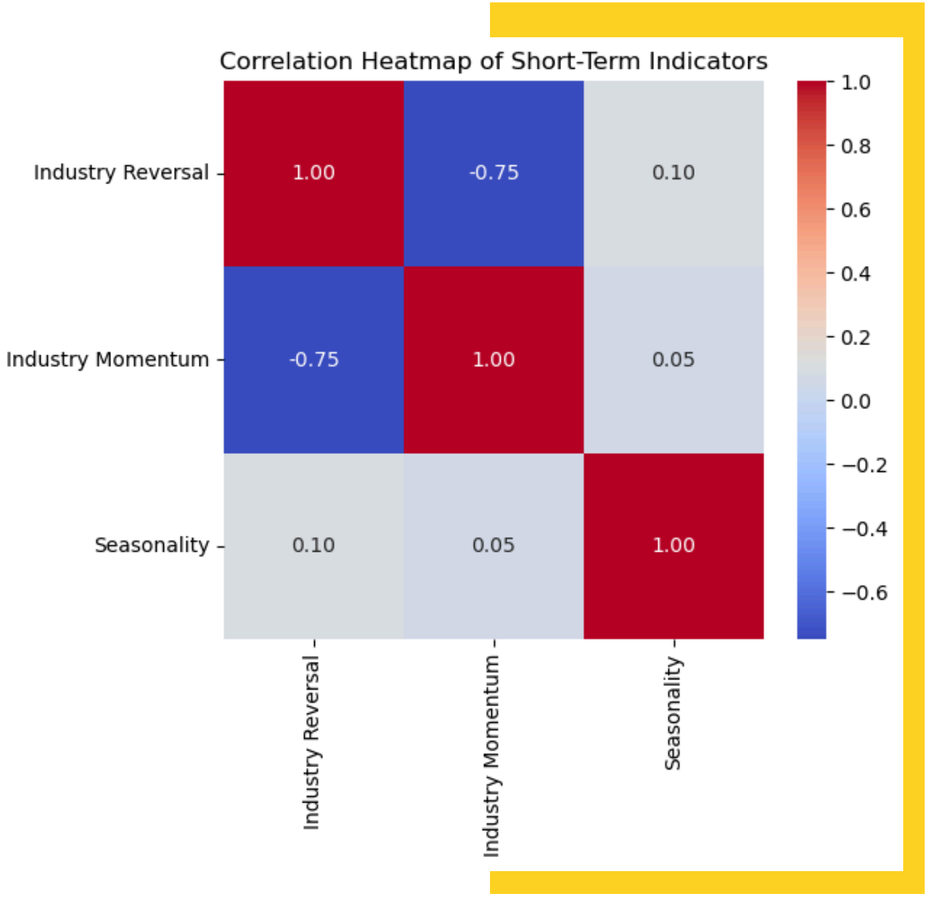
TUCKER FACTORS



- Tucker Factor Model introduced as an alternative to traditional models, resolving multicollinearity issues in asset pricing.
- Factor Exposures included size (market cap), value (market cap/price), momentum (12-month returns excluding the last month), quality (inverse return volatility), and volatility (standard deviation of returns).
- Collinearity Challenges arose due to strong correlation between quality and volatility (-1.000), with VIF calculations confirming infinite values, making regression models unreliable.
- Tucker Factorization with SVD extracted two independent principal components, reducing dimensionality while preserving 86.52% of dataset variance, improving statistical reliability.
- Sectoral Insights highlighted technology stocks driven by momentum, healthcare stocks sensitive to risk measures, and consumer stocks aligning with size and value, with NVDA and BAC identified as key sector outliers.



INDICATORS



- **Short-Term Trading Indicators**: Industry Relative Reversal, Industry Momentum, and Seasonality capture market inefficiencies and generate positive alpha, independent of traditional factors.
- **Indicator Insights**: Industry Reversal tracks short-term rebounds using 21-day cumulative returns, Momentum measures trends in strong industries, and Seasonality identifies recurring monthly patterns over ten years.
- **Key Findings**: Industry Reversal and Momentum showed a strong negative correlation, while Seasonality remained independent. Sector-level trends revealed momentum dominance in technology, seasonality effects in finance, and mean-reversion in energy, with NVDA and BAC as key outliers.
- **Impact on Performance**: These indicators contributed to CAPM alphas between 6% and 10%, with standardization improving stability and reliability, enhancing portfolio selection and systematic trading strategies.

CALCULATIONS

Industry Relative Reversal

$$STR_i = R_i^{21d} - \bar{R}_{\text{industry}}^{21d}$$

- STR_i = Industry Relative Reversal for stock i
- R_i^{21d} = Cumulative return of stock i over the last 21 trading days
- $\bar{R}_{\text{industry}}^{21d}$ = Average cumulative return of all stocks in the same industry over the last 21 trading days

Industry Momentum

$$IND_MOM_i = \frac{1}{N} \sum_{\substack{j \in \text{industry} \\ j \neq i}} R_j^{21d}$$

- IND_MOM_i = Industry momentum for stock i
- R_j^{21d} = Cumulative return of stock j over the last 21 trading days
- N = Number of peer stocks in the same industry (excluding stock i)

SEASONALITY

$$SEA_SAME_i = \frac{1}{T} \sum_{t=1}^{T} R_i^{\text{month}_t}$$

- SEA_SAME_i = Seasonality factor for stock i
- $R_i^{\text{month}_t}$ = Return of stock i in the same calendar month t over past years
- T = Number of years considered (typically 10, excluding the most recent year)

CORRELATION TEST

The VIF for each factor is calculated as $1/(1-R^2)$, where R^2 shows how much a factor can be explained by all other factors. A high VIF means we have redundant information.(VIF > 10)

Feature	Market VIF	Technology VIF	Healthcare VIF	Consumer VIF	Finance VIF	Energy VIF
str_signal	1.095508	6.552427	1.327586	1.282745	1.178464	1.934549
ind_mom	1.226263	1.470830	2.406624	22.414272	1.636158	1.681375
seasonality	1.630169	4.072995	1.114405	1.360813	1.266328	1.502086
Tucker_Factor_1	1.311924	11.499681	1.013306	1.090876	1.266917	1.350061
Tucker_Factor_2	1.216925	1.134027	1.369532	1.217746	1.136321	1.807330

FACTOR RETURNS

DATA MANIPULATION

In Data Manipulation, we process market data by calculating price changes over a 21-day rolling window and prepare our dataset for factor analysis

VIF INDICATOR

We used VIF to detect multicollinearity between factors. Generally the VIF is under a value of 2 but when VIF exceeds 10, we remove that factor to ensure model stability. This happened specifically with Tucker_Factor_1 in Technology and ind_mom in Consumer sectors. If we kept these high-VIF factors, our model would produce unreliable results, as it wouldn't be able to distinguish the individual impact of each factor.

FACTOR RETURNS

Looking at factor Factor returns across sectors: Technology shows the highest Factor returns, particularly through NVDA with extreme values (str_signal: 4.32, Tucker_Factor_2: -5.05) and AVGO (Tucker_Factor_2: 3.54). Healthcare follows with ABBV (Tucker_Factor_1: 3.59) and GILD (Tucker_Factor_2: 2.11). Consumer, Energy, and Finance sectors show progressively lower sensitivities, with Finance being the most stable sector where factor returns rarely exceed ±1.

IMPACT

Looking at factor impacts across sectors, the Industry relative reversal factor tend to drive the largest returns. For example, in most significant cases like NVDA, Industry relative reversal generates higher returns than Tucker Factors. However, Tucker Factors show more consistent impacts across all stocks, while the other 3 factors often have strong effects on specific companies but remain minimal for others.

$$\hat{R} = X_F \cdot \hat{R}_F + X_0 + \epsilon$$

- R : returns of the stocks analyzed
- X_0 : market return (e.g., S&P 500)
- $X_F \cdot \hat{R}_F$: product between betas (sensitivity coeff.) for each factor (X_F) and factor returns (R_F) representing the contribution of each factor to the return
- ϵ : component of the return not explained by the model

$$Y = \hat{R} - X_0$$
$$X = X_f$$
$$\Rightarrow \hat{R}_F$$

COVARIANCE MATRICES

1

HISTORICAL COVARIANCE MATRIX

$$\sum_{hist} = COV(R)$$

Where:

- **R** = Matrix of stock returns over t

2

FAMA-FRENCH FACTOR COVARIANCE MATRIX

$$FactorSigma = \beta^T \sum \beta$$

Where:

- **Beta** = The matrix of betas for each stock
- **Sigma** = The Variance-Covariance matrix of factors

3

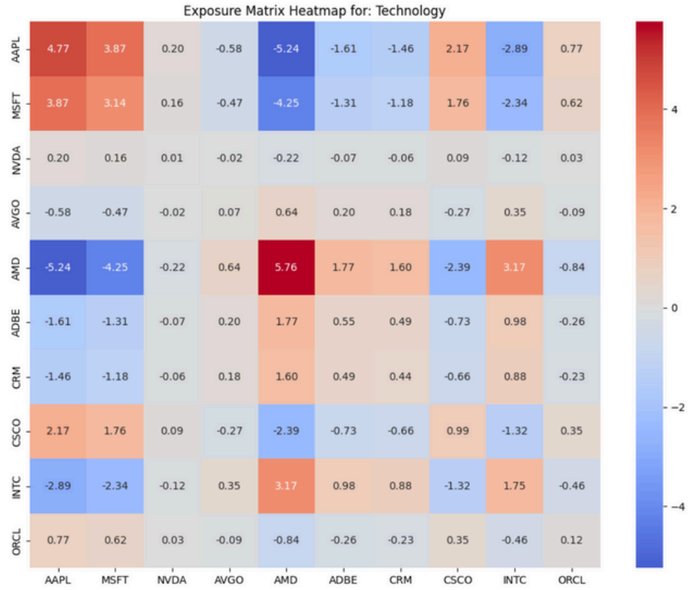
EXPOSURE-BASED COVARIANCE MATRIX

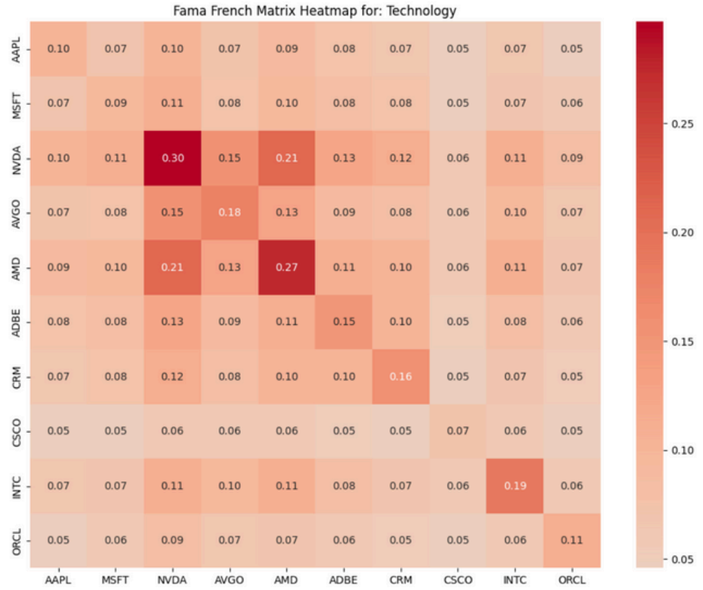
$$ExposureSigma = \beta^T \sum \beta$$

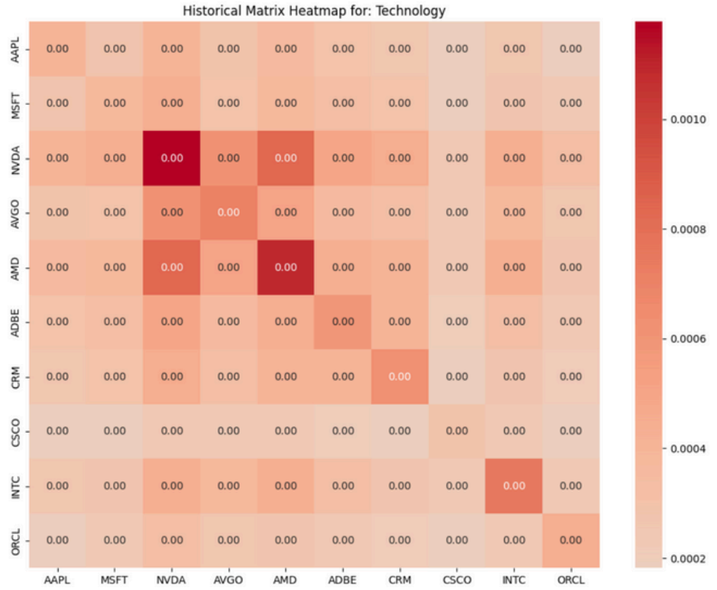
Where:

- **Beta** = Matrix of factor exposures
- **Sigma** = Variance-Covariance matrix of our factors

TECHNOLOGY

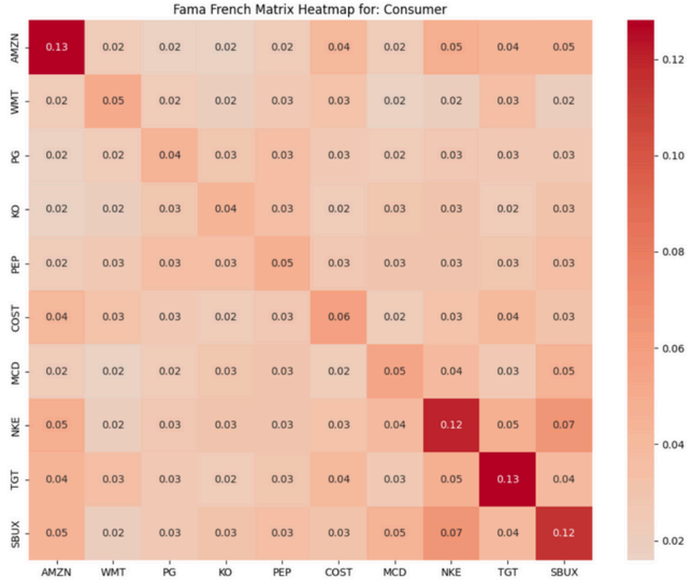

Exposure Matrix Heatmap for: Technology
AAPL 4.77 3.87 0.20 -0.58 -5.24 -1.61 -1.46 2.17 -2.89 0.77
MSFT 3.87 3.14 0.16 -0.47 -4.25 -1.31 -1.18 1.76 -2.34 0.62
NVDA 0.20 0.16 0.01 -0.02 -0.22 -0.07 -0.06 0.09 -0.12 0.03
AVGO -0.58 -0.47 -0.02 0.07 0.64 0.20 0.18 -0.27 0.35 -0.09
AMD -5.24 -4.25 -0.22 0.64 5.76 1.77 1.60 -2.39 3.17 -0.84
ADBE -1.61 -1.31 -0.07 0.20 1.77 0.55 0.49 -0.73 0.98 -0.26
CRM -1.46 -1.18 -0.06 0.18 1.60 0.49 0.44 -0.66 0.88 -0.23
CSCO 2.17 1.76 0.09 -0.27 -2.39 -0.73 -0.66 0.99 -1.32 0.35
INTC -2.89 -2.34 -0.12 0.35 3.17 0.98 0.88 -1.32 1.75 -0.46
ORCL 0.77 0.62 0.03 -0.09 -0.84 -0.26 -0.23 0.35 -0.46 0.12
AAPL MSFT NVDA AVGO AMD ADBE CRM CSCO INTC ORCL
4 2 0 −2 −4

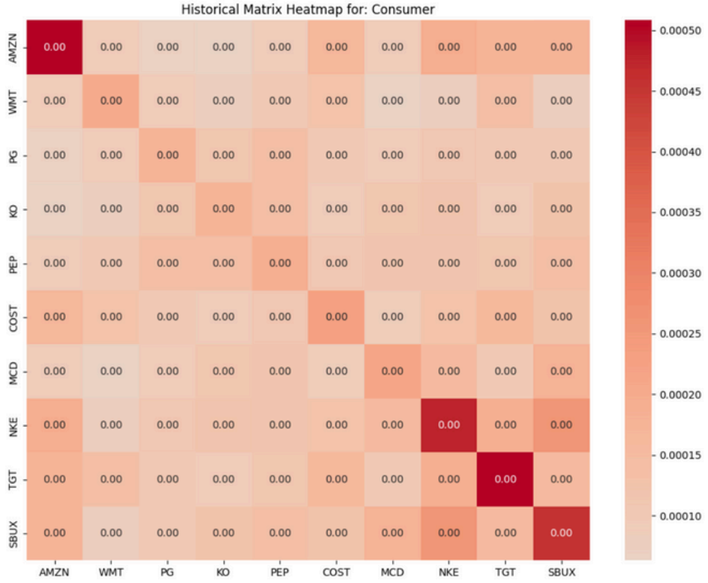

Fama French Matrix Heatmap for: Technology
AAPL 0.10 0.07 0.10 0.07 0.09 0.08 0.07 0.05 0.07 0.05
MSFT 0.07 0.09 0.11 0.08 0.10 0.08 0.08 0.05 0.07 0.06
NVDA 0.10 0.11 0.30 0.15 0.21 0.13 0.12 0.06 0.11 0.09
AVGO 0.07 0.08 0.15 0.18 0.13 0.09 0.08 0.06 0.10 0.07
AMD 0.09 0.10 0.21 0.13 0.27 0.11 0.10 0.06 0.11 0.07
ADBE 0.08 0.08 0.13 0.09 0.11 0.15 0.10 0.05 0.08 0.06
CRM 0.07 0.08 0.12 0.08 0.10 0.10 0.16 0.05 0.07 0.05
CSCO 0.05 0.05 0.06 0.06 0.06 0.05 0.05 0.07 0.06 0.05
INTC 0.07 0.07 0.11 0.10 0.11 0.08 0.07 0.06 0.19 0.06
ORCL 0.05 0.06 0.09 0.07 0.07 0.06 0.05 0.05 0.06 0.11
AAPL MSFT NVDA AVGO AMD ADBE CRM CSCO INTC ORCL
0.25 0.20 0.15 0.10 0.05


Historical Matrix Heatmap for: Technology
AAPL 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MSFT 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
NVDA 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AVGO 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AMD 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
ADBE 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
CRM 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
CSCO 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
INTC 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
ORCL 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AAPL MSFT NVDA AVGO AMD ADBE CRM CSCO INTC ORCL
0.0010 0.0008 0.0006 0.0004 0.0002

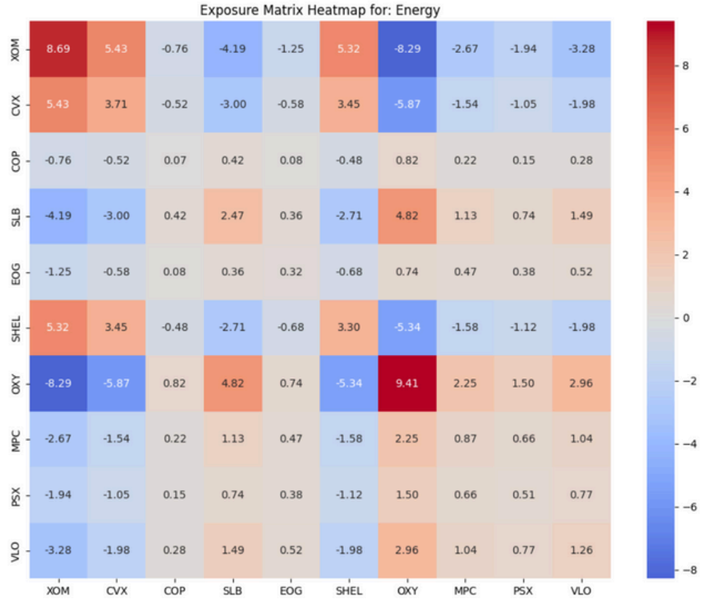
CONSUMER

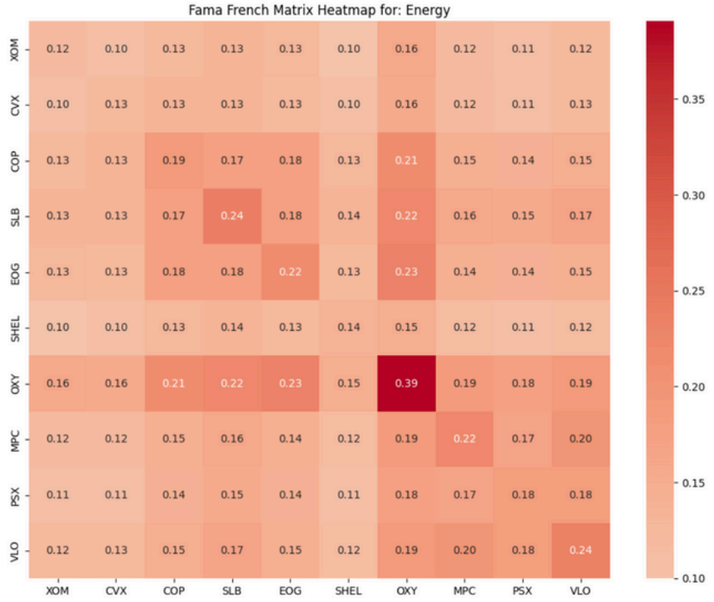

Exposure Matrix Heatmap for: Consumer
AMZN 7.78 2.44 -2.22 -1.93 -3.25 -1.27 -2.83 -0.33 0.19 0.07
WMT 2.44 5.17 1.15 1.38 -0.55 0.94 -0.65 -4.15 -3.74 -3.06
PG -2.22 1.15 1.41 1.39 1.13 0.93 0.91 -1.60 -1.64 -1.32
KO -1.93 1.38 1.39 1.37 1.02 0.92 0.81 -1.74 -1.75 -1.41
PEP -3.25 -0.55 1.13 1.02 1.41 0.68 1.21 -0.29 -0.48 -0.36
COST -1.27 0.94 0.93 0.92 0.68 0.62 0.54 -1.18 -1.18 -0.95
MCD -2.83 -0.65 0.91 0.81 1.21 0.54 1.04 -0.10 -0.27 -0.19
NKE -0.33 -4.15 -1.60 -1.74 -0.29 -1.18 -0.10 3.73 3.48 2.83
TGT 0.19 -3.74 -1.64 -1.75 -0.48 -1.18 -0.27 3.48 3.27 2.66
SBUX 0.07 -3.06 -1.32 -1.41 -0.36 -0.95 -0.19 2.83 2.66 2.17
AMZN WMT PG KO PEP COST MCD NKE TGT SBUX
6 4 2 0 −2 −4

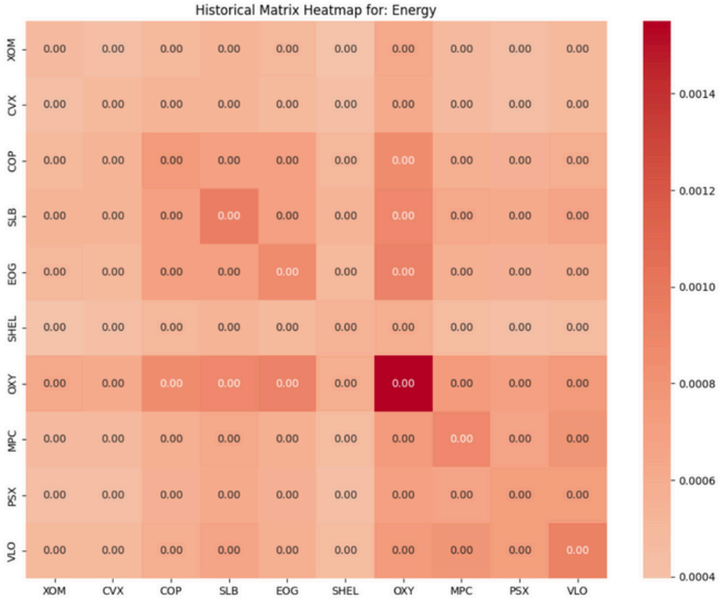

Fama French Matrix Heatmap for: Consumer
AMZN 0.13 0.02 0.02 0.02 0.02 0.04 0.02 0.05 0.04 0.05
WMT 0.02 0.05 0.02 0.02 0.03 0.03 0.02 0.02 0.03 0.02
PG 0.02 0.02 0.04 0.03 0.03 0.03 0.02 0.03 0.03 0.03
KO 0.02 0.02 0.03 0.04 0.03 0.02 0.03 0.03 0.02 0.03
PEP 0.02 0.03 0.03 0.03 0.05 0.03 0.03 0.03 0.03 0.03
COST 0.04 0.03 0.03 0.02 0.03 0.06 0.02 0.03 0.04 0.03
MCD 0.02 0.02 0.02 0.03 0.03 0.02 0.05 0.04 0.03 0.05
NKE 0.05 0.02 0.03 0.03 0.03 0.03 0.04 0.12 0.05 0.07
TGT 0.04 0.03 0.03 0.02 0.03 0.04 0.03 0.05 0.13 0.04
SBUX 0.05 0.02 0.03 0.03 0.03 0.03 0.05 0.07 0.04 0.12
AMZN WMT PG KO PEP COST MCD NKE TGT SBUX
0.12 0.10 0.08 0.06 0.04 0.02


Historical Matrix Heatmap for: Consumer
AMZN 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
WMT 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
PG 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
KO 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
PEP 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
COST 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MCD 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
NKE 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
TGT 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
SBUX 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AMZN WMT PG KO PEP COST MCD NKE TGT SBUX
0.00050 0.00045 0.00040 0.00035 0.00030 0.00025 0.00020 0.00015 0.00010

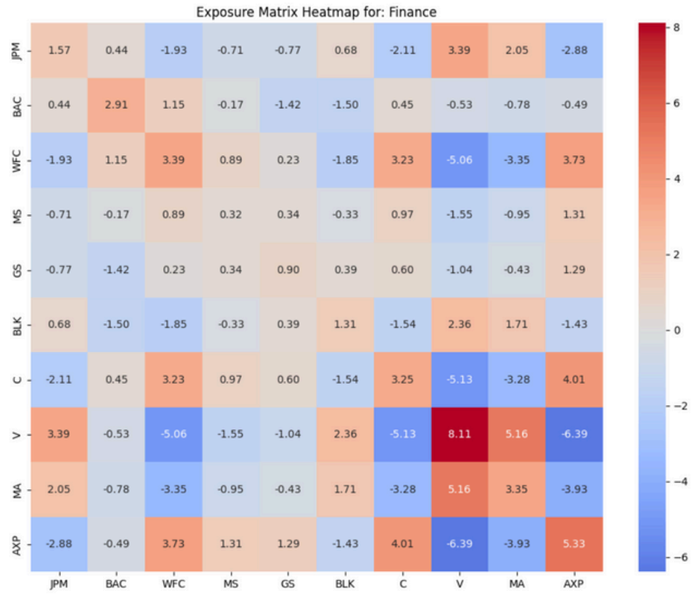
ENERGY

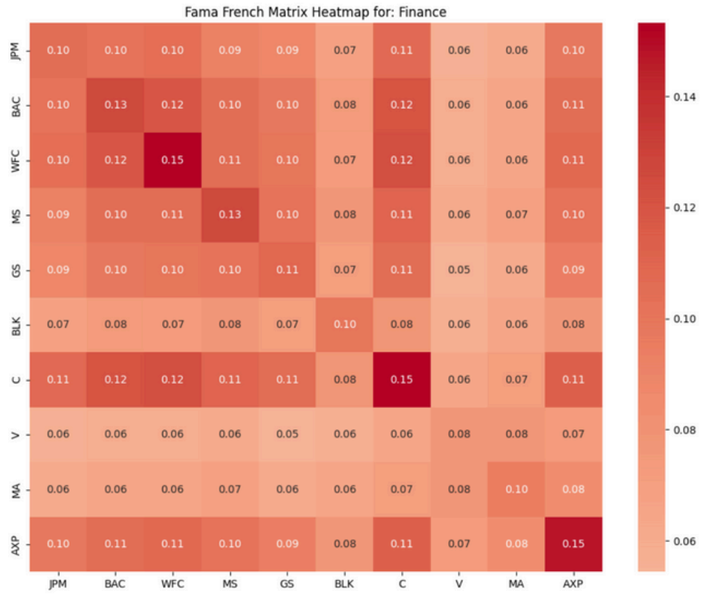

Exposure Matrix Heatmap for: Energy
XOM 8.69 5.43 -0.76 -4.19 -1.25 5.32 -8.29 -2.67 -1.94 -3.28
CVX 5.43 3.71 -0.52 -3.00 -0.58 3.45 -5.87 -1.54 -1.05 -1.98
COP -0.76 -0.52 0.07 0.42 0.08 -0.48 0.82 0.22 0.15 0.28
SLB -4.19 -3.00 0.42 2.47 0.36 -2.71 4.82 1.13 0.74 1.49
EOG -1.25 -0.58 0.08 0.36 0.32 -0.68 0.74 0.47 0.38 0.52
SHEL 5.32 3.45 -0.48 -2.71 -0.68 3.30 -5.34 -1.58 -1.12 -1.98
OXY -8.29 -5.87 0.82 4.82 0.74 -5.34 9.41 2.25 1.50 2.96
MPC -2.67 -1.54 0.22 1.13 0.47 -1.58 2.25 0.87 0.66 1.04
PSX -1.94 -1.05 0.15 0.74 0.38 -1.12 1.50 0.66 0.51 0.77
VLO -3.28 -1.98 0.28 1.49 0.52 -1.98 2.96 1.04 0.77 1.26
XOM CVX COP SLB EOG SHEL OXY MPC PSX VLO
8 6 4 2 0 −2 −4 −6 −8

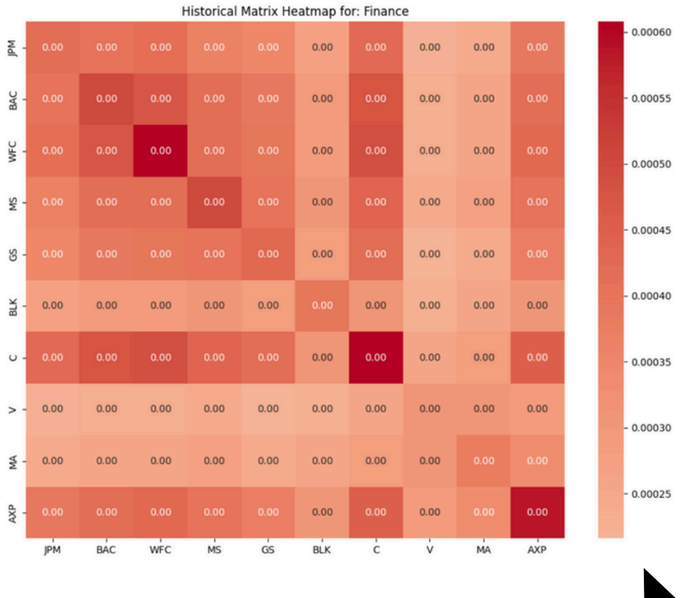

Fama French Matrix Heatmap for: Energy
XOM 0.12 0.10 0.13 0.13 0.13 0.10 0.16 0.12 0.11 0.12
CVX 0.10 0.13 0.13 0.13 0.13 0.10 0.16 0.12 0.11 0.13
COP 0.13 0.13 0.19 0.17 0.18 0.13 0.21 0.15 0.14 0.15
SLB 0.13 0.13 0.17 0.24 0.18 0.14 0.22 0.16 0.15 0.17
EOG 0.13 0.13 0.18 0.18 0.22 0.13 0.23 0.14 0.14 0.15
SHEL 0.10 0.10 0.13 0.14 0.13 0.14 0.15 0.12 0.11 0.12
OXY 0.16 0.16 0.21 0.22 0.23 0.15 0.39 0.19 0.18 0.19
MPC 0.12 0.12 0.15 0.16 0.14 0.12 0.19 0.22 0.17 0.20
PSX 0.11 0.11 0.14 0.15 0.14 0.11 0.18 0.17 0.18 0.18
VLO 0.12 0.13 0.15 0.17 0.15 0.12 0.19 0.20 0.18 0.24
XOM CVX COP SLB EOG SHEL OXY MPC PSX VLO
0.35 0.30 0.25 0.20 0.15 0.10


Historical Matrix Heatmap for: Energy
XOM 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
CVX 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
COP 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
SLB 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
EOG 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
SHEL 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
OXY 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MPC 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
PSX 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
VLO 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
XOM CVX COP SLB EOG SHEL OXY MPC PSX VLO
0.0014 0.0012 0.0010 0.0008 0.0006 0.0004

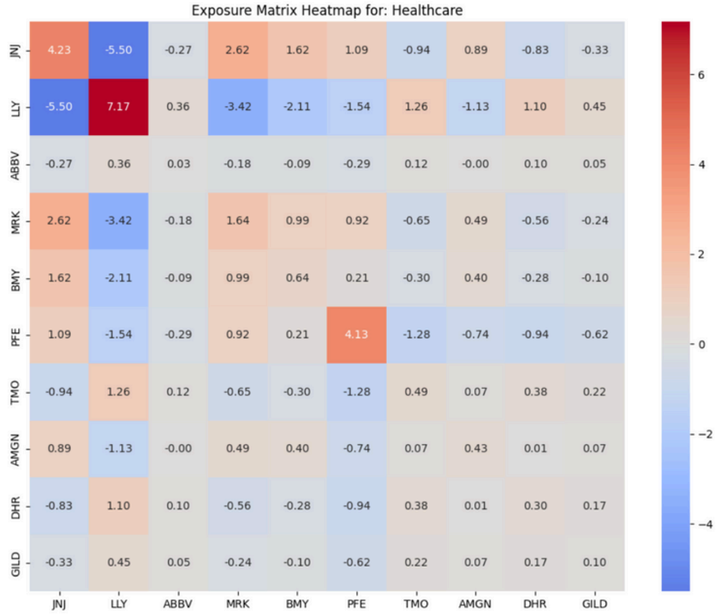
FINANCE

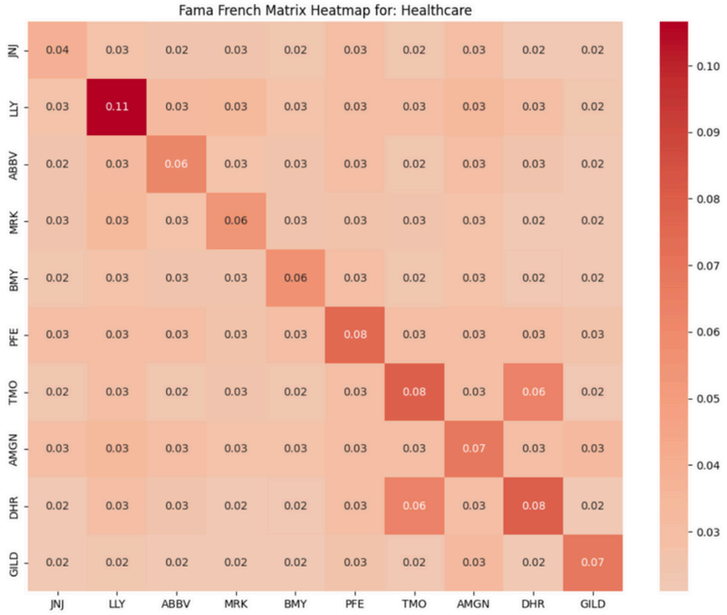

Exposure Matrix Heatmap for: Finance
JPM 1.57 0.44 -1.93 -0.71 -0.77 0.68 -2.11 3.39 2.05 -2.88
BAC 0.44 2.91 1.15 -0.17 -1.42 -1.50 0.45 -0.53 -0.78 -0.49
WFC -1.93 1.15 3.39 0.89 0.23 -1.85 3.23 -5.06 -3.35 3.73
MS -0.71 -0.17 0.89 0.32 0.34 -0.33 0.97 -1.55 -0.95 1.31
GS -0.77 -1.42 0.23 0.34 0.90 0.39 0.60 -1.04 -0.43 1.29
BLK 0.68 -1.50 -1.85 -0.33 0.39 1.31 -1.54 2.36 1.71 -1.43
C -2.11 0.45 3.23 0.97 0.60 -1.54 3.25 -5.13 -3.28 4.01
V 3.39 -0.53 -5.06 -1.55 -1.04 2.36 -5.13 8.11 5.16 -6.39
MA 2.05 -0.78 -3.35 -0.95 -0.43 1.71 -3.28 5.16 3.35 -3.93
AXP -2.88 -0.49 3.73 1.31 1.29 -1.43 4.01 -6.39 -3.93 5.33
JPM BAC WFC MS GS BLK C V MA AXP
8 6 4 2 0 −2 −4 −6

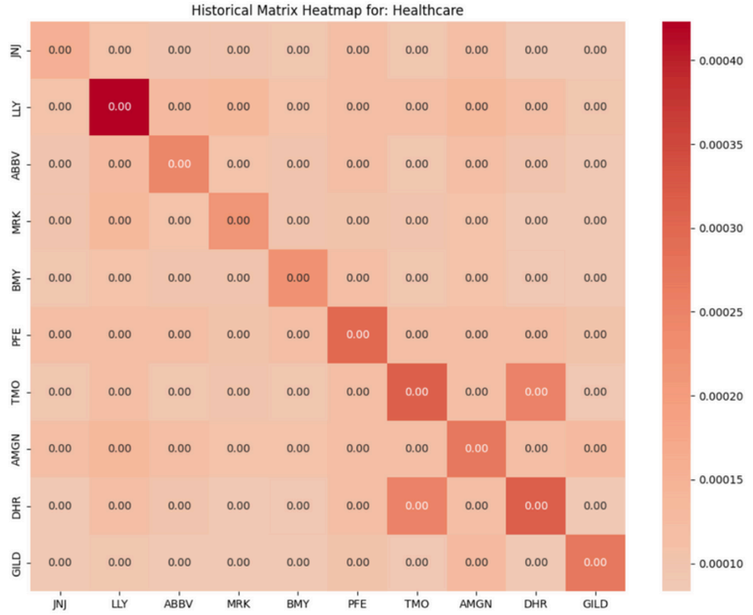

Fama French Matrix Heatmap for: Finance
JPM 0.10 0.10 0.10 0.09 0.09 0.07 0.11 0.06 0.06 0.10
BAC 0.10 0.13 0.12 0.10 0.10 0.08 0.12 0.06 0.06 0.11
WFC 0.10 0.12 0.15 0.11 0.10 0.07 0.12 0.06 0.06 0.11
MS 0.09 0.10 0.11 0.13 0.10 0.08 0.11 0.06 0.07 0.10
GS 0.09 0.10 0.10 0.10 0.11 0.07 0.11 0.05 0.06 0.09
BLK 0.07 0.08 0.07 0.08 0.07 0.10 0.08 0.06 0.06 0.08
C 0.11 0.12 0.12 0.11 0.11 0.08 0.15 0.06 0.07 0.11
V 0.06 0.06 0.06 0.06 0.05 0.06 0.06 0.08 0.08 0.07
MA 0.06 0.06 0.06 0.07 0.06 0.06 0.07 0.08 0.10 0.08
AXP 0.10 0.11 0.11 0.10 0.09 0.08 0.11 0.07 0.08 0.15
JPM BAC WFC MS GS BLK C V MA AXP
0.14 0.12 0.10 0.08 0.06


Historical Matrix Heatmap for: Finance
JPM 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
BAC 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
WFC 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MS 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
GS 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
BLK 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
C 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
V 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MA 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AXP 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
JPM BAC WFC MS GS BLK C V MA AXP
0.00060 0.00055 0.00050 0.00045 0.00040 0.00035 0.00030 0.00025

HEALTHCARE


Exposure Matrix Heatmap for: Healthcare
JNJ 4.23 -5.50 -0.27 2.62 1.62 1.09 -0.94 0.89 -0.83 -0.33
LLY -5.50 7.17 0.36 -3.42 -2.11 -1.54 1.26 -1.13 1.10 0.45
ABBV -0.27 0.36 0.03 -0.18 -0.09 -0.29 0.12 -0.00 0.10 0.05
MRK 2.62 -3.42 -0.18 1.64 0.99 0.92 -0.65 0.49 -0.56 -0.24
BMY 1.62 -2.11 -0.09 0.99 0.64 0.21 -0.30 0.40 -0.28 -0.10
PFE 1.09 -1.54 -0.29 0.92 0.21 4.13 -1.28 -0.74 -0.94 -0.62
TMO -0.94 1.26 0.12 -0.65 -0.30 -1.28 0.49 0.07 0.38 0.22
AMGN 0.89 -1.13 -0.00 0.49 0.40 -0.74 0.07 0.43 0.01 0.07
DHR -0.83 1.10 0.10 -0.56 -0.28 -0.94 0.38 0.01 0.30 0.17
GILD -0.33 0.45 0.05 -0.24 -0.10 -0.62 0.22 0.07 0.17 0.10
JNJ LLY ABBV MRK BMY PFE TMO AMGN DHR GILD
6 4 2 0 −2 −4


Fama French Matrix Heatmap for: Healthcare
JNJ 0.04 0.03 0.02 0.03 0.02 0.03 0.02 0.03 0.02 0.02
LLY 0.03 0.11 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.02
ABBV 0.02 0.03 0.06 0.03 0.03 0.03 0.02 0.03 0.03 0.02
MRK 0.03 0.03 0.03 0.06 0.03 0.03 0.03 0.03 0.02 0.02
BMY 0.02 0.03 0.03 0.03 0.06 0.03 0.02 0.03 0.02 0.02
PFE 0.03 0.03 0.03 0.03 0.03 0.08 0.03 0.03 0.03 0.03
TMO 0.02 0.03 0.02 0.03 0.02 0.03 0.08 0.03 0.06 0.02
AMGN 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.07 0.03 0.03
DHR 0.02 0.03 0.03 0.02 0.02 0.03 0.06 0.03 0.08 0.02
GILD 0.02 0.02 0.02 0.02 0.02 0.03 0.02 0.03 0.02 0.07
JNJ LLY ABBV MRK BMY PFE TMO AMGN DHR GILD
0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03


Historical Matrix Heatmap for: Healthcare
JNJ 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
LLY 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
ABBV 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
MRK 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
BMY 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
PFE 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
TMO 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
AMGN 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
DHR 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
GILD 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
JNJ LLY ABBV MRK BMY PFE TMO AMGN DHR GILD
0.00040 0.00035 0.00030 0.00025 0.00020 0.00015 0.00010

PORTFOLIOS

THE GOAL



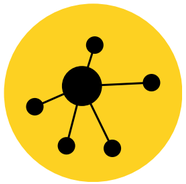
To maintain alignment with a benchmark (**market-cap-weighted portfolio**) while tilting - favoring - specific factor exposures (e.g., short-term indicators, Tucker factors)

FACTOR TILTING



Factor tilting means **adjusting portfolio weights** to increase exposure to some specific factors while still maintaining some alignment with a benchmark

THEREFORE..



When the script incorporates factor tilts, it means that instead of just matching the benchmark, **it overweights stocks with positive factor exposures and underweights (or avoids) stocks with negative factor exposures**

COMPONENTS

- **TRACKING ERROR**

It measures how much the optimized portfolio deviates from the benchmark

$$TE = (w - w_b)^T \Sigma (w - w_b)$$

w = Optimized portfolio weights.

w_b = Benchmark (market cap-weighted) portfolio weights.

Σ = Asset return covariance matrix.

- a measure of **portfolio return variance** due to weight differences
- a practical way to quantify active risk caused by deviations from the benchmark

- **PENALTY**

A penalty is applied for deviating too far from a target factor exposure

$$\text{Penalty} = \lambda_{tilt} \sum (B^T w - \text{tilt target})^2$$

B = Factor exposures per stock.

λ_{tilt} = Hyperparameter controlling tilt strength.

Factor exposure: how much is stock is influenced by a specific factor

- **TILT TARGET**

Target on the portfolio exposure:
in this case, the exposure to Tucuker_2 exposure of the benchmark

$$\text{Tilt Target} = \sum_i w_{b,i} F_i$$

- Where F_i represents the factor exposures for **all factors** in B.
- This ensures that each factor in B has a corresponding tilt target.

By tilting your portfolio toward Tucker 2, we ensure that the impact of the factors in our new portfolio is close to the impact of Tucker_2 on the benchmark

Tucker_2 favors smaller stocks with lower value but higher momentum and quality, and lower volatility

```
Loadings dei fattori Tucker:
                      Size     Value  Momentum   Quality Volatility
Tucker_Factor_1 -0.452759 -0.404855 -0.362565 -0.447017   0.447017
Tucker_Factor_2 -0.370082  -0.64374  0.343153  0.339768  -0.339768
```

OPTIMIZATION

- **OBJECTIVE**

  Ensures the optimized portfolio is both **benchmark-aligned** and **factor-tilted**

$$\min_{w} \quad \text{Tracking Error} + \text{Factor Tilt Penalty}$$

  This ensures that the portfolio:
  - **minimizes tracking error** relative to the benchmark
  - **controls exposure to specific factors** (via tilt penalty)

- **CONSTRAINTS**
  - the weights must sum to 1 (f**ully invested portfolio**)

$$\sum w_i = 1$$

  - **long short portfolio**

$$-1 \leq w_i \leq 1$$

OTHER CALCULATIONS

- **PORTFOLIO VOLATILITY**

  Measures overall risk, including both **systematic (factor-driven)** and **idiosyncratic (asset-specific) risks**

$$\sigma_P = \sqrt{w^T \Sigma w}$$

w = Vector of **portfolio weights**.

Σ = **Asset return covariance matrix**, which represents the historical or estimated co-movements of stock returns.

Normally used for setting **risk limits** to make sure that the portfolio portfolio stays **within an acceptable risk range**

- **FACTOR-BASED VOLATILITY**

  Measures systematic risk, i.e., **risk due to exposure to common risk**

$$\sigma_F = \sqrt{w^T B \Sigma_F B^T w}$$

w = Vector of **portfolio weights**.

B = **Matrix of factor exposures**, where each stock has loadings on different factors.

Σ_F = **Factor return covariance matrix**, which captures the **relationships between factors**.

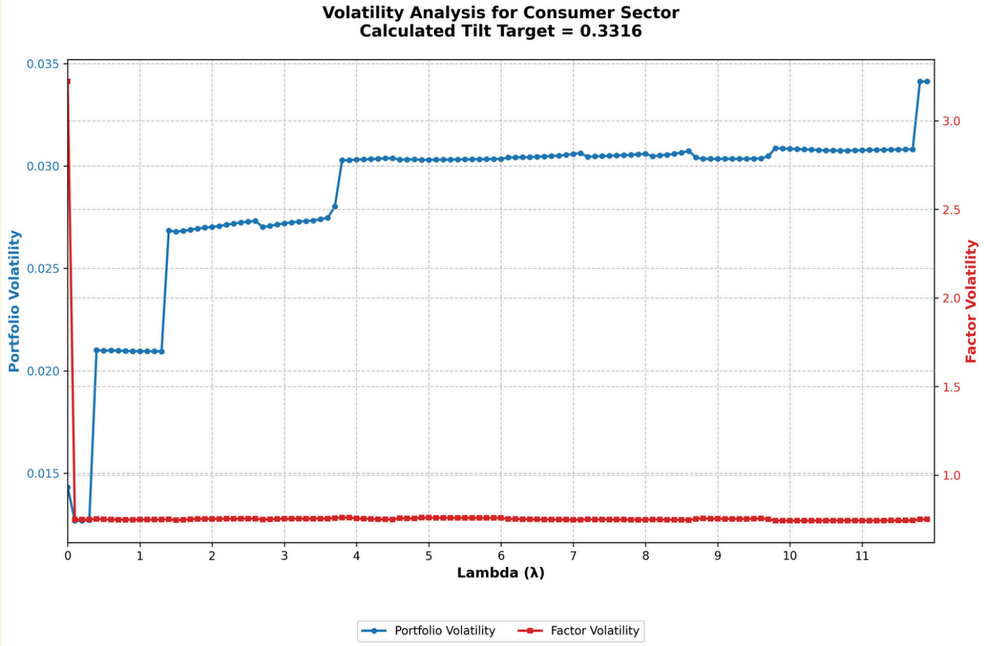
Normally used for **allocation** purposes to make sure that the portfolio is **diversified across risk factors**

- **High Factor Volatility** → the portfolio is overexposed to certain risk factors
- **Low Factor Volatility** → the portfolio has weak factor exposure and may be too diversified

LAMBDA - FACTOR CONTROL

	Suggested lambda	Interpretation
Light Tilt Control	0.01 - 1	Discourages extreme exposures - allows some factor tilts
Balanced Factor Control	1-10	If the goal is to reduce factor risk but still allow some flexibility -balance between factor exposure and factor risk
Strong Factor Control	10-100	Strongly discourages any factor exposure

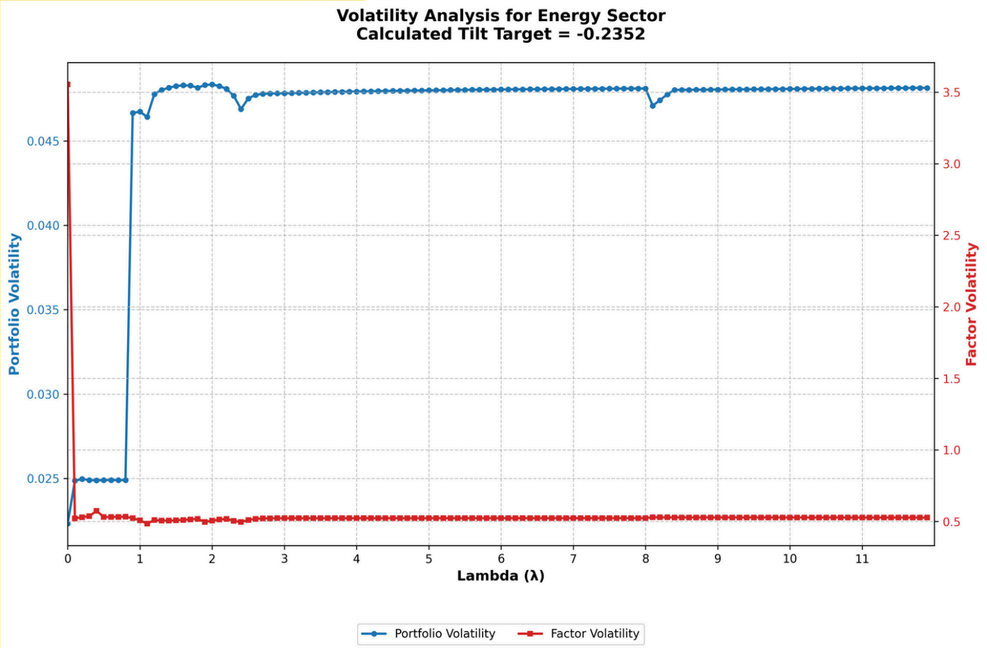
CONSUMER SECTOR



Best Choice: 2 < λ < 6

- Portfolio volatility is relatively stable
- Factor volatility remains low and controlled
- There are no sharp jumps in portfolio volatility

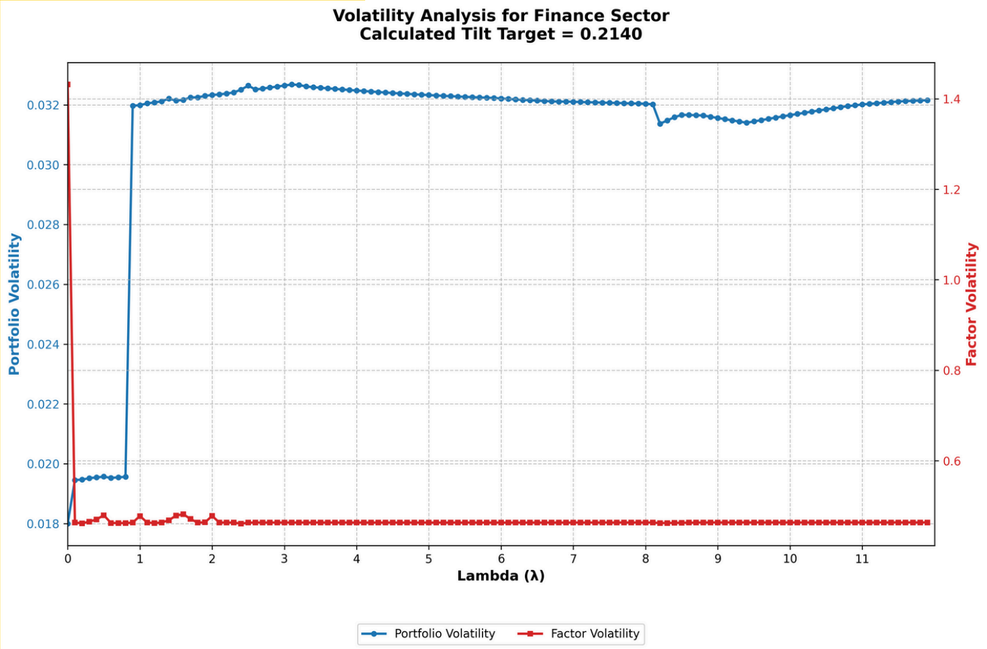
ENERGY SECTOR



Best Choice: 2.5 < λ < 7.5

- Factor volatility is stable at a low level.
- Portfolio volatility stabilizes

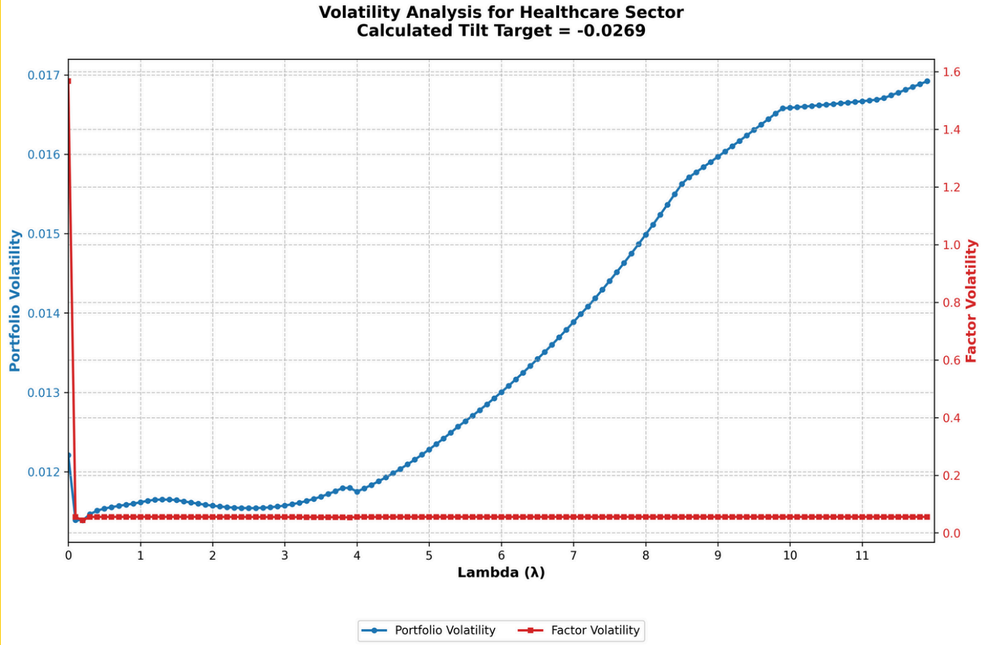
FINANCE SECTOR



Best Choice: 4 < λ < 8

- provides a balanced risk-return trade-off

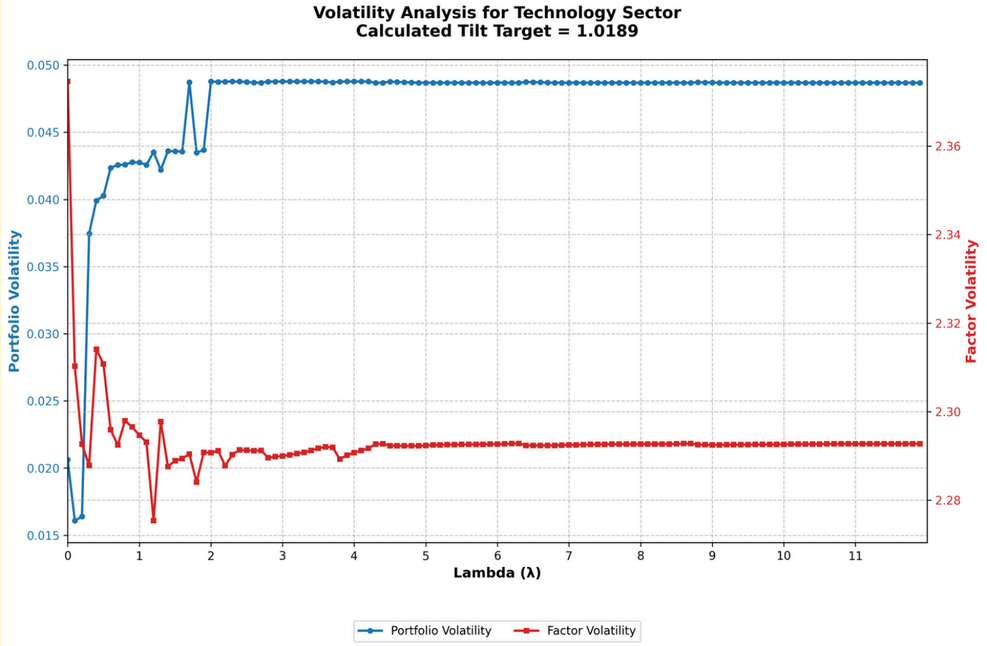
HEALTHCARE SECTOR



Best Choice: 2 < λ < 3

- Factor volatility is low and stable
- Portfolio volatility remains relatively stable
- No unnecessary increase in risk

TECHNOLOGY SECTOR



Best Choice: λ < 3

- No significant fluctuations beyond this range

THANK YOU