



Group 3
Trend-Following Strategy

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Introduction

We Invest Solely On Trends



Trend-Following

The Strategy seeks to provide **long-term capital appreciation**. The Fund invests primarily in industry and factor portfolios, and seeks to **maximize returns in the long run**.

Introduction



Investment Thesis

Long the “winners”, Short the “losers”

The momentum effect is based on the idea that assets with relatively higher returns in the recent past trend tend to have a relatively higher future returns than assets with relatively lower past returns.

This strategy seeks to capitalize on the continuation of existing market trends, whether upward or downward.

Investment Universe

01

Listing Criteria

Firms incorporated in the US, and listed on the NYSE, AMEX, or NASDAQ.

02

Security Type

Only ordinary common shares.
No ADRs, Certificates, Shares of Beneficial Interest.

03

Data Availability

Shares must have good pricing and returns data as of inclusion date.

Key

Return

Drivers

01

Macroeconomic Factors

Affects broader economic environment, inducing continued market trends in either direction that can be exploited.

02

Behavioral Factors

Overconfidence, under-confidence, and other biases encourages momentum by over/under-reaction.

03

Valuation Multiples

If markets assign higher/lower valuation multiples to industry over time, it can lead to sustained trends.

Key

Risk

Drivers

01

Momentum
Crashes

Risk of a sudden strong market correction after a period of recession.

02

Asset Class

Similar to risk of underlying asset class.

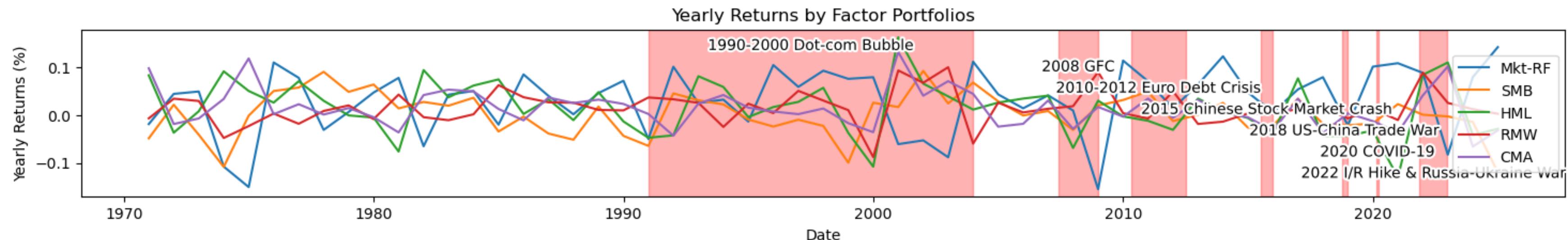
03

Illiquidity/
Ability to short

Ability to take short positions might be impaired/hindered by availability or excessive borrowing fees.

Research

Returns - 5 Factor Portfolios

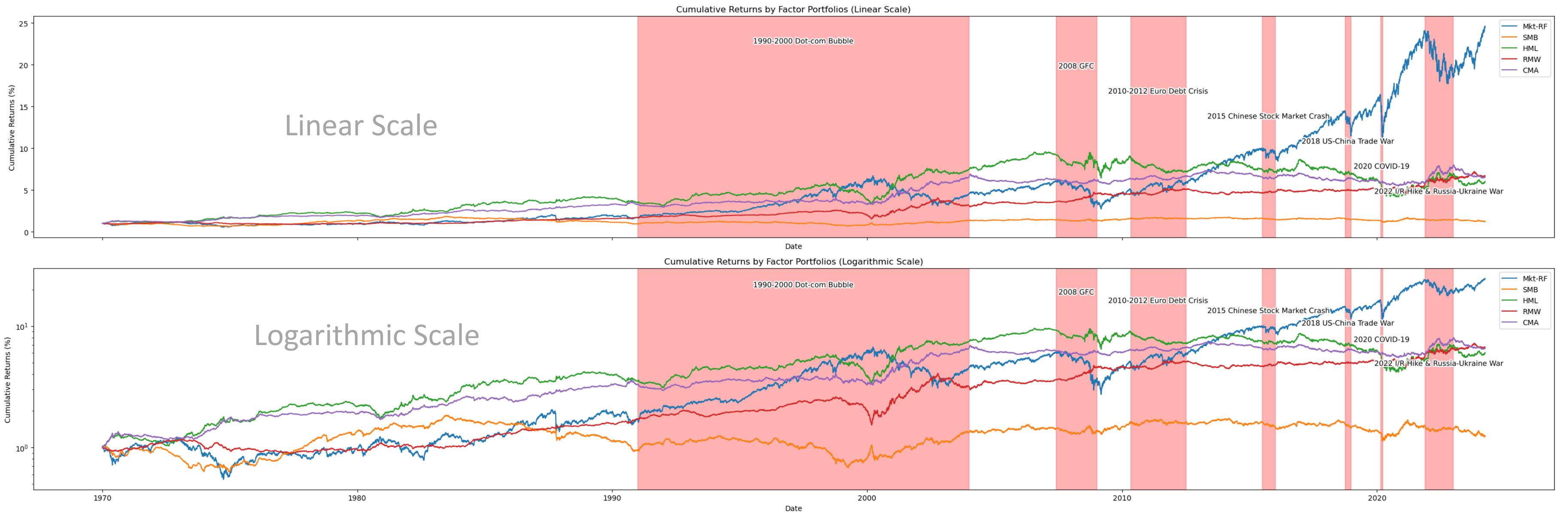


Factor	Count of Positive Annual Returns	Count of Negative Annual Returns	Annualized Volatility (Market Crashes)	Annualized Volatility (Normal Periods)
Mkt-RF	41	14	24.65%	16.86%
SMB	29	26	9.26%	9%
HML	32	23	19.56%	9.65%
RMW	40	15	13.63%	6.59%
CMA	35	20	12.63%	6.14%

- Visually, we observe that the yearly returns of the 5 Factor Portfolios follows a somewhat cyclical pattern
 - Indicating a rise and fall of momentum in the underlying price
- Volatility of returns during major market crashes > normal periods
 - A momentum-based strategy may perform strongly during such periods
- No. **positive** annual returns > No. **negative** annual returns
 - Indication of how we should balance our long / short portfolio

Research

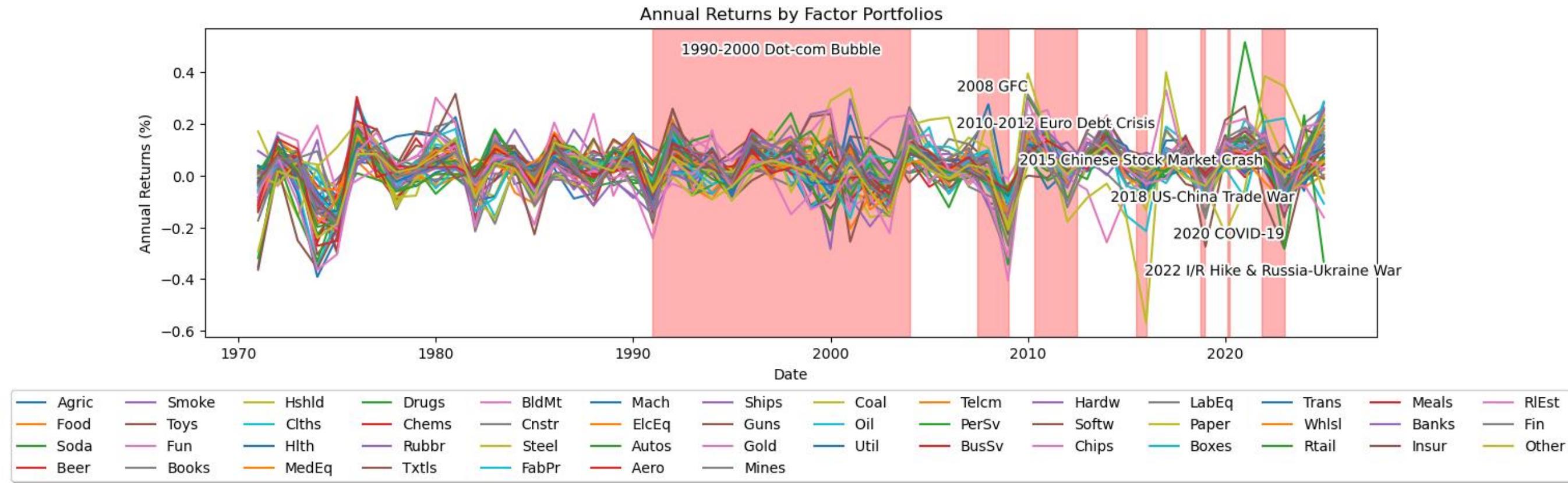
Returns - 5 Factor Portfolios



- Plotting the historical returns of the 5 Factor Portfolios, we observe that the portfolios tend to have positive returns given sufficient time – Gives us direction on long and short weightage allocation for our trading strategy

Research

Returns – 49 Industry Portfolios



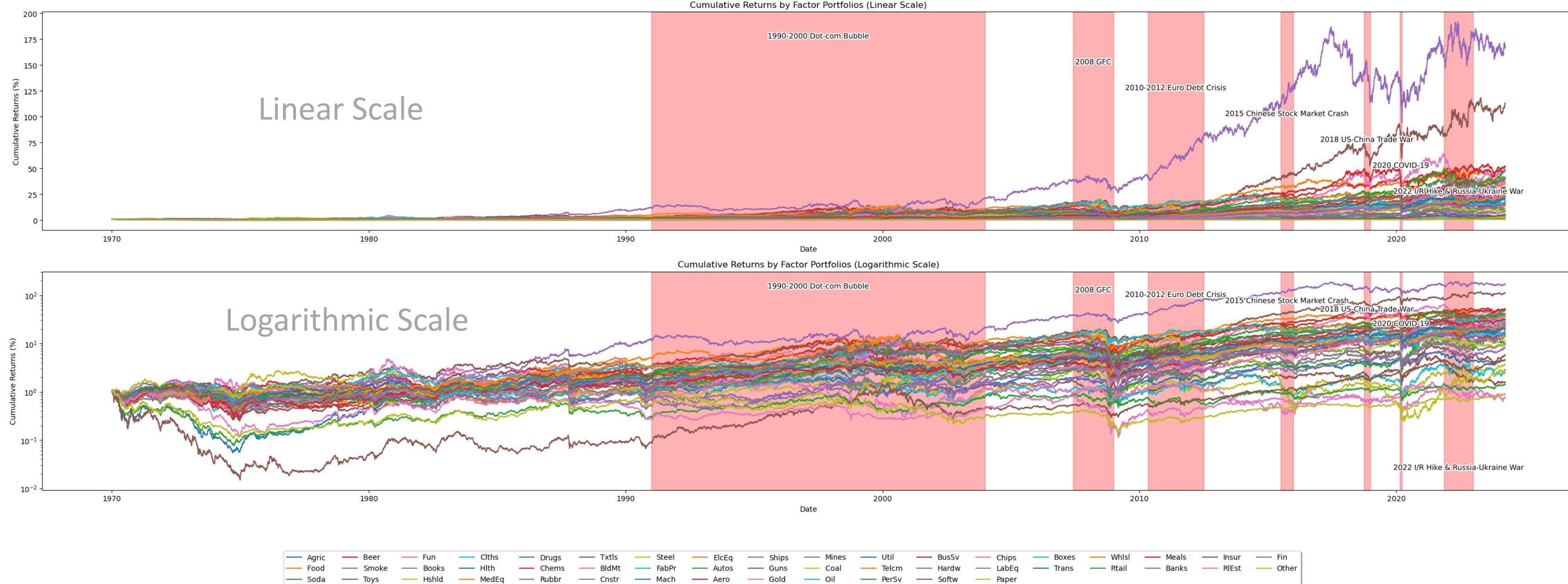
Industry	Count of Positive Annual Returns	Count of Negative Annual Returns	Annualized Volatility (Market Crashes)	Annualized Volatility (Normal Periods)
Coal	30	25	59.26%	39.87%
Autos	33	22	54.43%	26.33%
FabPr	33	22	53.68%	27.24%
Fun	43	12	44.30%	27.16%
Toys	31	24	43.30%	25.29%
Steel	37	18	40.55%	27.41%
Gold	28	27	37.98%	37.35%
Clths	35	20	37.81%	21.44%
Txlts	37	18	46.67%	24.21%
Mines	34	21	36.01%	26.86%

- Positively performing years outnumber the negative
- Returns follow a cyclical pattern
- Volatility during crises periods is higher than the non crises periods

*10 randomly selected industries for brevity

Research

Returns – 49 Industry Portfolios



- Plotting the historical returns of the 49 Industry Portfolios, we observe that the portfolios tend to have positive returns given sufficient time – Gives us direction on long and short weightage allocation for our trading strategy



Investment Methodology

Defining Momentum

We test two methods to capture momentum risk premia.

1. Returns over lookback period > cross-sectional returns
2. Crossing of moving averages

Industry & factor slices follow Fama & French methodology.

Benchmark will be the market portfolio as defined by Fama & French.

The following analyzes parameter tuning over the backtest period of 1970 – 2024.

Weighting Schemes

01

Equal Weighted

Equal weight long and short positions

02

Rank Weighted

Rank Assets based on **momentum strength**.
Rescaled to ensure **net 100% long**.

03

Target Volatility

Scaling asset weights to **smoothen portfolio volatility** depending on **volatility states** (target 20%).

Other Parameters

01

Rebalancing Frequency

Monthly Rebalancing

First trading day of each month

Quarterly Rebalancing.

First trading day of Jan/Apr/Jul/Oct.

02

Position Constraints

Total short position up to -100% of portfolio value.

Total net position must sum to 100%
(borrow/lend at risk-free rate).

03

Slippage

Assume constant 0.5% slippage.

Strategy

Period Returns

On Rebalancing Day

If past 61d returns > median cross-sectional returns

Long

Else

Short

Python Code

```
period_ret = (hist_df + 1).prod() - 1

weights = np.where(period_ret.values > np.median(period_ret.values), 1, -1)

weights = self.compute_equal_weights(weights)
```



Strategy

MA Cross

On Rebalancing Day

If $MA1(7d) \geq MA2(21d)$

Long

Else

Short

Python Code

```
MA = trend_indicators(hist_df)
MA_1 = MA.compute_moving_average(window_1)[-1]
MA_2 = MA.compute_moving_average(window_2)[-1]

weights = np.where(MA_1 >= MA_2, 1, -1)
weights = self.compute_equal_weights(weights)
self.weights[date] = weights
```



Strategy

Setup

Backtest

- rebalancing
- generate_performance
- generate_report
- plotting_metrics

Strategy

- compute_equal_weights
- compute_ranked_weights
- compute_vol_target_weights
- moving_avg_crossover
- trailing_rets

Trend_indicators

- compute_moving_average

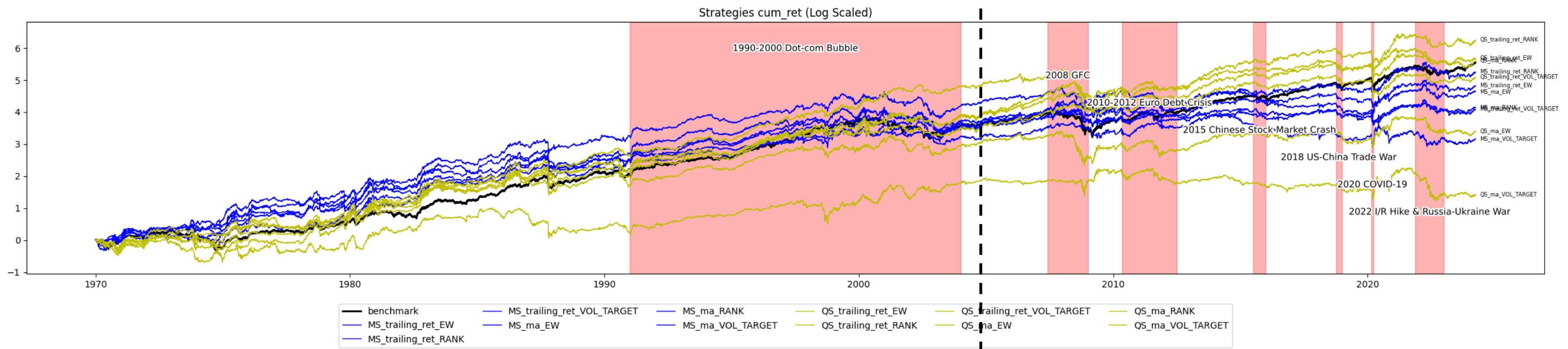
Compare

- compare_chart

Performance

- compute_cum_rets
- compute_annualized_rets
- compute_sharpe
- compute_rolling_sharpe
- compute_sortino
- compute_rolling_sortino
- compute_max_dd
- compute_drawdown
- compute_volatility
- compute_information_ratio
- compute_rolling_information_ratio
- compute_rolling_beta

Strategy – Monthly Vs Quarterly Rebalancing

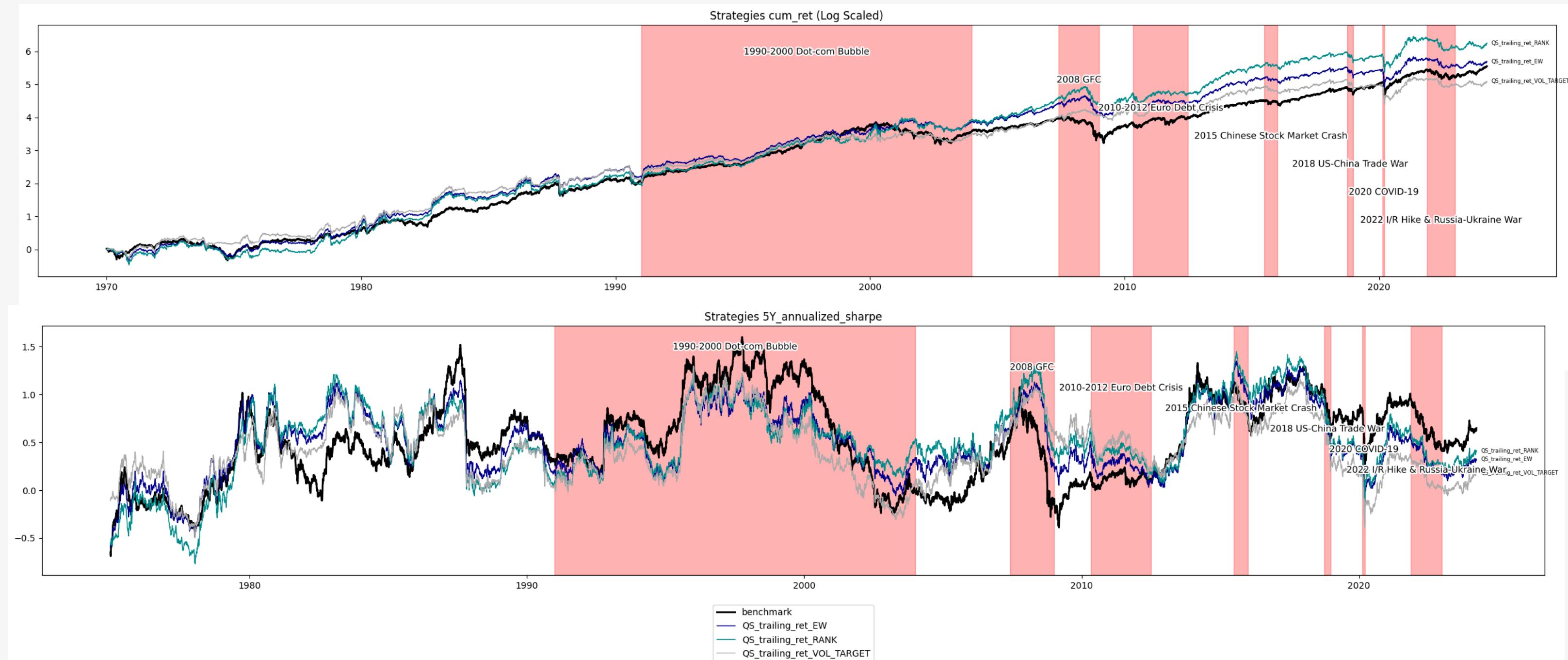


Monthly Rebalanced Portfolios outperformed quarterly rebalanced portfolios

Quarterly Rebalanced Portfolios outperformed monthly rebalanced portfolios post 2000s

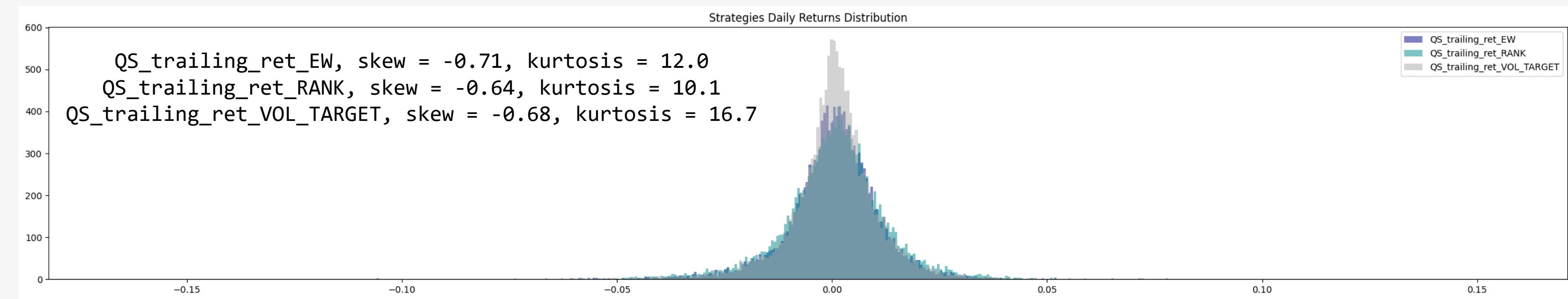
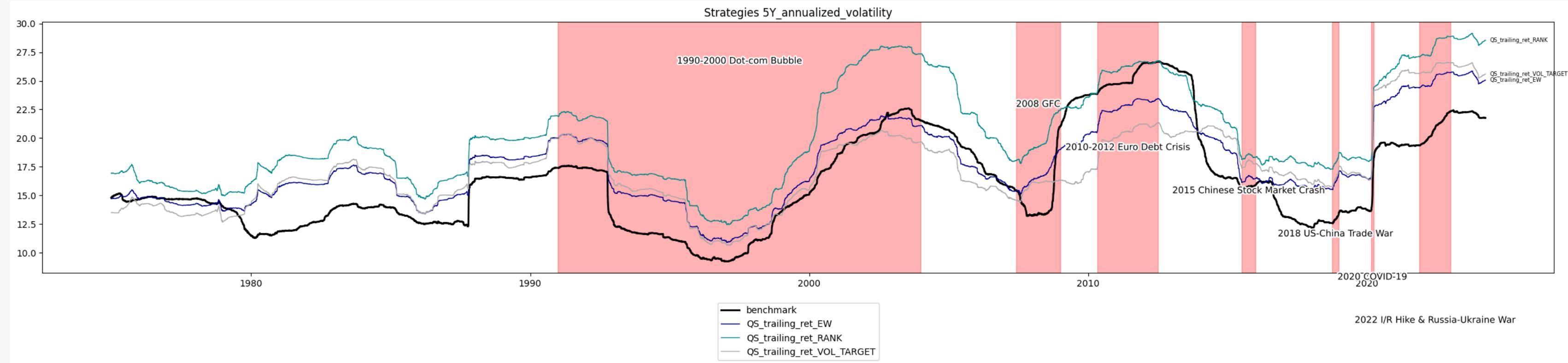
- Monthly rebalancing prompts adjustments during temporary reversals.
- Quarterly rebalancing avoids premature adjustments that could overlook larger trends.

Strategy – Weighting Scheme Comparison



- Ranked weighting outperformed for the most part
- Volatility targeting did not improve Sharpe
 - Reasons: Constant volatility assumption, Constrained by -100/200% unlevered, Point-in-Time rebalancing

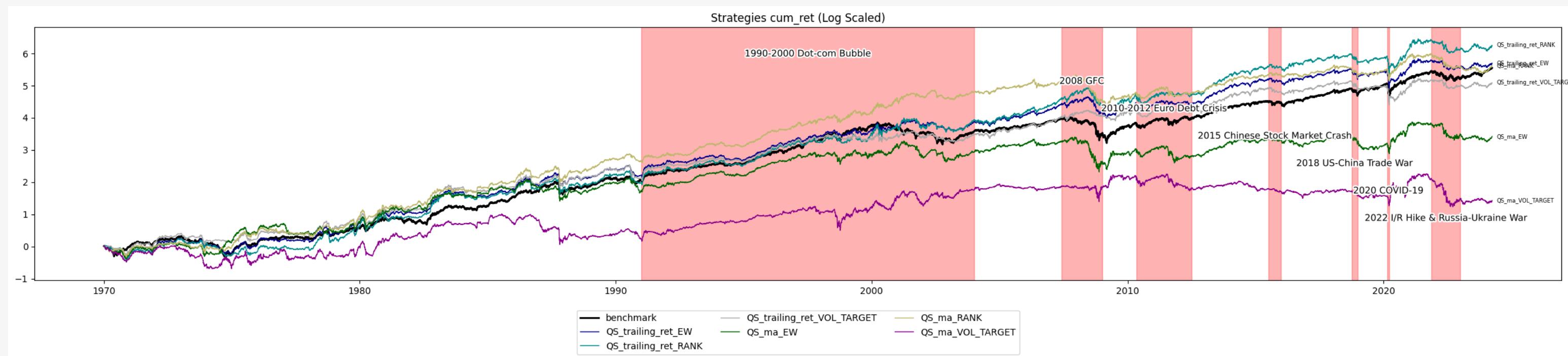
Strategy – Weighting Scheme Comparison



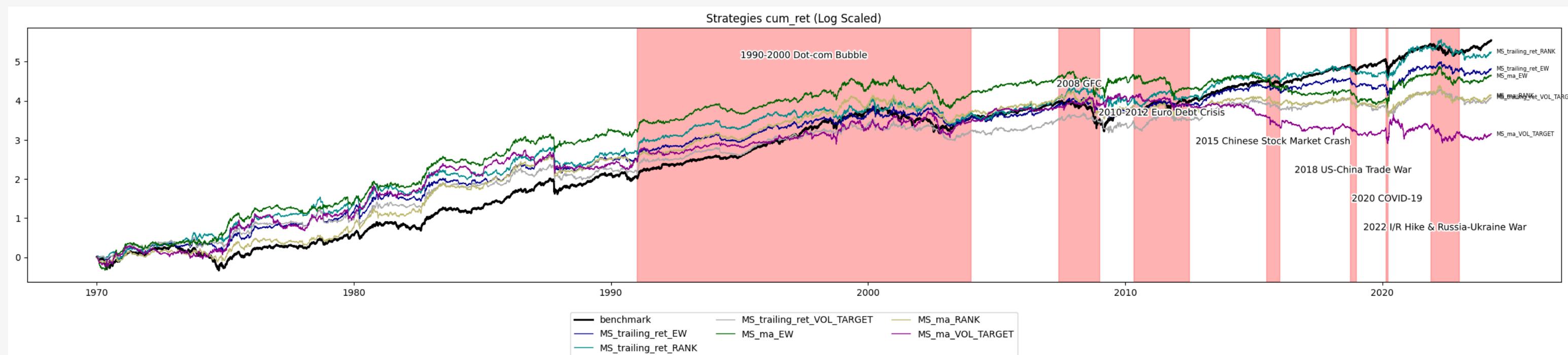
Volatility targeting reduces volatility of portfolio with higher kurtosis

Strategy - Cumulative Returns

Quarterly Rebalancing

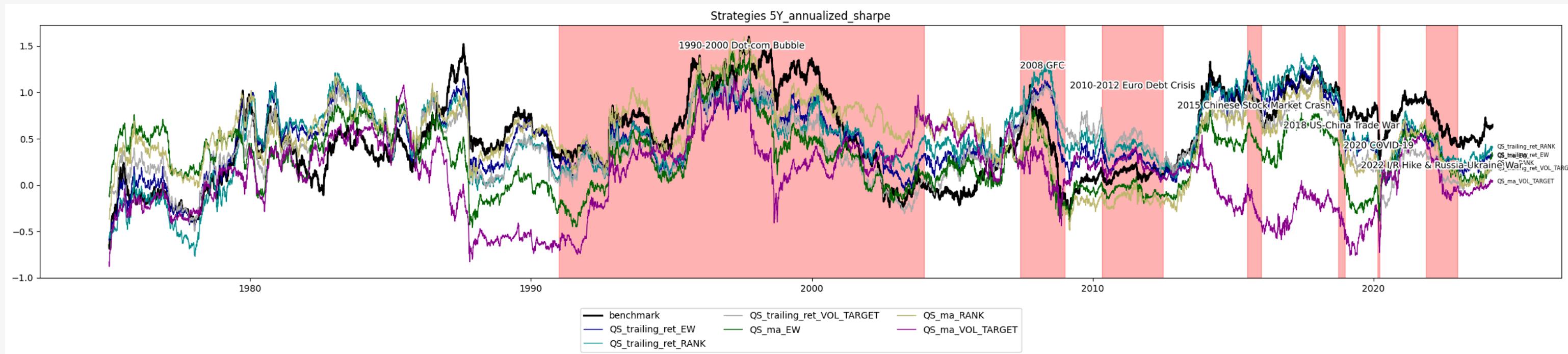


Monthly Rebalancing

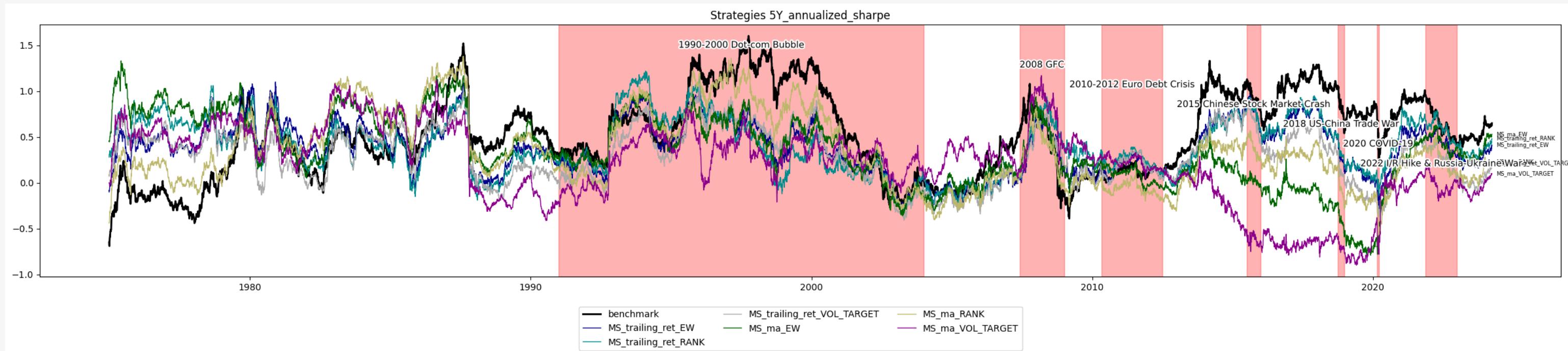


Strategy - T5Y Rolling Sharpe

Quarterly Rebalancing



Monthly Rebalancing

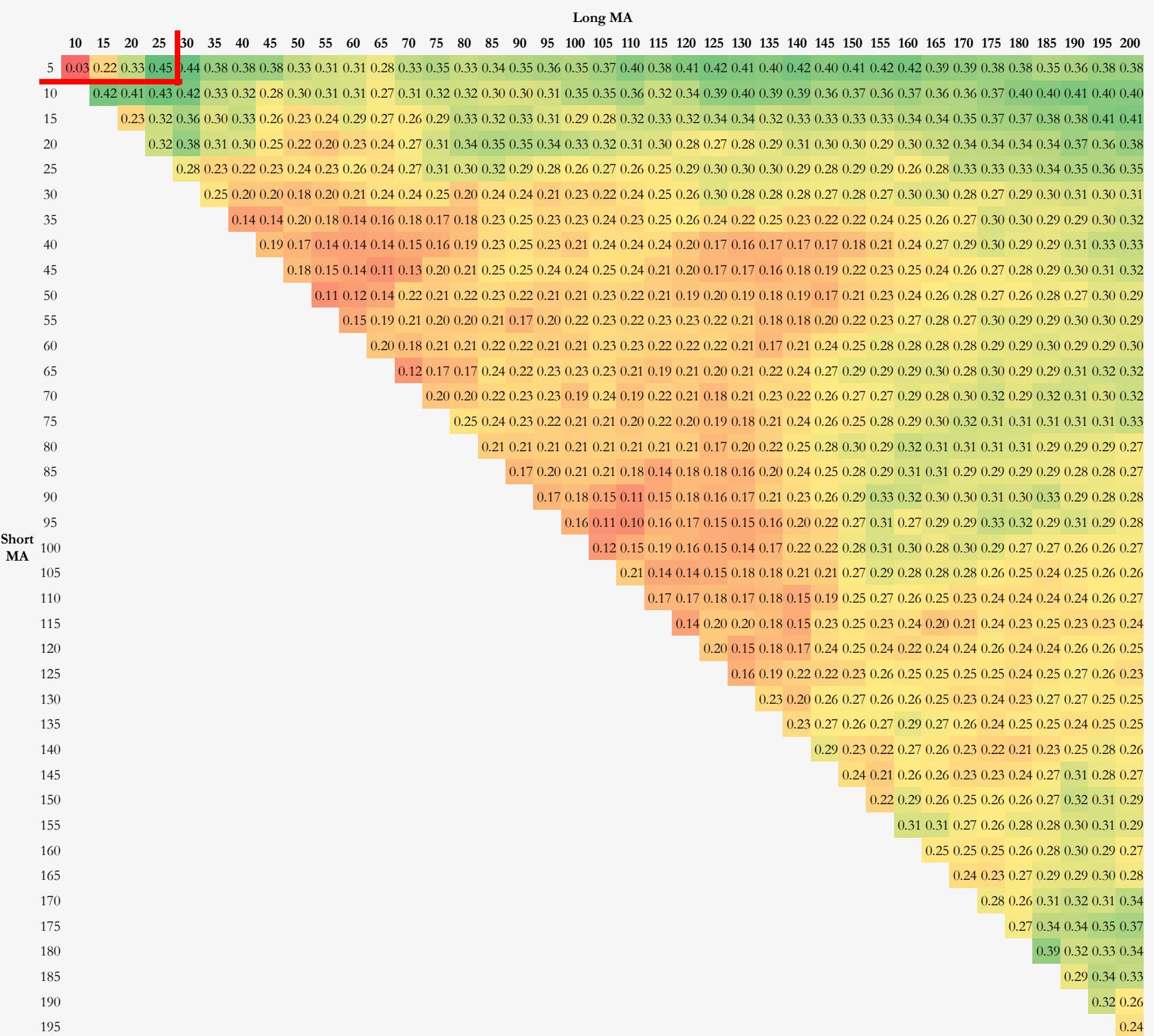


Strategy - Sensitivity Analysis – MA Cross Average 5Y Sharpe Equal Weight

Quarterly Rebalancing

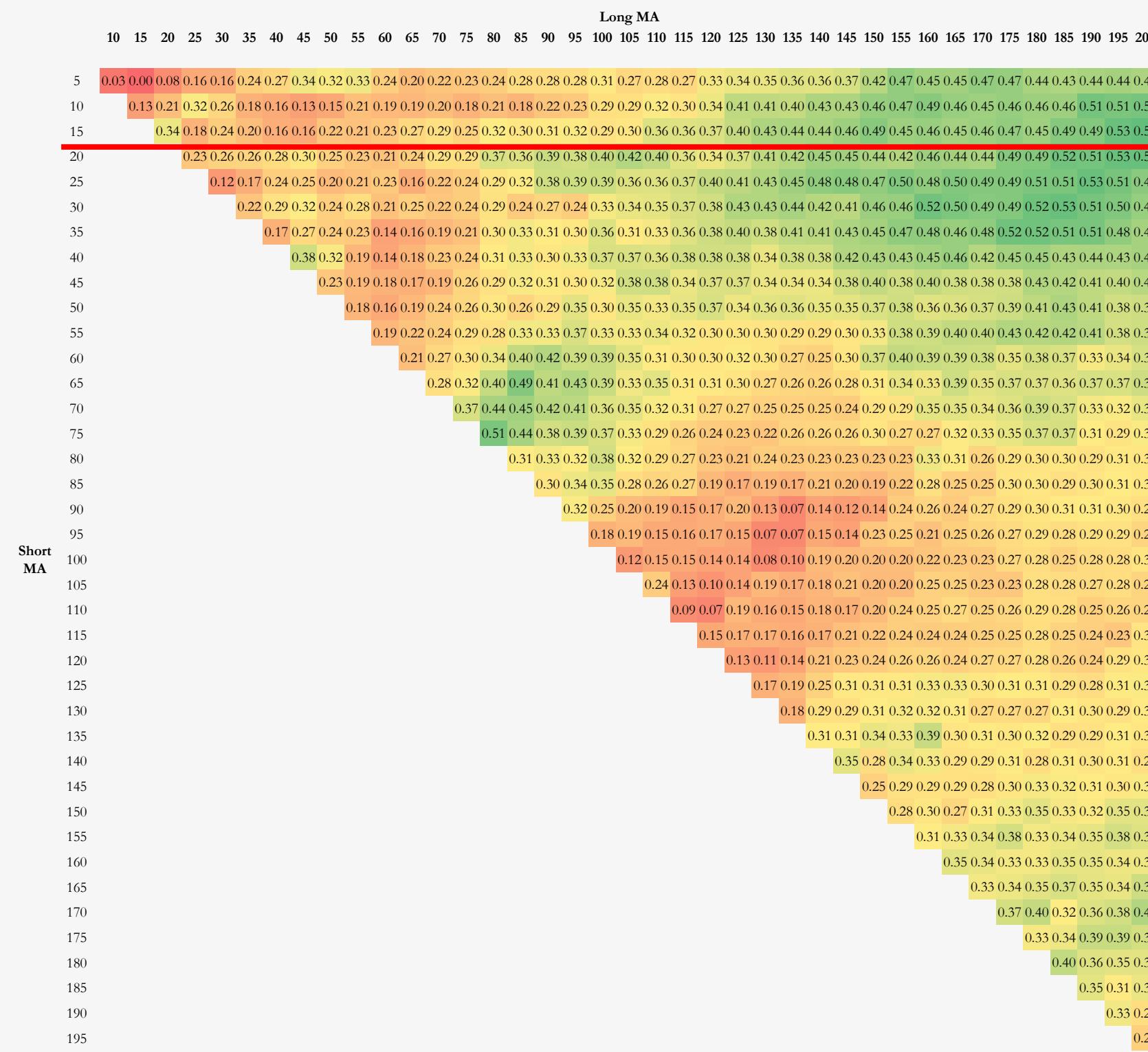


Monthly Rebalancing



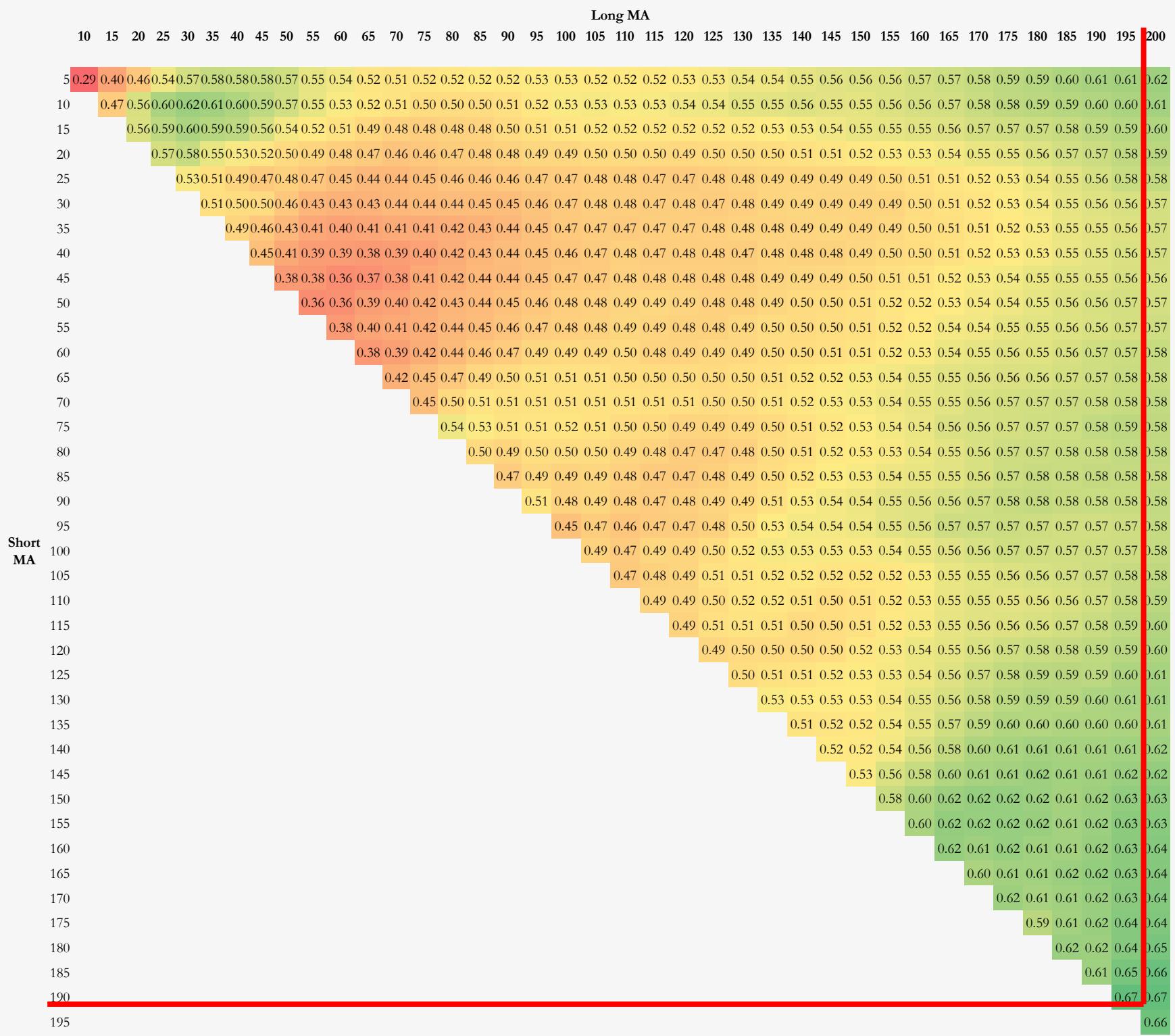
Strategy - Sensitivity Analysis – MA Cross Average 5Y Sharpe Volatility Targeting

Quarterly Rebalancing

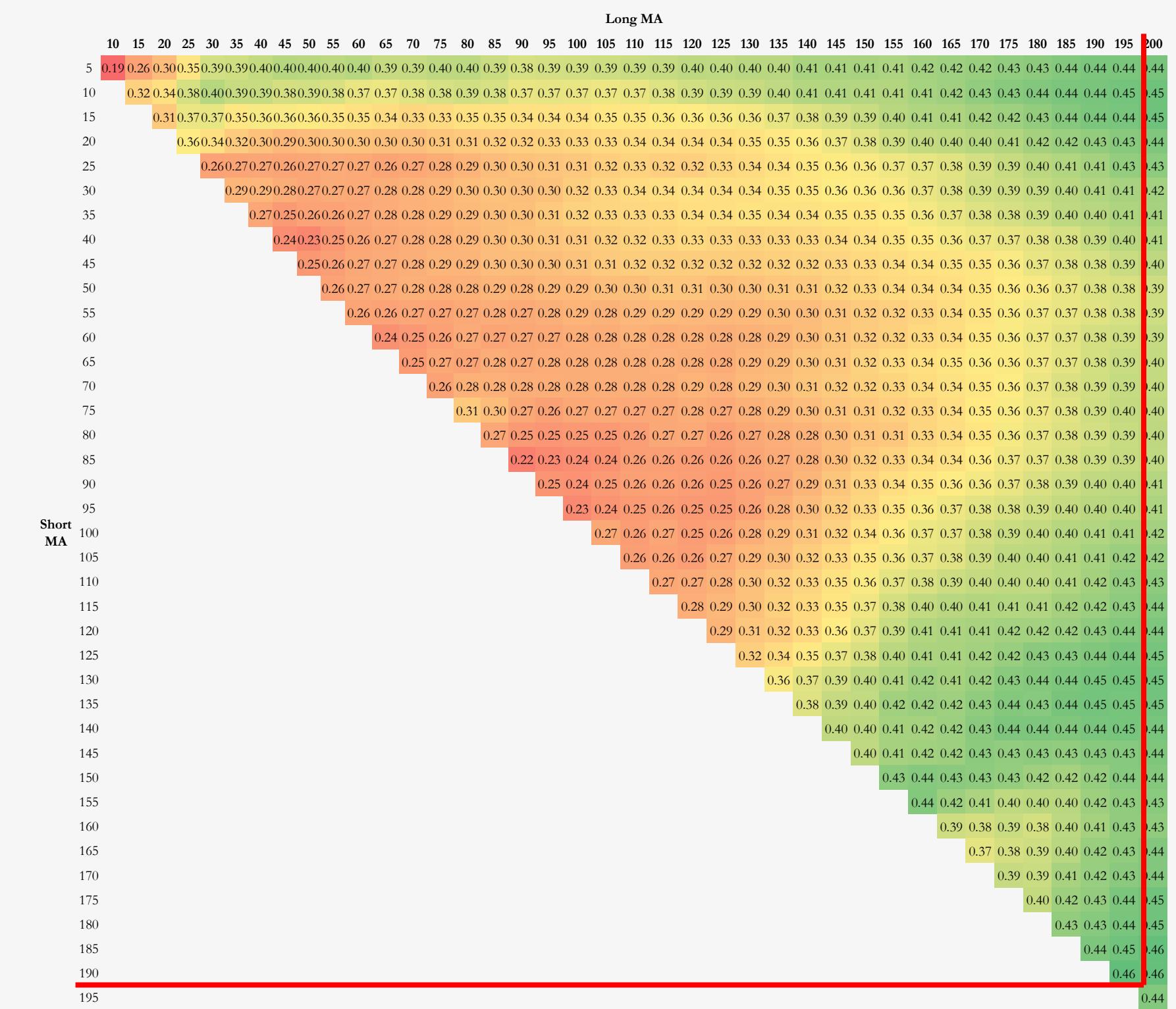


Strategy - Sensitivity Analysis – MA Cross Average 5Y Sharpe Ranked

Quarterly Rebalancing



Monthly Rebalancing



Strategy - Sensitivity – Period Returns Average 5Y Sharpe

Quarterly Rebalancing

lookback	Avg T5Y Sharpe		
	Equal	Ranked	Vol_Target
5	0.27	0.25	0.12
10	0.37	0.35	0.26
15	0.33	0.33	0.27
20	0.43	0.45	0.33
25	0.49	0.49	0.44
30	0.48	0.50	0.45
35	0.53	0.54	0.44
40	0.55	0.55	0.47
45	0.53	0.53	0.47
50	0.53	0.54	0.44
55	0.52	0.53	0.43
60	0.51	0.55	0.44
65	0.54	0.53	0.46
70	0.49	0.52	0.40
75	0.45	0.47	0.38
80	0.43	0.44	0.35
85	0.44	0.44	0.39
90	0.48	0.46	0.41
95	0.52	0.46	0.45
100	0.49	0.48	0.40
105	0.46	0.48	0.37
110	0.48	0.52	0.40
115	0.47	0.50	0.36
120	0.51	0.53	0.42
125	0.49	0.51	0.38
130	0.52	0.55	0.41
135	0.56	0.55	0.44
140	0.53	0.54	0.41
145	0.53	0.53	0.41
150	0.47	0.51	0.32
155	0.48	0.51	0.33
160	0.49	0.49	0.35
165	0.51	0.49	0.38
170	0.49	0.48	0.36
175	0.52	0.51	0.40
180	0.52	0.52	0.38
185	0.53	0.51	0.40
190	0.50	0.50	0.38
195	0.48	0.49	0.33
200	0.48	0.49	0.35

Monthly Rebalancing

lookback	Avg T5Y Sharpe		
	Equal	Ranked	Vol_Target
5	0.03	-0.02	-0.10
10	0.20	0.19	0.21
15	0.29	0.35	0.30
20	0.33	0.37	0.30
25	0.37	0.42	0.36
30	0.44	0.49	0.45
35	0.46	0.52	0.48
40	0.49	0.52	0.51
45	0.45	0.48	0.43
50	0.47	0.48	0.38
55	0.40	0.46	0.33
60	0.37	0.40	0.29
65	0.43	0.42	0.34
70	0.38	0.42	0.29
75	0.36	0.42	0.26
80	0.37	0.42	0.32
85	0.40	0.40	0.34
90	0.38	0.41	0.33
95	0.37	0.40	0.31
100	0.39	0.43	0.35
105	0.34	0.41	0.28
110	0.33	0.42	0.28
115	0.32	0.39	0.25
120	0.33	0.41	0.26
125	0.32	0.37	0.24
130	0.31	0.39	0.20
135	0.33	0.39	0.23
140	0.36	0.40	0.27
145	0.33	0.39	0.23
150	0.31	0.38	0.22
155	0.37	0.39	0.28
160	0.33	0.38	0.26
165	0.29	0.35	0.21
170	0.29	0.37	0.21
175	0.34	0.40	0.26
180	0.37	0.43	0.27
185	0.35	0.40	0.25
190	0.33	0.38	0.25
195	0.35	0.40	0.26
200	0.33	0.39	0.24

Strategy - Overall Comparison

Strategy	Average T5Y Sharpe
opt_QS_ma_RANK	0.67
opt_QS_ma_EW	0.61
opt_QS_trailing_ret_EW	0.56
opt_QS_trailing_ret_RANK	0.55
opt_QS_ma_VOL_TARGET	0.54
QS_ma_RANK	0.54
opt_MS_trailing_ret_RANK	0.52
QS_trailing_ret_RANK	0.52
opt_MS_trailing_ret_VOL_TARGET	0.51
QS_trailing_ret_EW	0.50
opt_MS_trailing_ret_EW	0.49
opt_QS_trailing_ret_VOL_TARGET	0.47
opt_MS_ma_RANK	0.46
opt_MS_ma_EW	0.45
QS_trailing_ret_VOL_TARGET	0.43
opt_MS_ma_VOL_TARGET	0.42
MS_trailing_ret_RANK	0.41
MS_trailing_ret_EW	0.39
MS_ma_EW	0.36
MS_ma_RANK	0.35
MS_trailing_ret_VOL_TARGET	0.30
QS_ma_EW	0.30
MS_ma_VOL_TARGET	0.21
QS_ma_VOL_TARGET	0.10



Strategy	MaxDD	Average T5YIR
opt_QS_ma_Rank	-47%	0.40
opt_QS_ma_EW	-42%	0.27
opt_QS_trailing_ret_EW	-47%	0.21



And Then There Was One

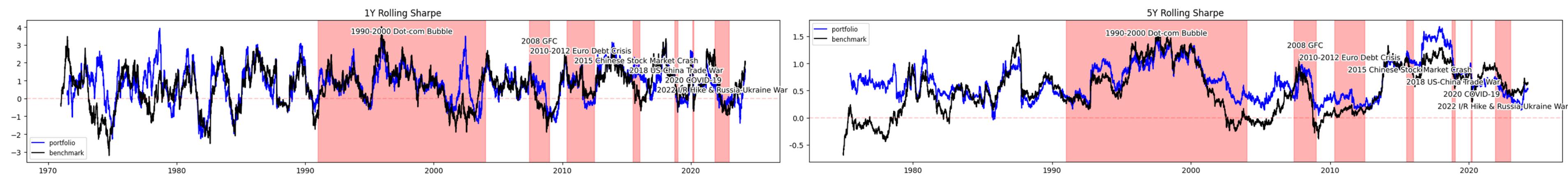
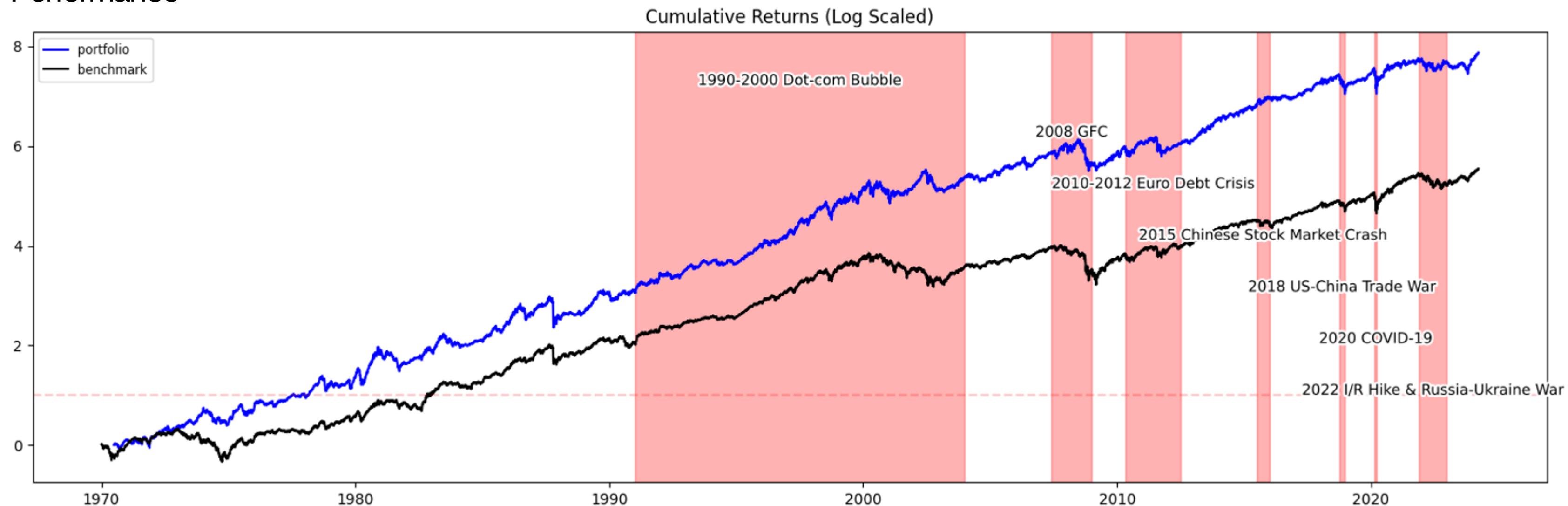
Moving The Needle

The strategy requires the computation of the **190-day & 195-day simple moving average** for each industry at each reset point.

A buy/sell signal for each industry will be calculated **based on the relative levels** of both moving average indicators, then **rebalanced every quarter**.

Assigned weight will be via **ranked weighting**, scaled to **200% long, -100% short**.

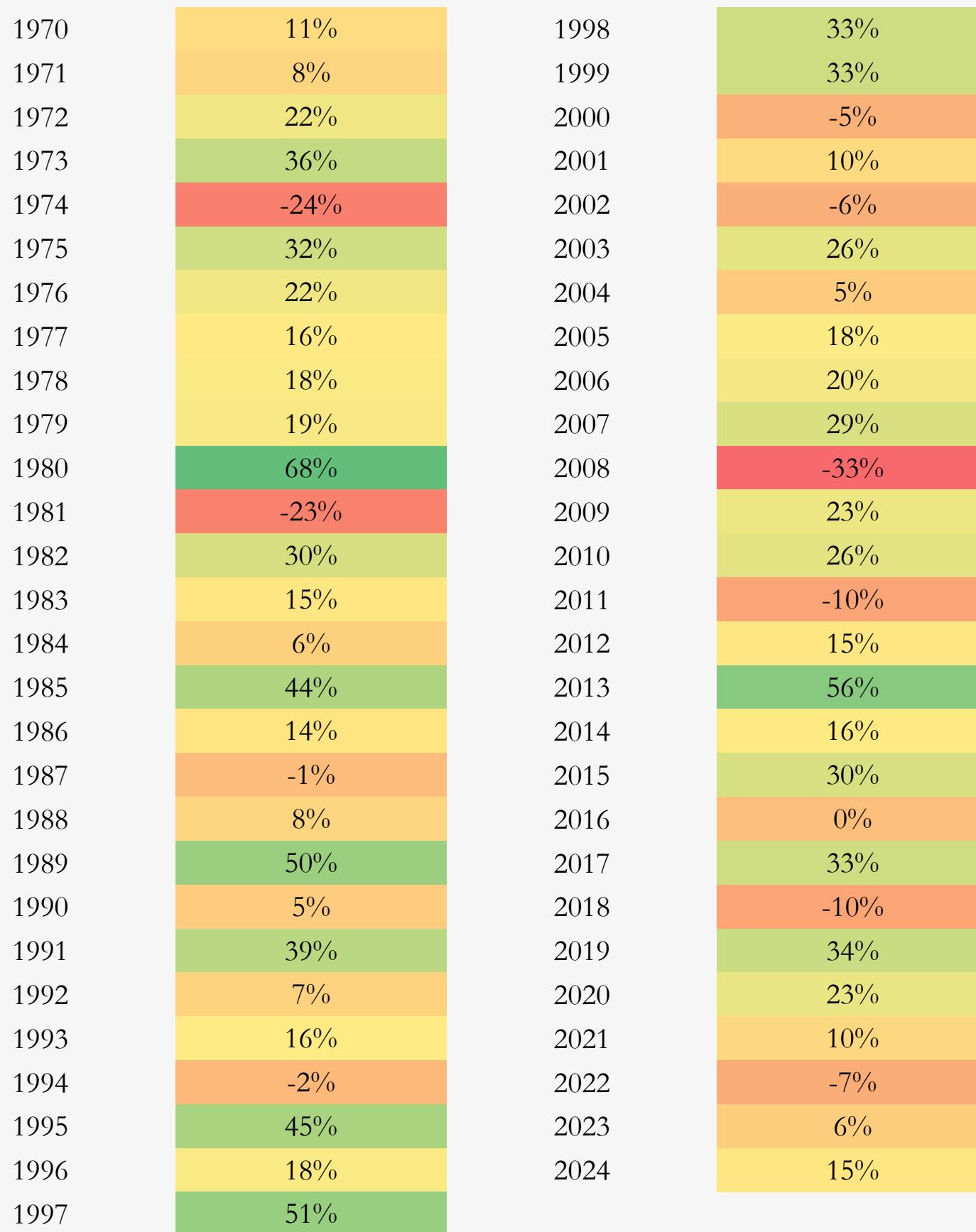
Performance



Performance - Summary

Statistics	Strategy	Market
Quarterly Mean (%)	4.3	3.1
Quarterly Standard Deviation (%)	10.8	8.7
Minimum Quarter (%)	-29.2	-24.8
Maximum Quarter (%)	34.2	24.5
Number of Negative Months (out of total)	65 / 215	65 / 215
Skew	-0.4	-0.5
Kurtosis	0.9	0.7
Correlation With Market	70.7	100.0

A Deeper Analysis - Average Period Returns



- **1980, 2013, & 1997** were top 3 performing years
 - Continued market uptrend for the almost whole year
 - Benchmark returns exceeded 30%
- **2008** was the worst performing year
 - Volatile markets that had strong & sudden reversal of trend (Momentum crashes?)

Risk

Metrics

01

Beta (Normal Period)

0.95417

*Average of Oct 2002 – Sep 2007,
and Apr 2009 – Mar 2015*

02

Beta (Stressed Period)

0.64541

*Worst of Apr 2000 – Sep 2002,
or Oct 2007 – Mar 2009*

03

Sharpe Ratio

1Y Sharpe : 0.79

5Y Sharpe : 0.67

04

Information Ratio

1Y IR : 0.48

5Y IR : 0.40

05

Sortino Ratio

1Y Sortino : 1.85

5Y Sortino : 1.46

06

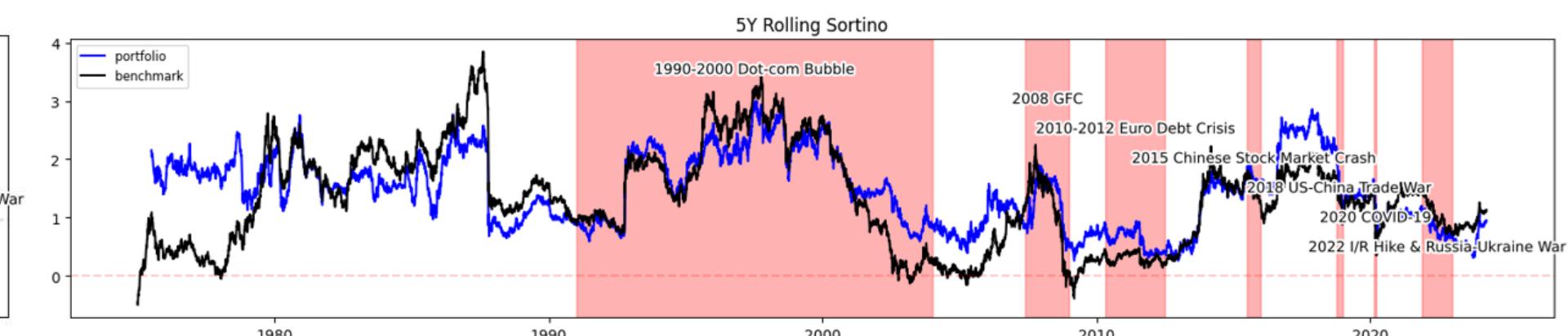
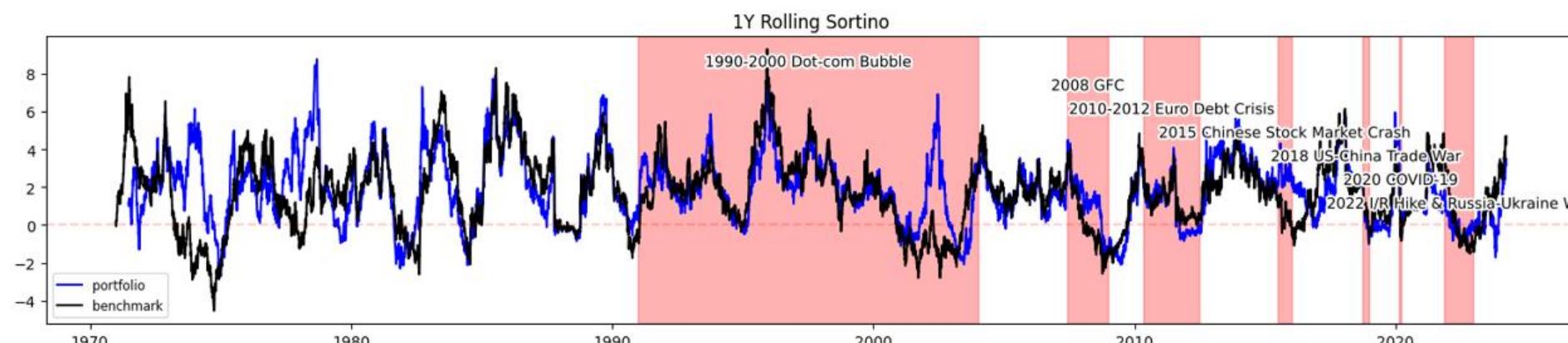
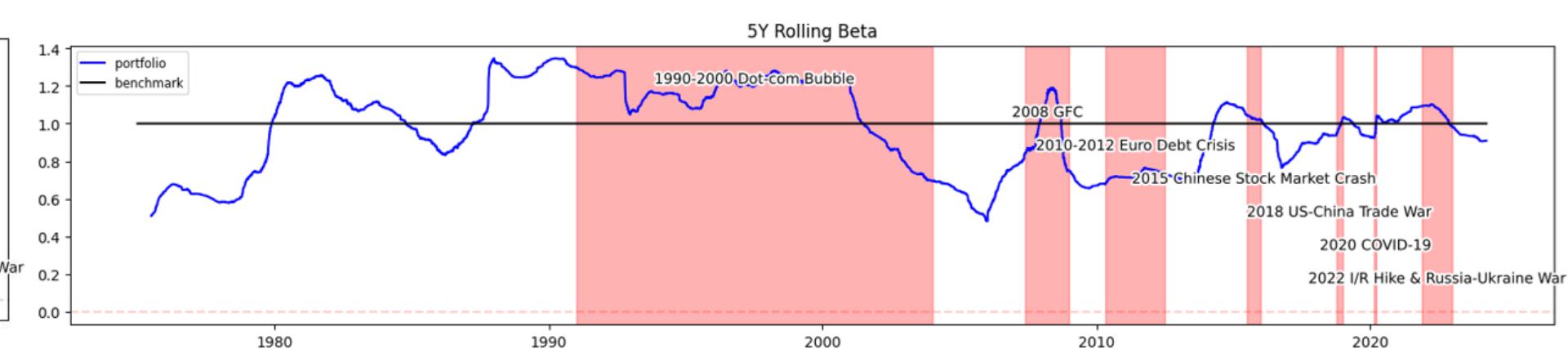
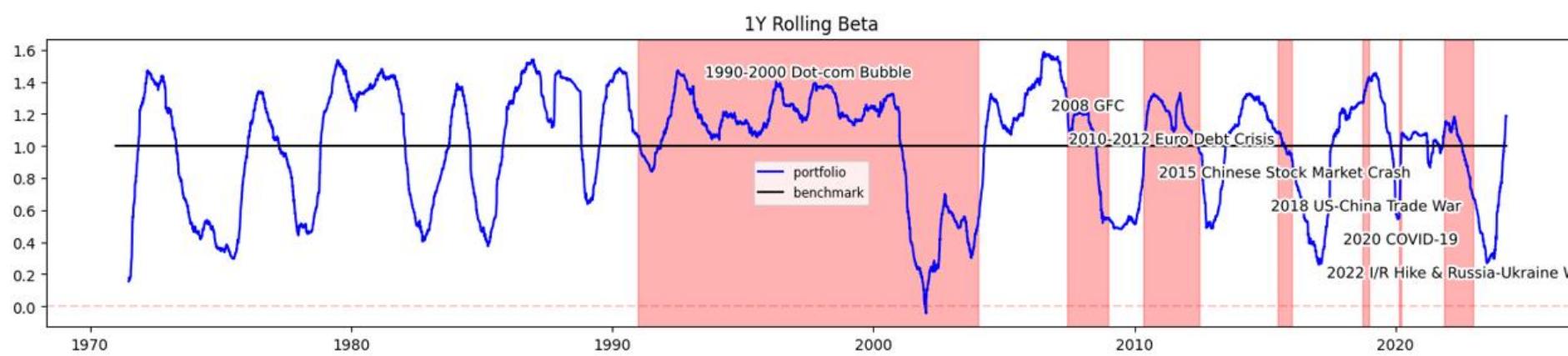
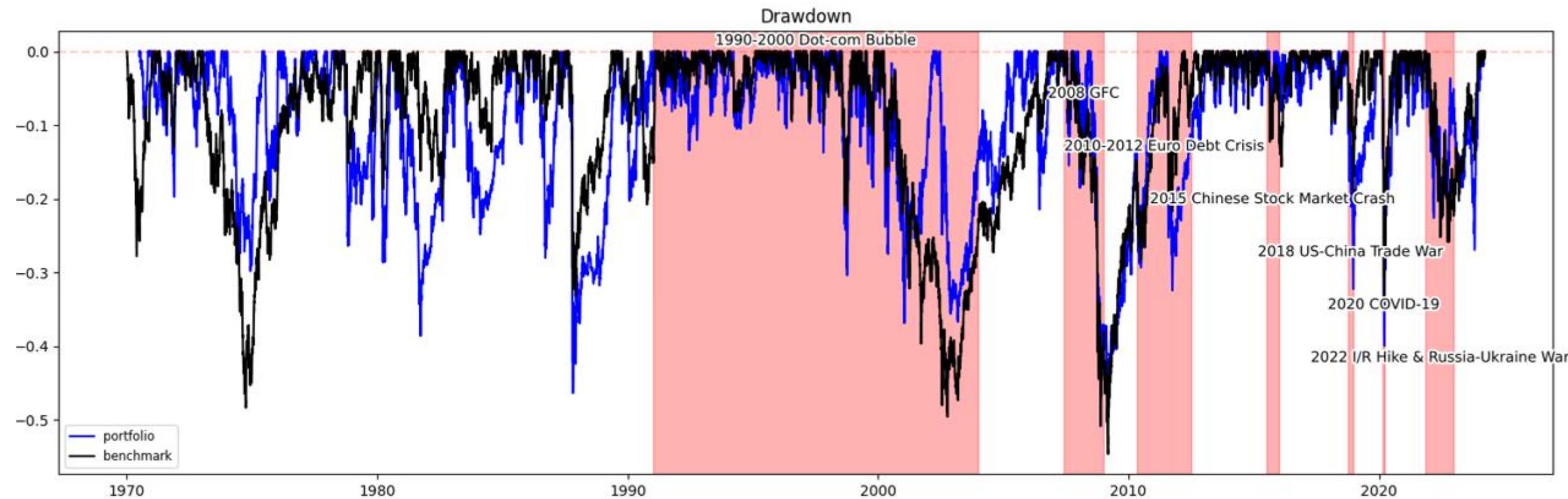
Drawdown

1Y Rolling Max Drawdown : -20.47%

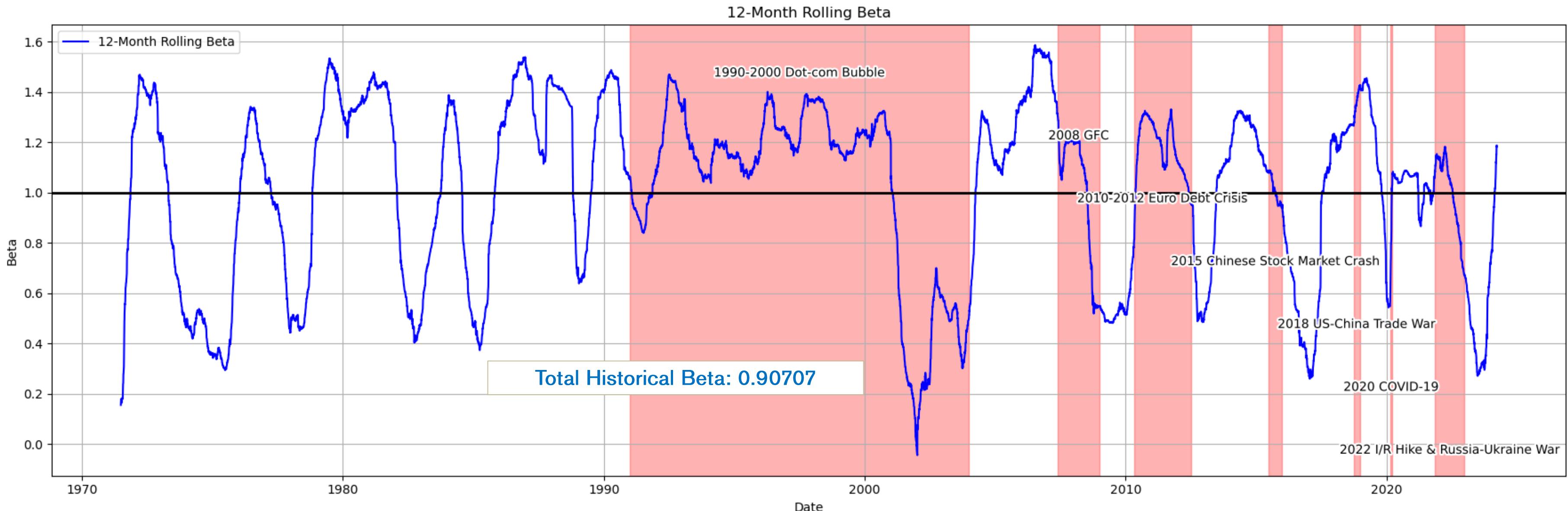
5Y Rolling Max Drawdown : -39.95%

Max Drawdown : -47.00%

Risk



Risk – Strategy Beta



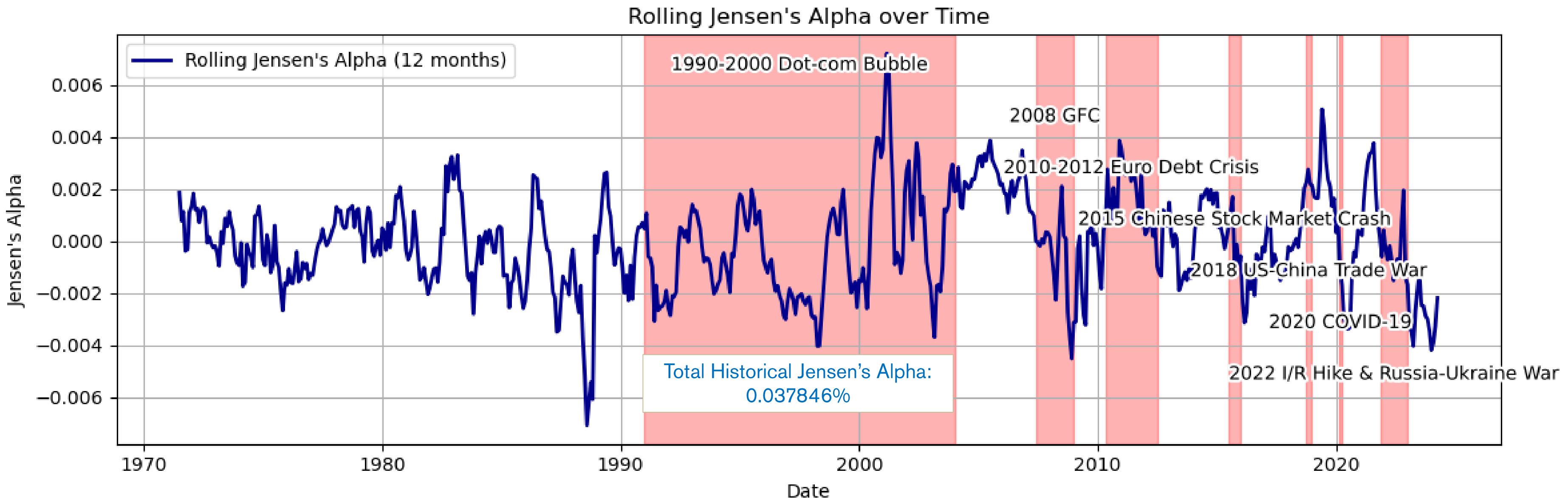
Beta (Normal Period)

Beta for Oct 2002 - Sep 2007: 0.86283
Beta for Apr 2009 - Mar 2015: 1.0045
Average Beta: 0.95417

Beta (Stressed Period)

Beta for Apr 2000 - Sep 2002: 0.64541
Beta for Oct 2007 - Mar 2009: 0.55881
Max Beta: 0.64541

Risk - Portfolio Jensen's Alpha



Jensen's Alpha (Normal Period)

JA for Oct 2002 - Sep 2007: 0.02355%
JA for Apr 2009 - Mar 2015: 0.01020%
Average Jensen's Alpha: 0.01669%

Jensen's Alpha (Stressed Period)

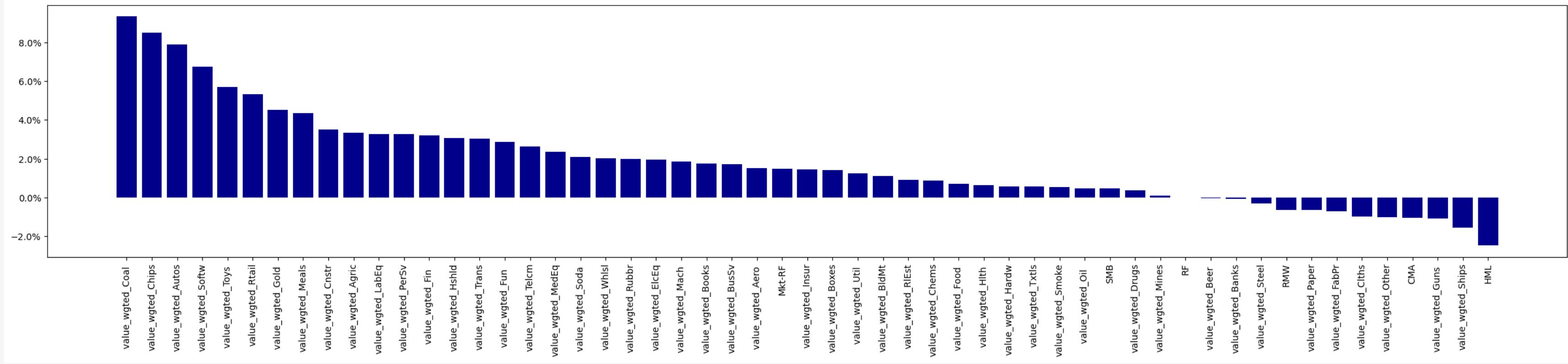
JA for Apr 2000 - Sep 2002: 0.09034%
JA for Oct 2007 - Mar 2009: 0.00501%
Max Jensen's Alpha: 0.09034%

Analysis

The Ingredients For Success



A Deeper Analysis - Contribution to Strategy Returns



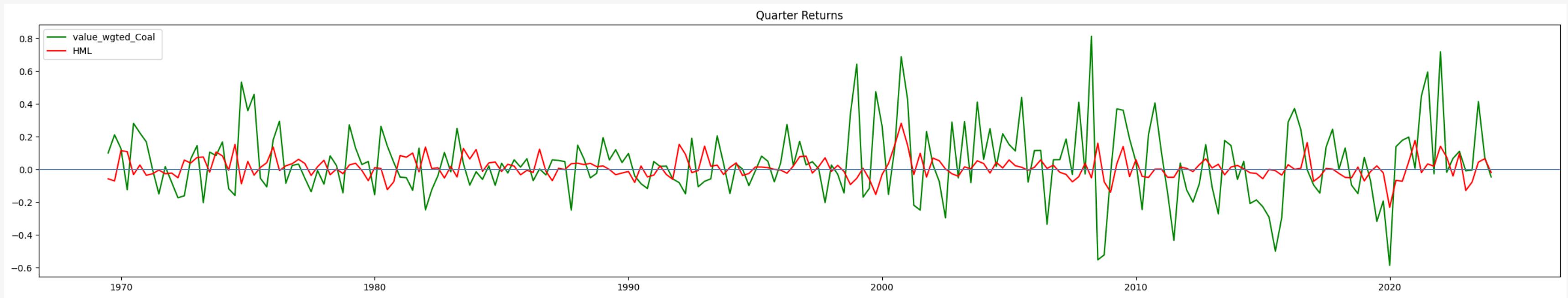
Top 5 Contributors

Portfolios	Return Contribution
Value Weighted Coal	9.4%
Value Weighted Chips	8.5%
Value Weighted Autos	7.9%
Value Weighted Softw	6.8%
Value Weighted Toys	5.7%

Bottom 5 Contributors

Portfolios	Returns Contribution
Value Weighted Other	-1.0%
CMA	-1.1%
Value Weighted Guns	-1.1%
Value Weighted Ships	-1.6%
HML	-2.5%

A Deeper Analysis - Contribution to Strategy Returns



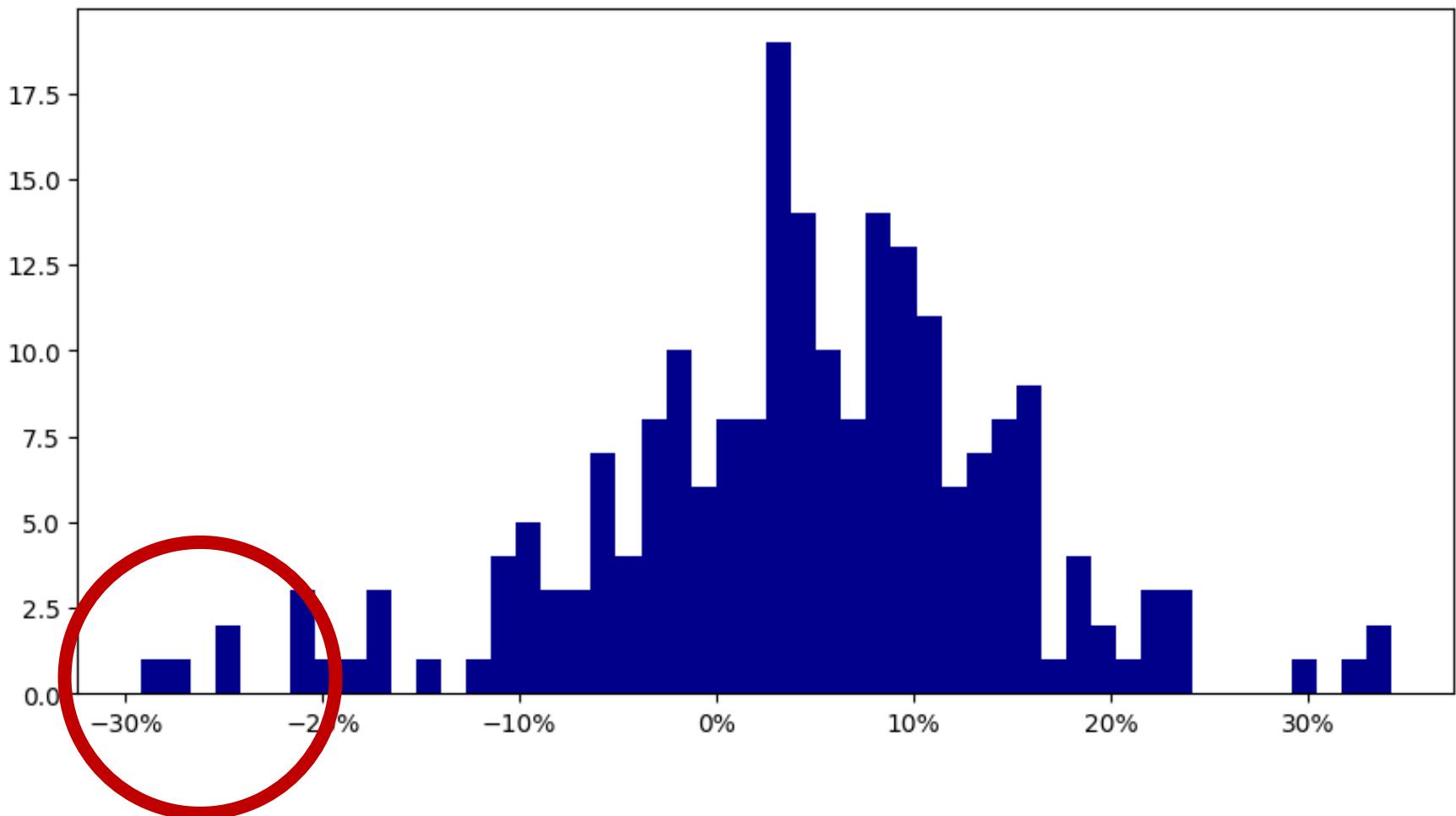
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Value Weighted Toys	5.7%

Bottom 5 Contributors

Portfolios	Returns Contribution
Value Weighted Other	-1.0%
CMA	-1.1%
Value Weighted Guns	-1.1%
Value Weighted Ships	-1.6%
HML	-2.5%

A Deeper Analysis – Quarterly Returns Distribution



On Momentum Crashes

These momentum “crashes” are forecastable: they occur following market declines, when market volatility is high, and contemporaneous with market “rebounds.”

- Daniel and Moskowitz, 2013

Comparing Strategy Returns and Market Returns During Market Decline

Python Output

```
t_stat, p_value = stats.ttest_ind(stratret, mktreturn, equal_var=False)

print(f'T-Statistic: {t_stat}')
print(f'P-Value: {p_value}')

[32]
...
T-Statistic: -0.5829405579776307
P-Value: 0.5645287007822459
```

Paired T-Test (Assuming Unequal Variance)

A paired t-test was used to compare the strategy returns and market returns during a crisis, assuming unequal variance.

The difference between the two was not statistically significant, indicating that the strategy was not impacted by momentum crash.

A Deeper Analysis – Quarterly Returns Distribution

Quarter	Strategy Returns	Market-2Y	Market Returns
1/10/1987	-29%	17%	-23%
1/7/2011	-28%	16%	-15%
1/7/1986	-25%	9%	-8%
1/10/2018	-25%	5%	-15%
1/7/2008	-21%	4%	-8%
1/10/2008	-21%	7%	-22%
1/7/1998	-20%	3%	-12%
1/7/2002	-19%	0%	-17%
1/7/1981	-19%	8%	-12%
1/7/1975	-18%	8%	-12%
1/1/2020	-17%	0%	-20%
1/4/1974	-17%	0%	-10%
1/4/2010	-15%	-2%	-11%
1/1/1990	-12%	8%	-3%
1/7/1983	-11%	-12%	-1%
1/4/1981	-11%	4%	-1%
1/1/2022	-11%	-20%	-6%
1/7/1999	-10%	10%	-6%
1/10/1978	-10%	5%	-7%
1/1/1980	-10%	-3%	-6%

Partial Protection

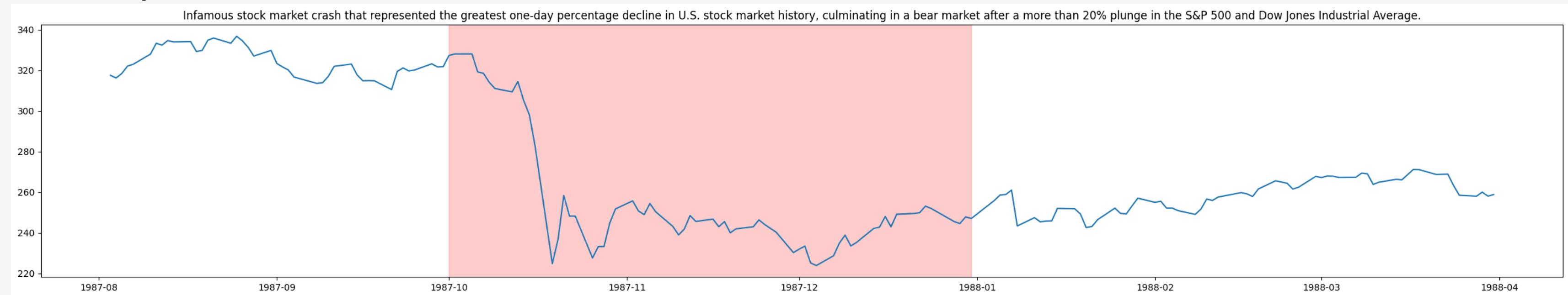
We are less impacted by momentum crashes as defined by Daniel & Moskowitz.

Our strategy's methodology dampens the overperformance of the short side ("loser decile") by scaling our portfolio to be net 100% long.

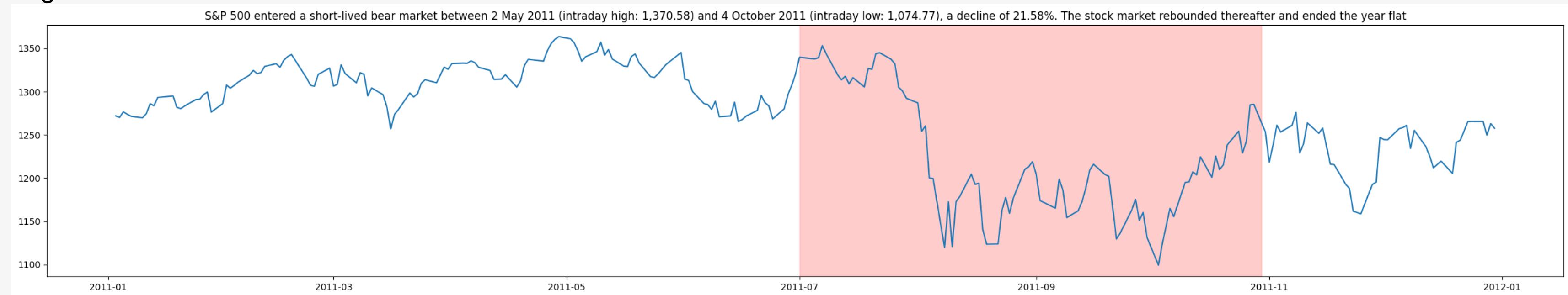
A Deeper Analysis – Quarterly Returns Distribution

Quarter	Strategy Returns	Market-2Y	Market Returns
1/10/1987	-29%	17%	-23%
1/7/2011	-28%	16%	-15%

Black Monday



August 2011 Market Falls



Further Works

- Strategies to Explore
 - Z-score (rolling)
 - Mean Reversion
- Selective Allocation (not investing in all 54 portfolios)
- Dynamic Rebalancing
- Universe Expansion
- Parameter optimization
- Leverage / short sell constraints