Executive Summary

- Objective: Design an equity long/short portfolio that profits when both the S&P 500 and the USD weaken (based on a 126-day rolling window) in environments of elevated market stress (VIX ≥ 18) that typically challenge conventional long-biased and factor-neutral books.
- This study builds two 30-stock long/short spreads that monetise the defensive-vs-cyclical compression typically seen when the S&P 500 and the dollar fall together under stress. Across the seven biggest co-decline regimes since 2009, the simple static sleeve earns a 1.5 Sharpe with 4–5 % max draw-down, while adding a z-score timing layer halves the risk at the cost of some carry; a broader Multi-PC variant smooths tails further. Factor and ETF regressions confirm the following exposures: short beta, short value, long low-vol. Sized at ~2 % of NAV, it could generate ~60 bp a year of 'crisis alpha' without distorting the core book; a targeted, macro-coherent overlay that could be used by discretionary macro and equity L/S desks.

1. Factor discovery	Ran PCA on the two deepest USD-stress bear markets (May 2002–Jan 2003; Nov 2007–Aug 2008).	Extracts the latent spread that widens when risk and the dollar both deteriorate.
2. Basket design	• **PC1**: long defensives, short cyclicals. • **Multi-PC**: PC-1 plus smaller PC-2/PC-3 tilts.	PC1 captures the pure "cyclical-vs-defensive" premium; PC2 and PC3 capture different factors.
3. Execution	*Static* (always on; short leg vol-scaled to 22 %) and *Dynamic* (z-score triggers, best pairs: **–0.5/0.5** for PC-1, **–1/1** for Multi-PC; short leg re-scaled weekly).	Best pairs found during calibration applied across 5 periods
4. Tests	Seven post-2009 co-decline regimes **plus** eight shock periods (GFC, Covid, Brexit, SVB, etc.) with 4 bp round-trip cost; full Fama-French & ETF attribution.	Checks repeatability, crisis alpha and diversification value.

Strategy	Avg Sharpe	Avg Max DD	Comment
PC-1 Static	**1.47**	–4.6 %	Highest carry; best Post-GFC & 2025 windows
PC-1 Dynamic	0.98	**–2.7 %**	Lower risk; mixed hit-rate
Multi-PC Static	1.07	–4.5 %	Broader factor mix smooths tails
Multi-PC Dynamic	**1.26**	**–1.9 %**	Best risk-adjusted after costs; short leg drives >60 % of P&L

Fama-French 5-Factor	PC1 Static · 2023	Multi-PC Static · 2023	Comment
Alpha (bps/day)	**3.33**	–0.12	Modest alpha; stronger in PC1
t(Alpha)	0.30	–0.01	Not statistically significant
R^2	0.41	**0.51**	Better model fit with multi-PC exposures
MKT	–0.03	0.05	Mild market neutrality
SMB	–0.51	–0.34	Tilted short small caps
HML	–0.68	–0.70	Deep value short bias
RMW	–0.23	–0.43	Low profitability exposure
CMA	0.57	**0.91**	Strong tilt to conservative investment styles
UMD	0.21	0.27	Moderate momentum tilt

- Key Takeaways
  - Both baskets are positive in at least 6 out of 7 regimes (static); stress-test Sharpe peaks at 4-5 (Taper Tantrum, SVB).
  - Short cyclicals hedge long defensives well when VIX > 25 and 10-yr moves ±40 bp.
  - With drawdowns capped near 3 %, a 2 %-of-NAV sleeve can add ~50-70 bp annualised (portfolio-level Sharpe ≈ 1.3).
  - Static PC1 as a permanent macro-hedge; overlay Dynamic Multi-PC around known event-risk windows and together they can capture both slow-burn stress and abrupt shocks.
  - In the stress-test panel the static Multi-PC sleeve posted a 2.0 Sharpe with max DD < 4 %, demonstrating additive crisis alpha when several factor axes dislocate at once.
  - Bottom line: The strategy offers a targeted, low-capacity hedge that converts USD/SPX co-declines into alpha and could add value to both discretionary-macro and equity L/S books as an add-on crisis sleeve.

Calibration and OOS Periods

Set	Regime Window	Calendar	Trading Days	Regime Description
Calibration (5 events · 169 days)				
C-1	Post-GFC Snap-back	22 Apr 2009 → 14 May 2009	**17**	Oldest slice; GFC-related but short.
C-2	QE-2 Anticipation	20 Sep 2010 → 29 Oct 2010	**30**	Rates-down, USD-weak, low-growth.
C-3	US Debt-Ceiling Downgrade	01 Aug 2011 → 09 Sep 2011	**30**	High-vol, policy shock; equity stress.
C-4	China Deval / Global-Growth Scare	24 Aug 2015 → 15 Oct 2015	**39**	EM-led risk, USD bid then faded.
C-5	Covid "Summer Consolidation"	04 Jun 2020 → 17 Aug 2020	**53**	Same year but structurally different (rates floored, vol ≥ 18).
Out-of-Sample (2 events · 94 days)				
OOS-1	Post-Inflation-Peak Unwind	21 Dec 2022 → 16 Mar 2023	**58**	Falling CPI and USD; fresh macro mix.
OOS-2	2025 Macro-Risk Regime *(Live)*	03 Apr 2025 → 23 May 2025	**36**	"Live" slice; most recent regime observed.

Stress Tests Periods

#	Label	Start date	End date	Catalyst / Notes
1	Euro-area debt crisis – Wave 1	**26-Apr-2010**	**10-Jun-2010**	Greek junk downgrade: ECB SMP / Bundestag vote
2	2013 Taper-Tantrum	**22-May-2013**	**24-Jun-2013**	Bernanke “taper” testimony: UST-yield spike & EM rout
3	Oil-price collapse / deflation scare	**28-Nov-2014**	**20-Jan-2015**	OPEC refuses cuts: WTI lows, ECB QE announcement
4	Brexit referendum shock	**24-Jun-2016**	**01-Jul-2016**	GBP collapse: BoE easing signals steady markets
5	US–China tariff re-escalation	**06-May-2019**	**28-Jun-2019**	Trump 25 % tariff tweet: G-20 Osaka “truce”
6	COVID-19 crash	**20-Feb-2020**	**23-Mar-2020**	Global lockdowns: Fed “QE-infinite” & CARES Act
7	2022 inflation / Fed shock	**03-Jan-2022**	**16-Jun-2022**	CPI surge & FOMC 75 bp lift-off: YTD SPX low
8	SVB banking panic	**06-Mar-2023**	**30-Mar-2023**	SVB warning/FDIC takeover: funding stress eases

Macro Rationale

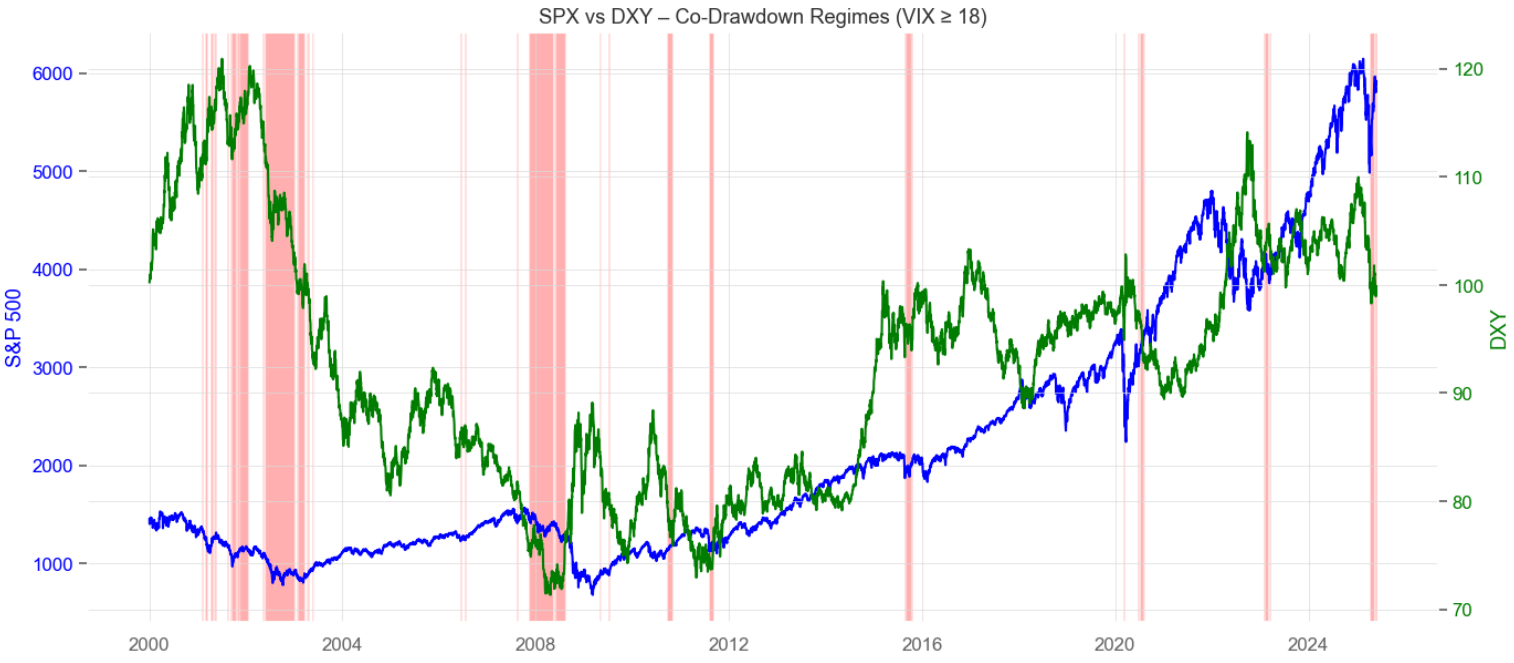
- The US Dollar tends to go up in risk-off events. During periods of stress, cross-border buying of US Treasuries strengthens the USD as money flows in the US, seen as a safe-heaven. However, the USD can sometimes co-decline with markets, as we have seen it so far this year. We identified two distinct periods (post-Dot-com Bubble and GFC buildup) during which the US Dollar (proxied by the Dollar Index - DXY) and the S&P 500 (SPX) both traded lower (based on a 126-day rolling window), while the VIX remained at or above 18, for a prolonged period of time (over 300 trading days). What is interesting is that dual declines of stocks and the dollar have occurred under two different regimes. In “growth scare” episodes, Treasury yields plunge on safe-haven flows and expectations of Fed easing. By contrast, in “inflation scare” episodes, bonds are sold alongside stocks as the Fed either tightens or is perceived as behind the curve. Crucially, in both cases the VIX was elevated (often well above 20), underscoring the stress in markets when both equities and the dollar are falling. The post-Dot-com Bubble was preceded by both lower rates and a recession while the GFC buildup experienced lower rates then followed by a recession. These two timeframes had in common a US idiosyncratic crisis, that led to capital outflows, affecting US markets but also the credibility of the USD, despite a lack of clear alternative.

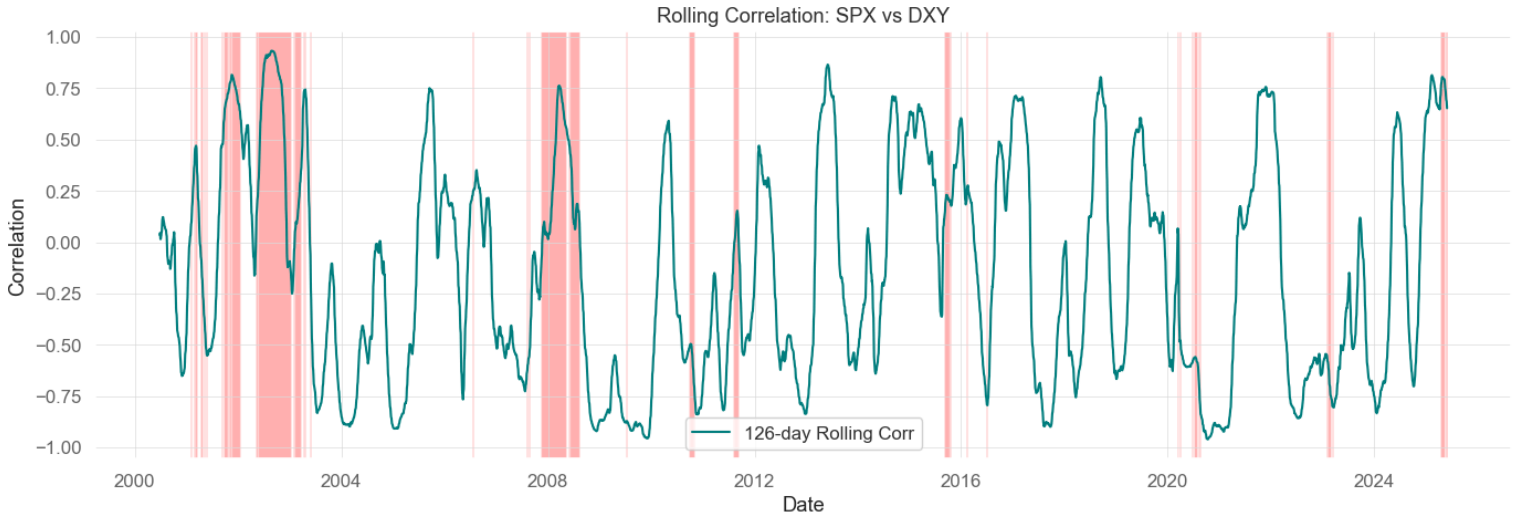
- Investors are currently pricing in persistently weak growth for quarters on end (SPX - went from 14% EPS growth last September to now 7% FY 2025), a couple of goods-induced spikes in inflation, and a slow reactive Fed that will cut rates slowly and get to neutral levels in 2026 (even when a new Fed Chair). Given the challening macro environment (trade war, higher fiscal deficit, de-globalization, weaker soft data etc), the probability for markets to enter such periods of stress, during which the USD and US assets are no longer seen as safe-heavens, has increased substantially since the 2024 US presidential election. Said differently, the US idiosyncratic risk increased. Liberation Day was a good example, and other similar periods of stress could follow. One of the highest risks would be to see the ongoing trade war turn into a financial capital war.

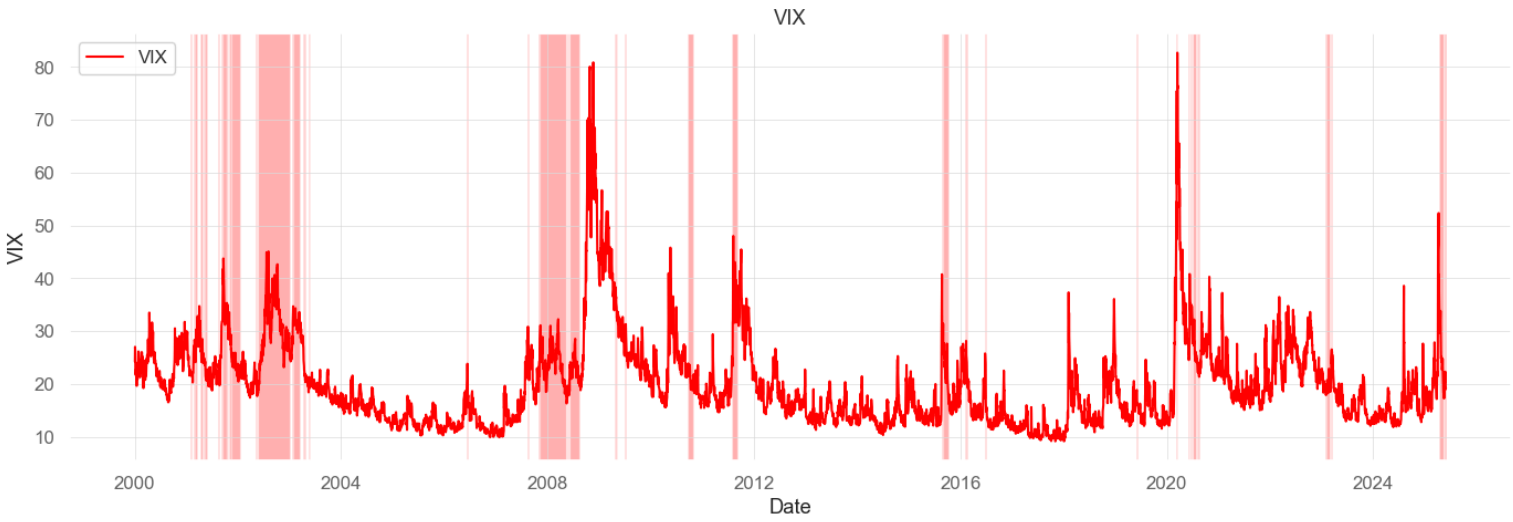
Methodology

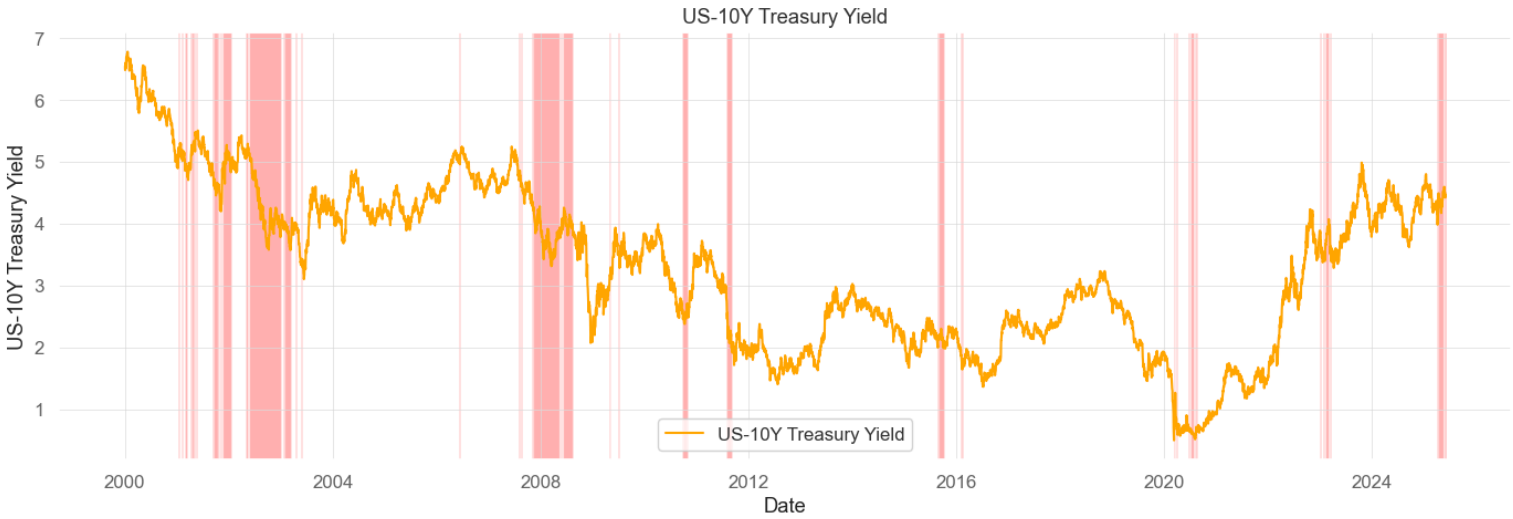
- We compute the daily returns of SPX stocks, still listed today, over the two periods of stress. We perform PCA on the returns for each period and average the principal components for each security across both periods (only stocks present in both periods are kept). Periods of simultaneous USD and SPX decline historically coincide with episodes of global deleveraging or crisis-driven capital flight. During such times, dispersion increases, and crowded trades unwind, leading to temporary dislocations captured by PC1 that becomes more of a “stress factor”. Our strategy assumes that PC1 represents latent market sentiment which tends to mean-revert after peak stress. If statistically significant, PC2 and PC3 can also be used to add factor diversification. We will use the results of the PCA applied on these two timeframes to build an equity long / short portfolio aimed at outperforming during similar environments of stress, whether yields go up or down. We will see that PC1 is strongly, positively loaded on classic “high-beta / cyclicals” (banks, capital-goods, semis) and negatively loaded on defensives (gold miners, staples, health care). We will also see that PC2/3 add low-correlated tilts (value vs momentum, rate-sensitives) and improve Sharpe in reflationary bounces, which is a plus. We will use the results of the PCA to build two Equity Long/Short portfolios of 30 stocks in total (15 in each leg). We acknowledge the presence of survivorship bias in the dataset, as we were unable to retrieve data for delisted stocks. As a result, the performance of the long leg may be overstated, while the short leg’s performance could be understated.

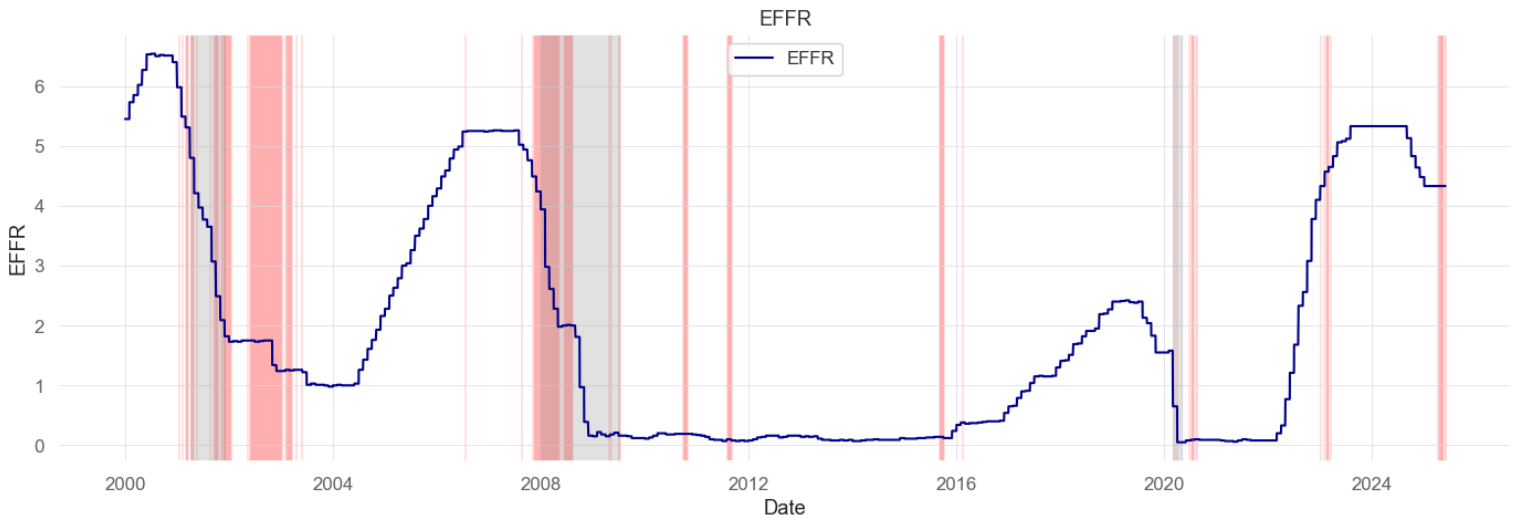
- Macro Charts with Regime Periods Highlighted in Red (Jan 2000 - May 2025)




Rolling Correlation: SPX vs DXY
Correlation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
126-day Rolling Corr
2000
2004
2008
2012
2016
2020
2024
Date


VIX
VIX
80
70
60
50
40
30
20
10
2000
2004
2008
2012
2016
2020
2024
Date


US-10Y Treasury Yield
US-10Y Treasury Yield
7
6
5
4
3
2
1
US-10Y Treasury Yield
2000
2004
2008
2012
2016
2020
2024
Date


EFFR
EFFR
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2000
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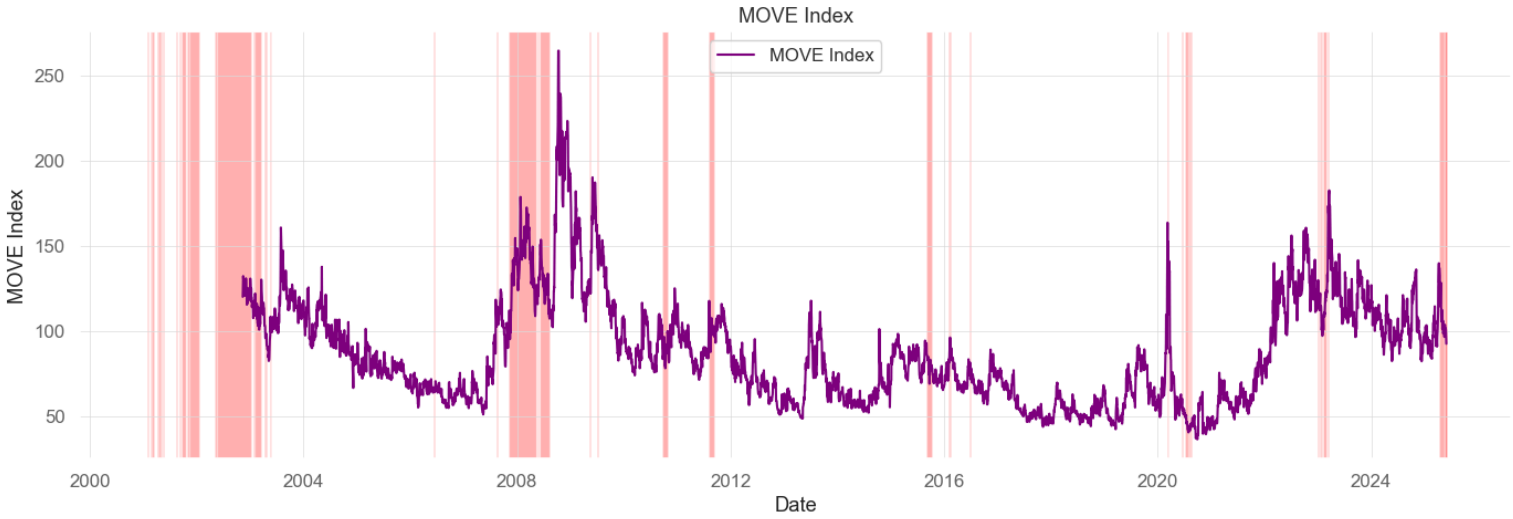
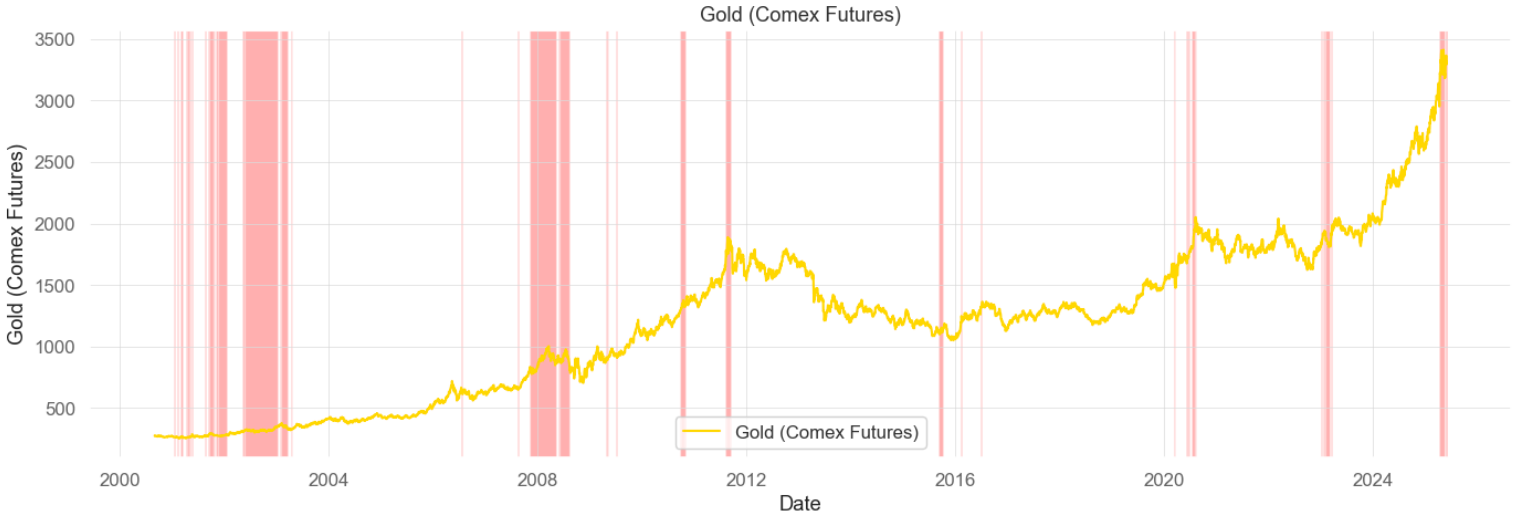
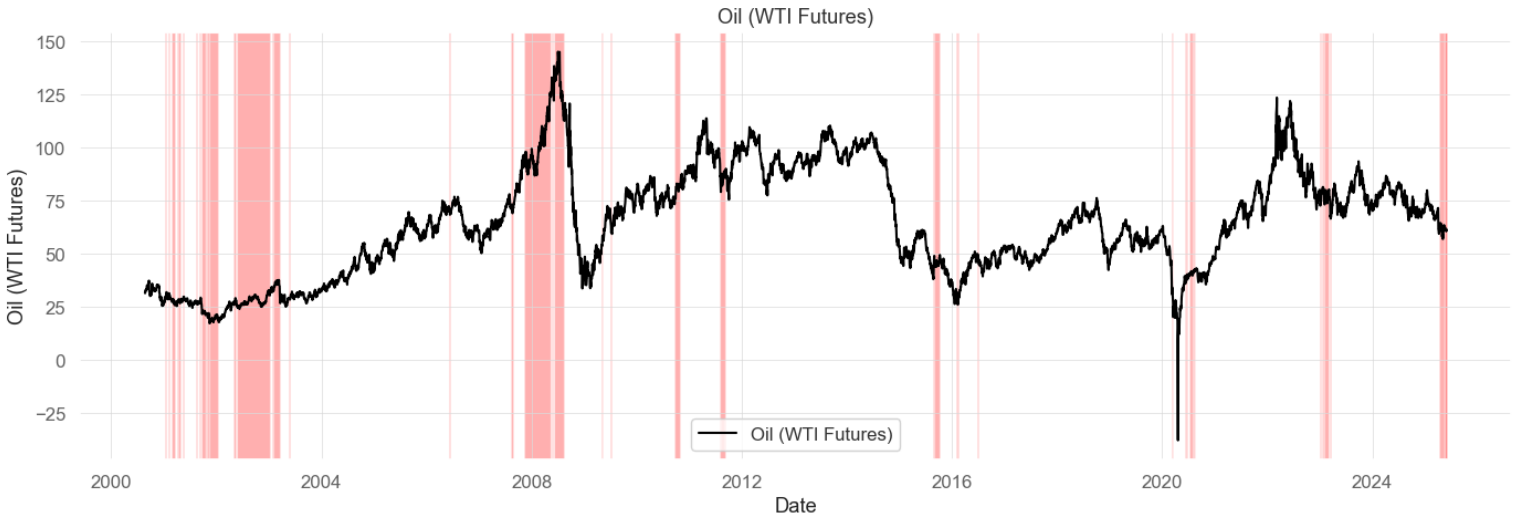
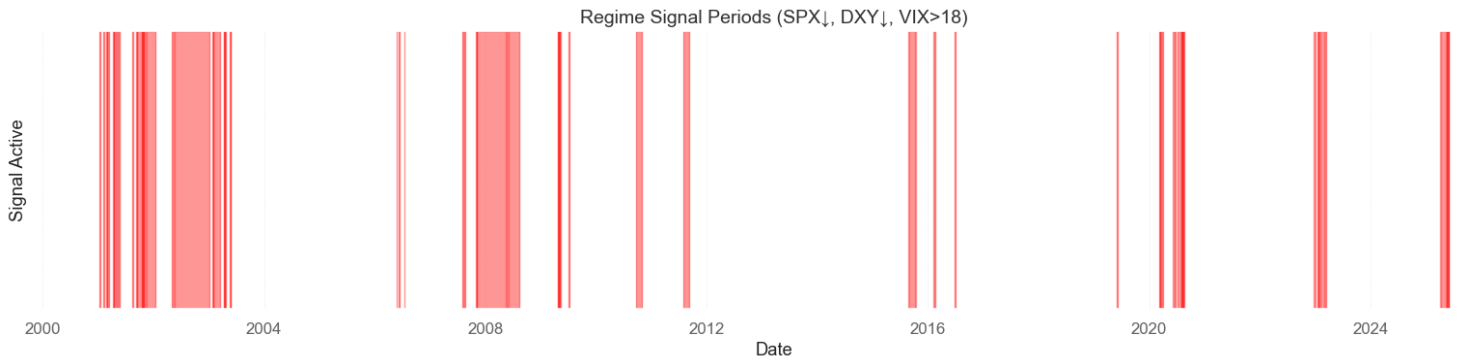




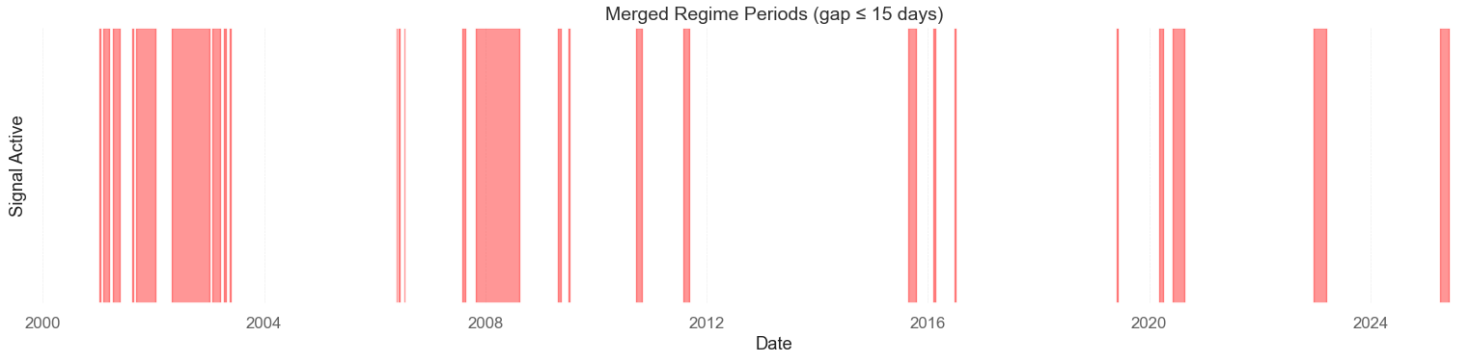


- SPX and DXY recently entered a co-downward move validated by a 126-day rolling window, with the VIX above or equal to 18.
- VIX reached the elevated intraday level of 60, on April 7 and closed at 46.98, marking its highest closing level of 2025.
- YTD the US 10-Year Treasury Yield has been in a range of 3.98% to 4.8%.
- We can see from the EFFR chart that post Dot-com bubble was preceded by a recession during which the Fed lowered rates while the GFC buildup experienced lower rates before and during a recession.
- Since 2023, the MOVE Index is back to levels experienced during the GFC and the two years that followed.
- Gold is on its highest, up nearly 30% YTD.

- In total, we identified 68 periods of various lengths where we can observe a co-downward move of SPX and DXY (based on a 126-day rolling window) when the VIX was at 18 or higher.



- To reduce noise, we apply a ≤ 15-calendar day gap rule and obtain 26 merged blocks.

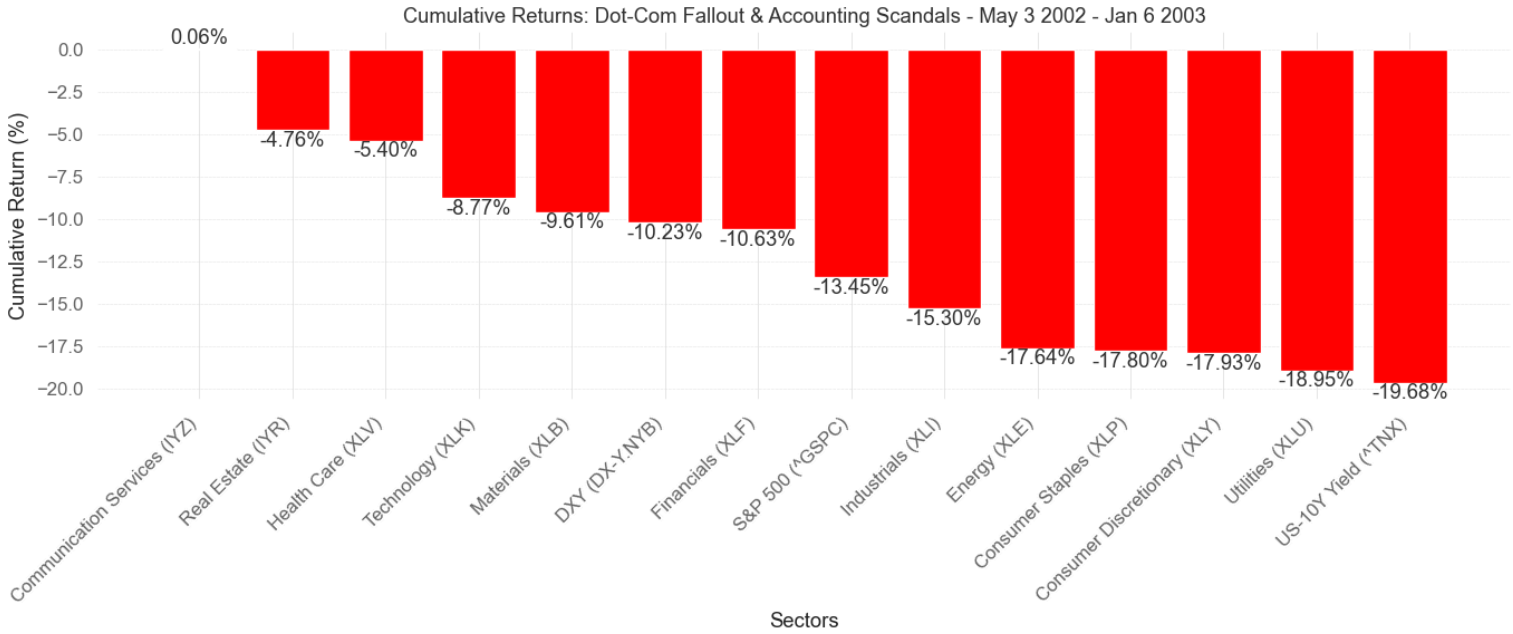


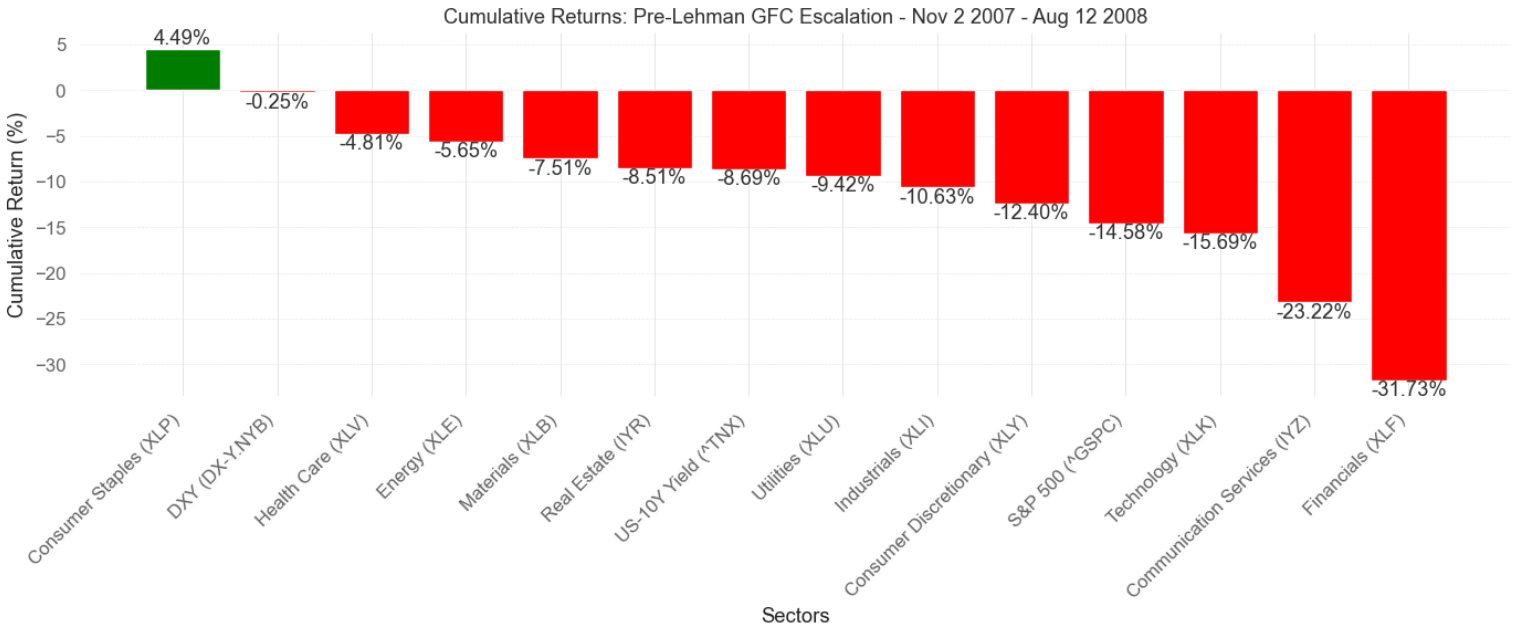
	start	end	trading_days
1	2001-01-11	2001-01-15	2
2	2001-01-31	2001-03-16	32
3	2001-04-06	2001-05-23	33
4	2001-08-16	2001-08-20	3
5	2001-09-07	2002-01-16	87
6	2002-05-03	2003-01-06	171
7	2003-01-22	2003-03-17	38
8	2003-04-09	2003-04-21	8
9	2003-05-19	2003-05-27	6
10	2006-05-23	2006-05-24	2
11	2006-06-09	2006-06-15	5
12	2006-07-14	2006-07-18	3
13	2007-08-03	2007-08-22	14
14	2007-11-02	2008-08-12	195
15	2009-04-22	2009-05-14	17
16	2009-07-01	2009-07-10	7
17	2010-09-20	2010-10-29	30
18	2011-08-01	2011-09-09	29
19	2015-08-24	2015-10-15	38
20	2016-02-03	2016-02-16	9
21	2016-06-24	2016-06-29	4
22	2019-06-03	2019-06-04	2
23	2020-03-06	2020-03-30	17
24	2020-06-04	2020-08-17	52
25	2022-12-21	2023-03-16	58
26	2025-04-03	2025-05-29	39

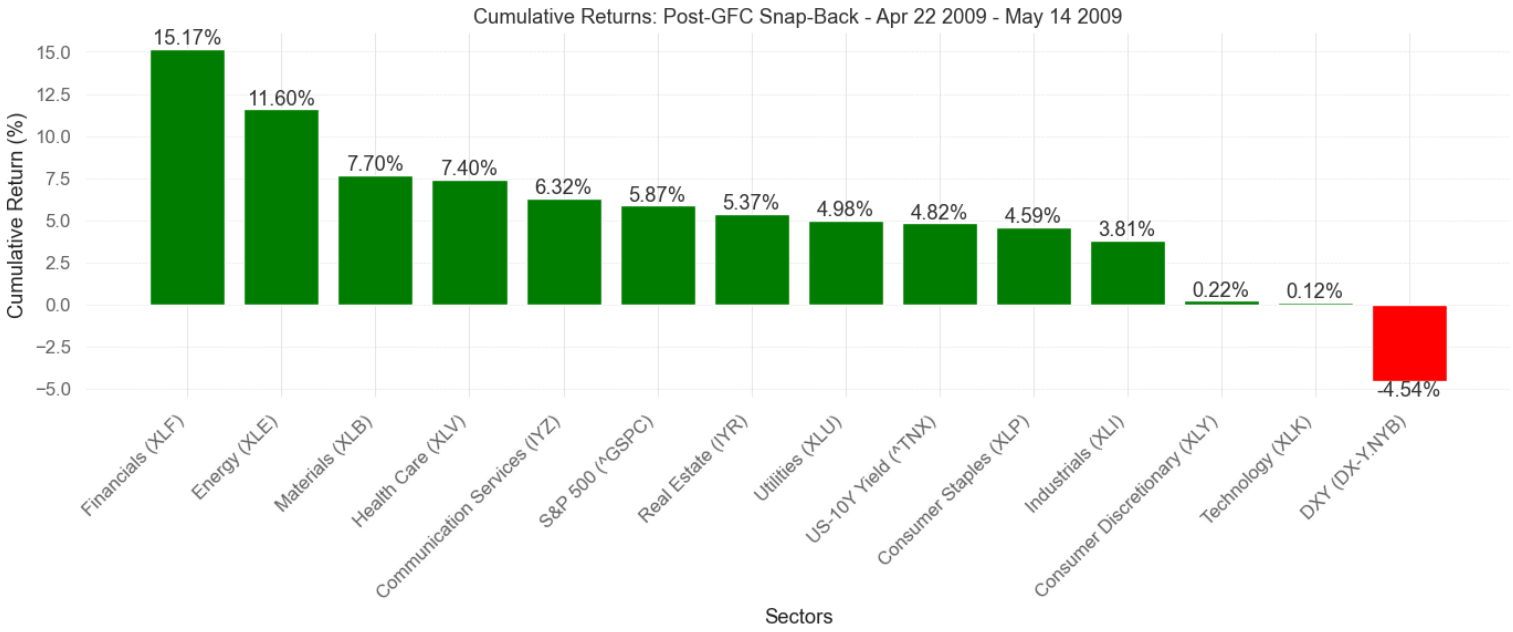
- Out of the 26 periods, the US 10Y yield traded higher only on 10 occurrences (38.5%).

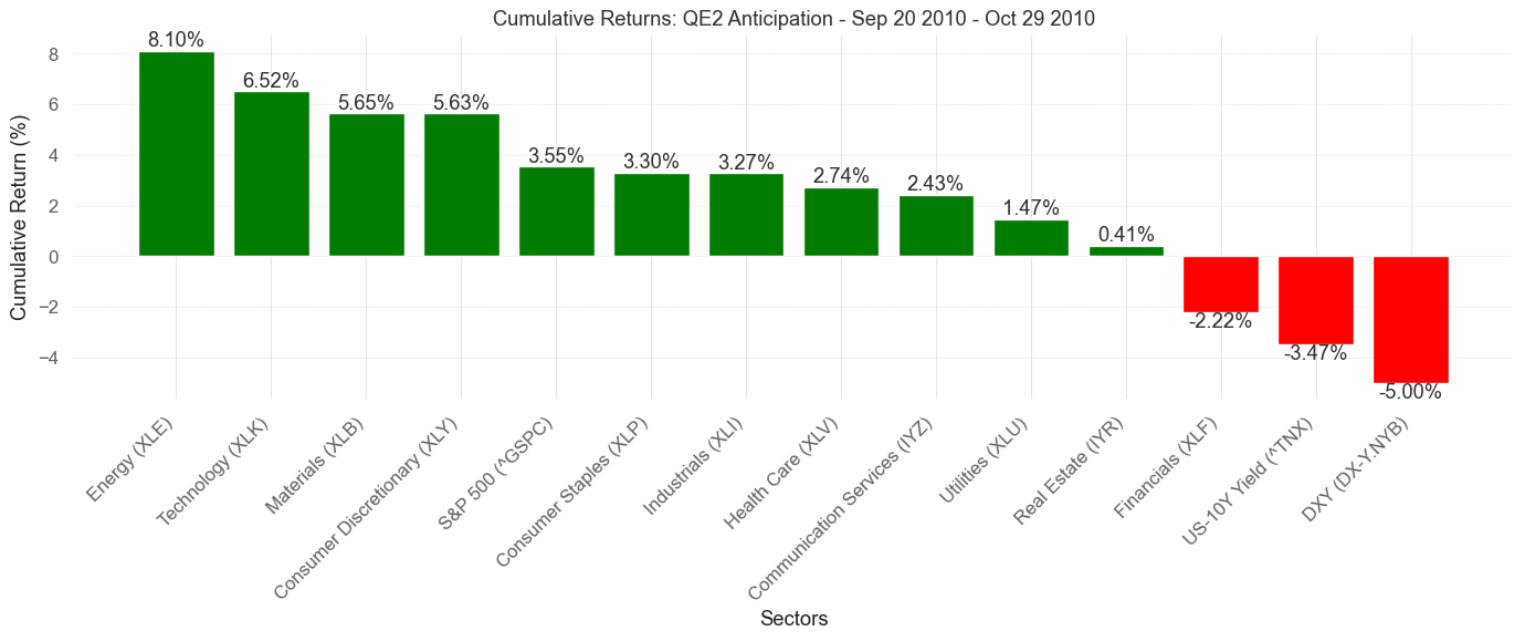
Start	End	Start Yield	End Yield	Yield Change (bps)
2001-01-11	2001-01-15	5.12%	5.23%	11.4 bps
2001-04-06	2001-05-23	4.87%	5.39%	51.7 bps
2001-09-07	2002-01-16	4.80%	4.84%	4.3 bps
2003-04-09	2003-04-21	3.90%	3.98%	7.8 bps
2006-06-09	2006-06-15	4.98%	5.10%	11.7 bps
2006-07-14	2006-07-18	5.06%	5.13%	7.1 bps
2009-04-22	2009-05-14	2.96%	3.11%	14.3 bps
2015-08-24	2015-10-15	2.00%	2.02%	2.6 bps
2019-06-03	2019-06-04	2.08%	2.12%	3.8 bps
2025-04-03	2025-05-26	4.05%	4.51%	45.4 bps

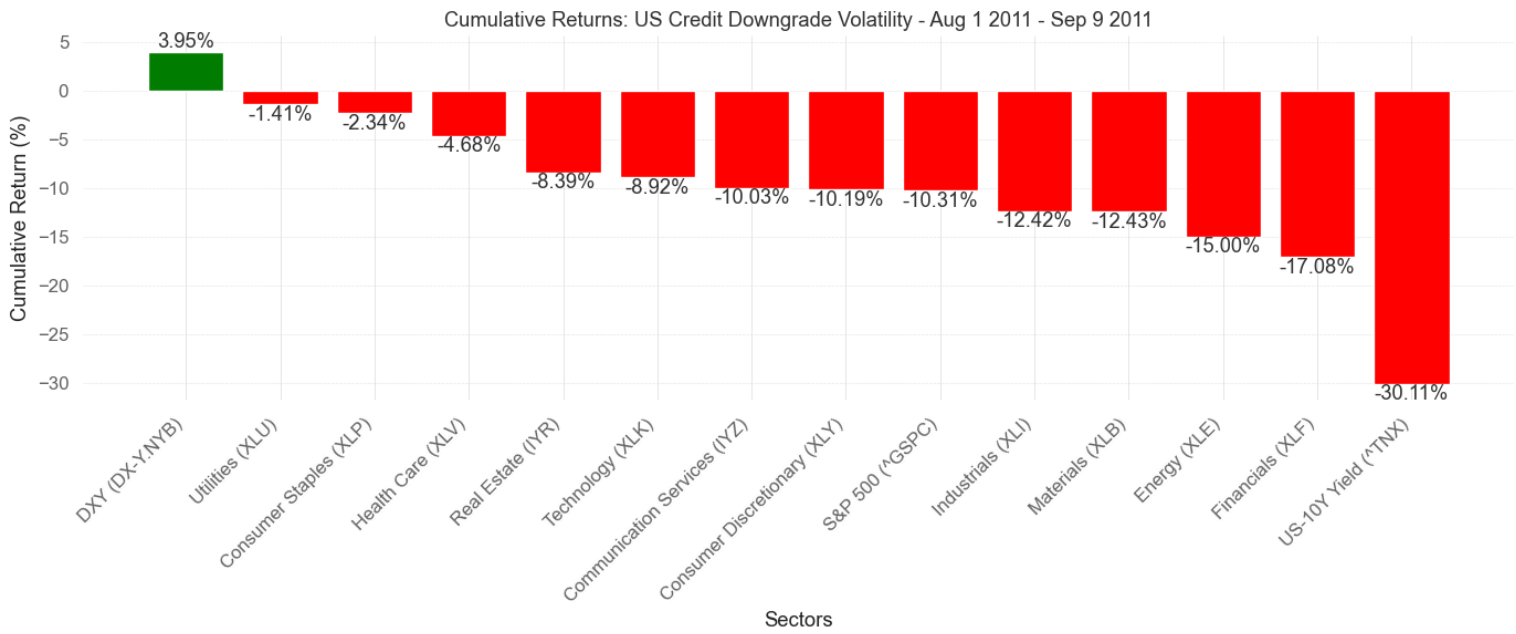
- Performance charts during regimes used for PCA, Calibrations and Backtests.

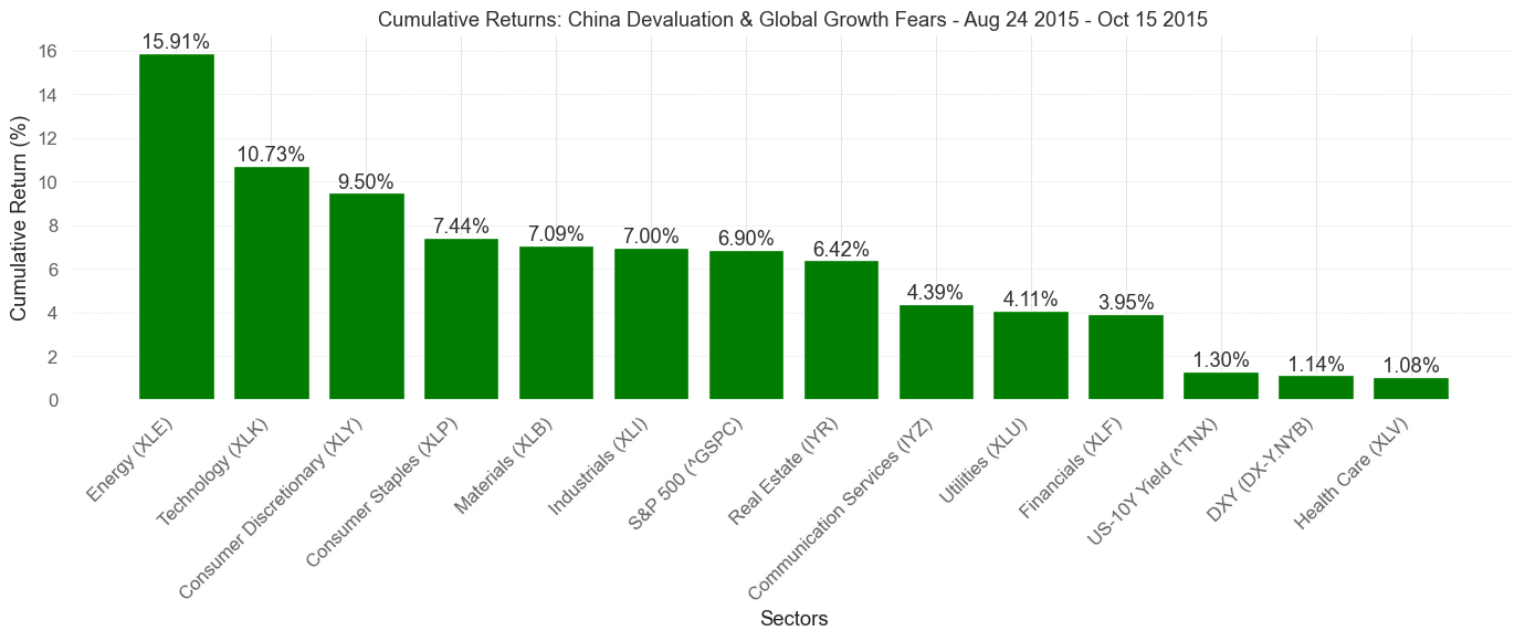

Cumulative Returns: Dot-Com Fallout & Accounting Scandals - May 3 2002 - Jan 6 2003
Cumulative Return (%)
0.0
−2.5
−5.0
−7.5
−10.0
−12.5
−15.0
−17.5
−20.0
0.06%
-4.76%
-5.40%
-8.77%
-9.61%
-10.23%
-10.63%
-13.45%
-15.30%
-17.64%
-17.80%
-17.93%
-18.95%
-19.68%
Communication Services (IYZ)
Real Estate (IYR)
Health Care (XLV)
Technology (XLK)
Materials (XLB)
DXY (DX-Y.NYB)
Financials (XLF)
S&P 500 (^GSPC)
Industrials (XLI)
Energy (XLE)
Consumer Staples (XLP)
Consumer Discretionary (XLY)
Utilities (XLU)
US-10Y Yield (^TNX)
Sectors

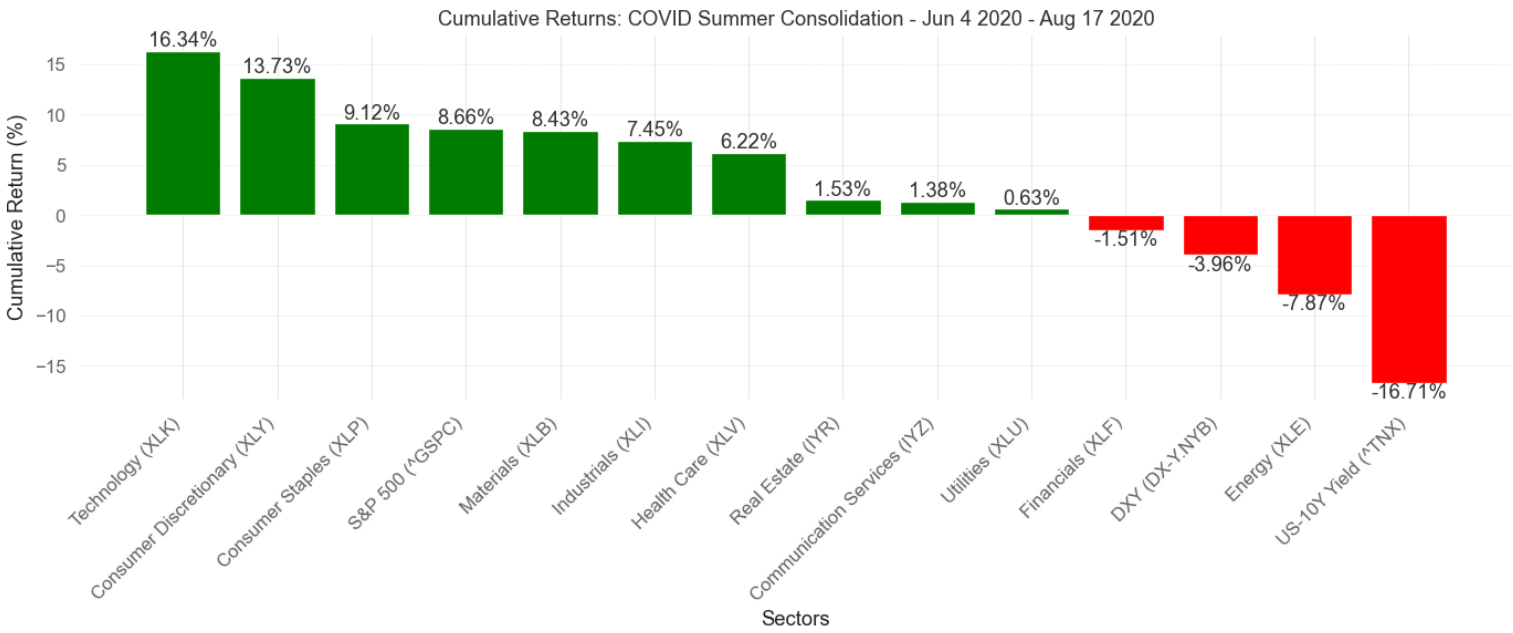

Cumulative Returns: Pre-Lehman GFC Escalation - Nov 2 2007 - Aug 12 2008
Cumulative Return (%)
5
0
−5
−10
−15
−20
−25
−30
4.49%
-0.25%
-4.81%
-5.65%
-7.51%
-8.51%
-8.69%
-9.42%
-10.63%
-12.40%
-14.58%
-15.69%
-23.22%
-31.73%
Consumer Staples (XLP)
DXY (DX-Y.NYB)
Health Care (XLV)
Energy (XLE)
Materials (XLB)
Real Estate (IYR)
US-10Y Yield (^TNX)
Utilities (XLU)
Industrials (XLI)
Consumer Discretionary (XLY)
S&P 500 (^GSPC)
Technology (XLK)
Communication Services (IYZ)
Financials (XLF)
Sectors

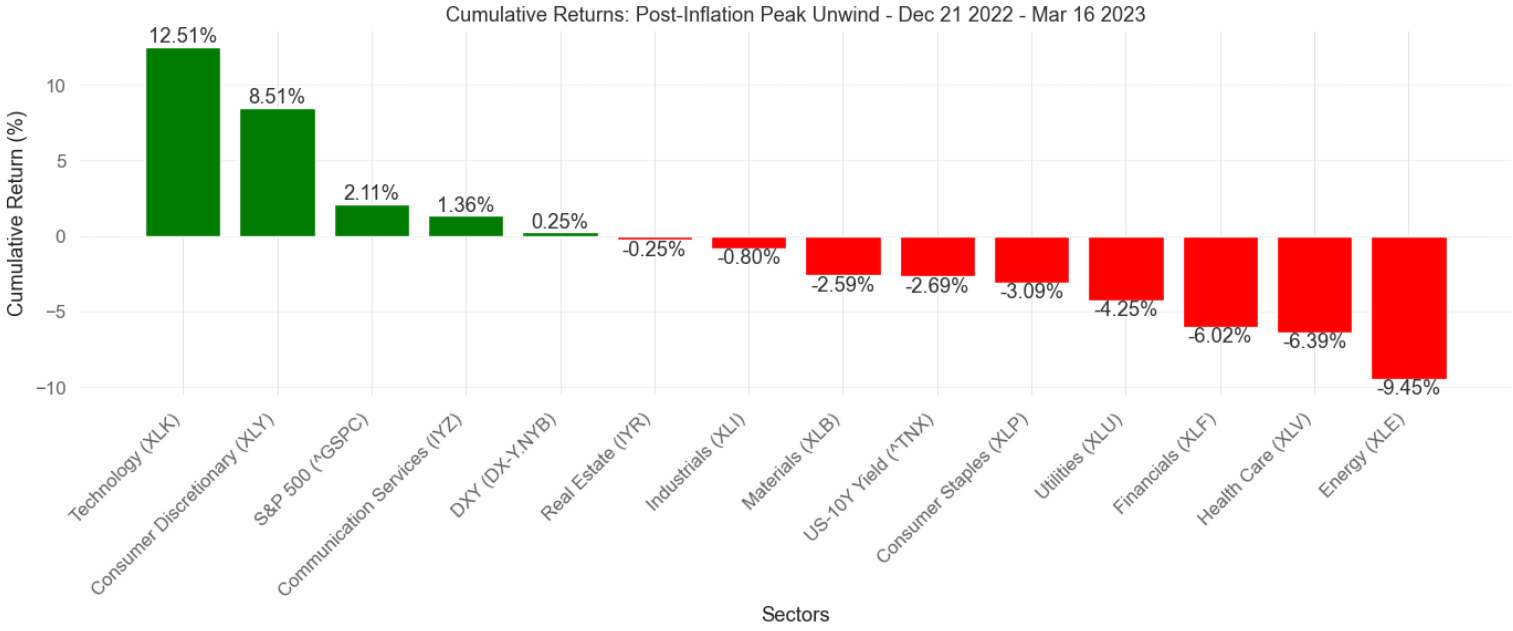

Cumulative Returns: Post-GFC Snap-Back - Apr 22 2009 - May 14 2009
Cumulative Return (%)
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
15.17%
11.60%
7.70%
7.40%
6.32%
5.87%
5.37%
4.98%
4.82%
4.59%
3.81%
0.22%
0.12%
-4.54%
Financials (XLF)
Energy (XLE)
Materials (XLB)
Health Care (XLV)
Communication Services (IYZ)
S&P 500 (^GSPC)
Real Estate (IYR)
Utilities (XLU)
US-10Y Yield (^TNX)
Consumer Staples (XLP)
Industrials (XLI)
Consumer Discretionary (XLY)
Technology (XLK)
DXY (DX-Y.NYB)
Sectors

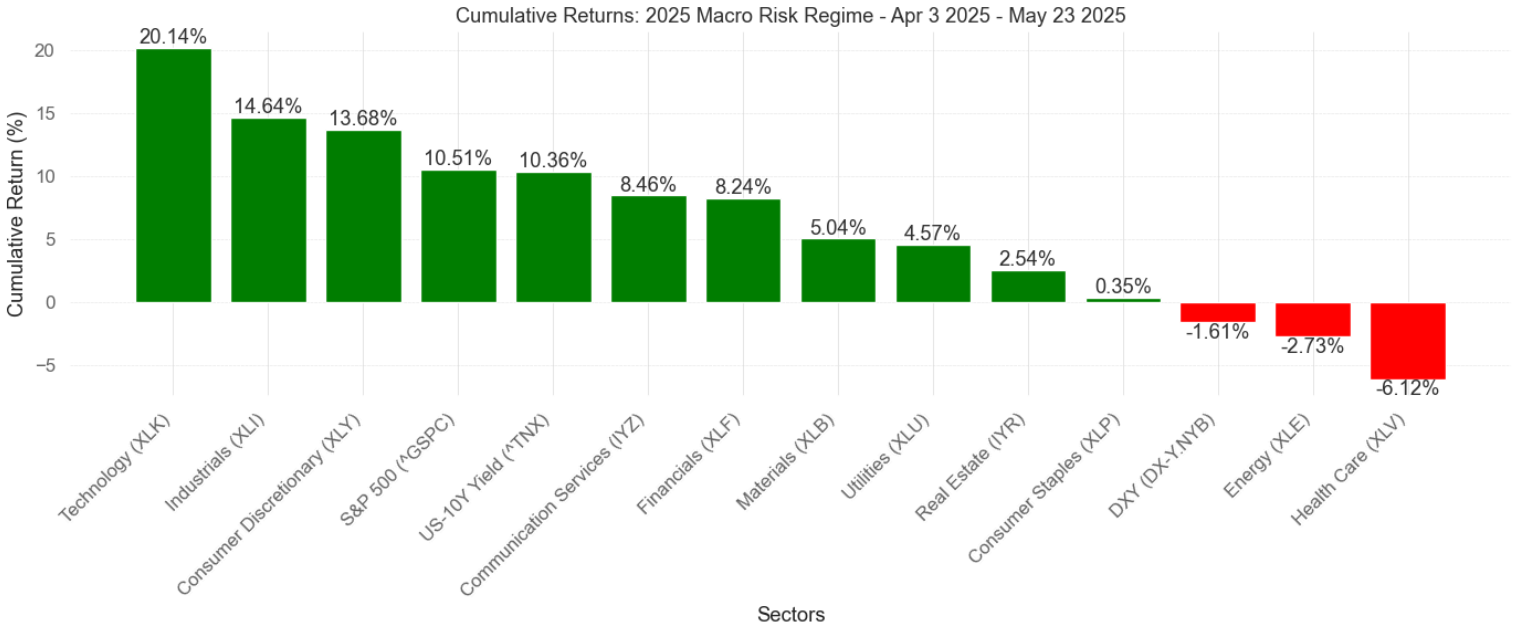

Cumulative Returns: QE2 Anticipation - Sep 20 2010 - Oct 29 2010
Cumulative Return (%)
8.10%
6.52%
5.65%
5.63%
3.55%
3.30%
3.27%
2.74%
2.43%
1.47%
0.41%
-2.22%
-3.47%
-5.00%
Energy (XLE)
Technology (XLK)
Materials (XLB)
Consumer Discretionary (XLY)
S&P 500 (^GSPC)
Consumer Staples (XLP)
Industrials (XLI)
Health Care (XLV)
Communication Services (IYZ)
Utilities (XLU)
Real Estate (IYR)
Financials (XLF)
US-10Y Yield (^TNX)
DXY (DX-Y.NYB)
Sectors


Cumulative Returns: US Credit Downgrade Volatility - Aug 1 2011 - Sep 9 2011
Cumulative Return (%)
3.95%
-1.41%
-2.34%
-4.68%
-8.39%
-8.92%
-10.03%
-10.19%
-10.31%
-12.42%
-12.43%
-15.00%
-17.08%
-30.11%
DXY (DX-Y.NYB)
Utilities (XLU)
Consumer Staples (XLP)
Health Care (XLV)
Real Estate (IYR)
Technology (XLK)
Communication Services (IYZ)
Consumer Discretionary (XLY)
S&P 500 (^GSPC)
Industrials (XLI)
Materials (XLB)
Energy (XLE)
Financials (XLF)
US-10Y Yield (^TNX)
Sectors


Cumulative Returns: China Devaluation & Global Growth Fears - Aug 24 2015 - Oct 15 2015
Cumulative Return (%)
15.91%
10.73%
9.50%
7.44%
7.09%
7.00%
6.90%
6.42%
4.39%
4.11%
3.95%
1.30%
1.14%
1.08%
Energy (XLE)
Technology (XLK)
Consumer Discretionary (XLY)
Consumer Staples (XLP)
Materials (XLB)
Industrials (XLI)
S&P 500 (^GSPC)
Real Estate (IYR)
Communication Services (IYZ)
Utilities (XLU)
Financials (XLF)
US-10Y Yield (^TNX)
DXY (DX-Y.NYB)
Health Care (XLV)
Sectors

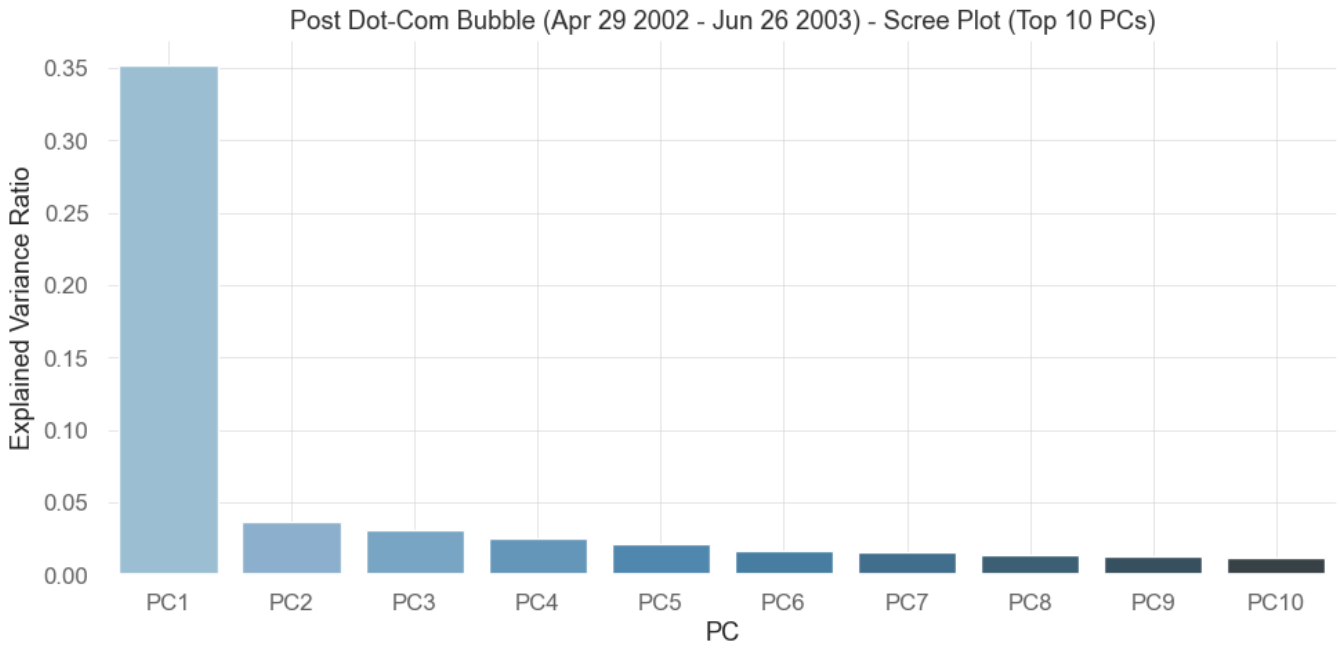


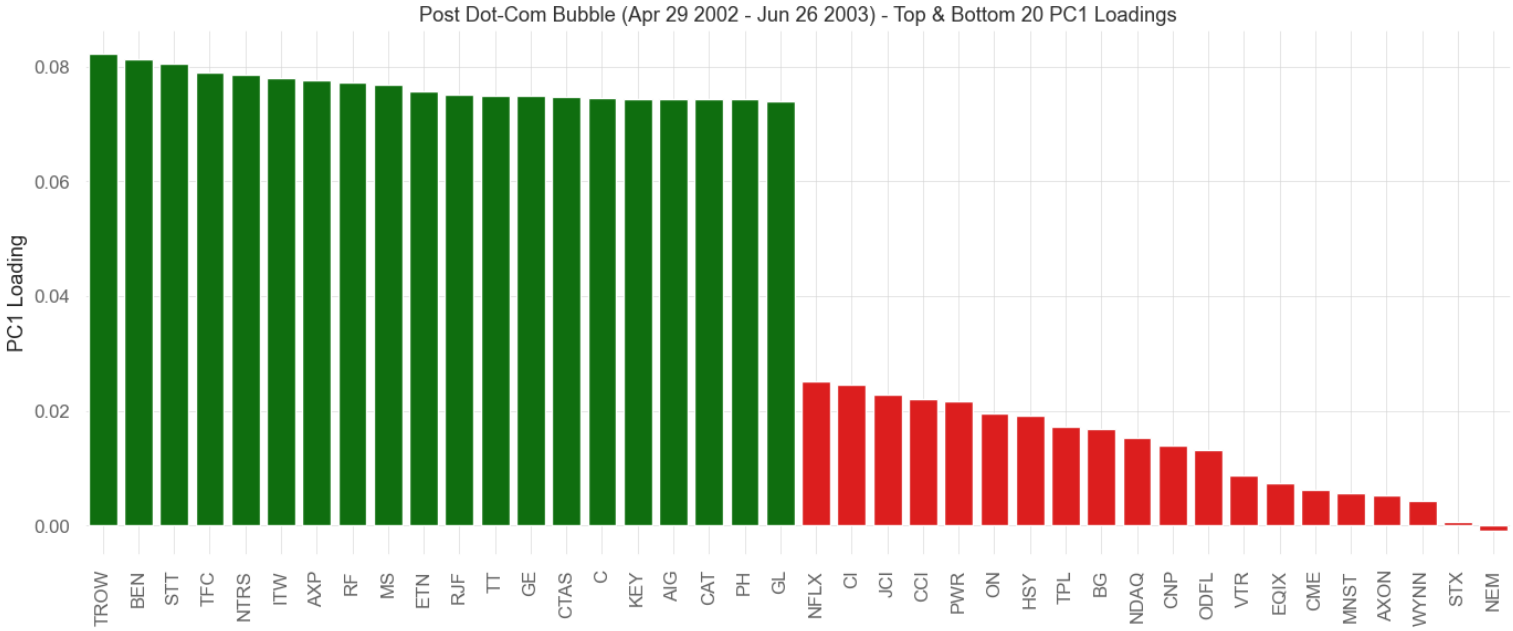




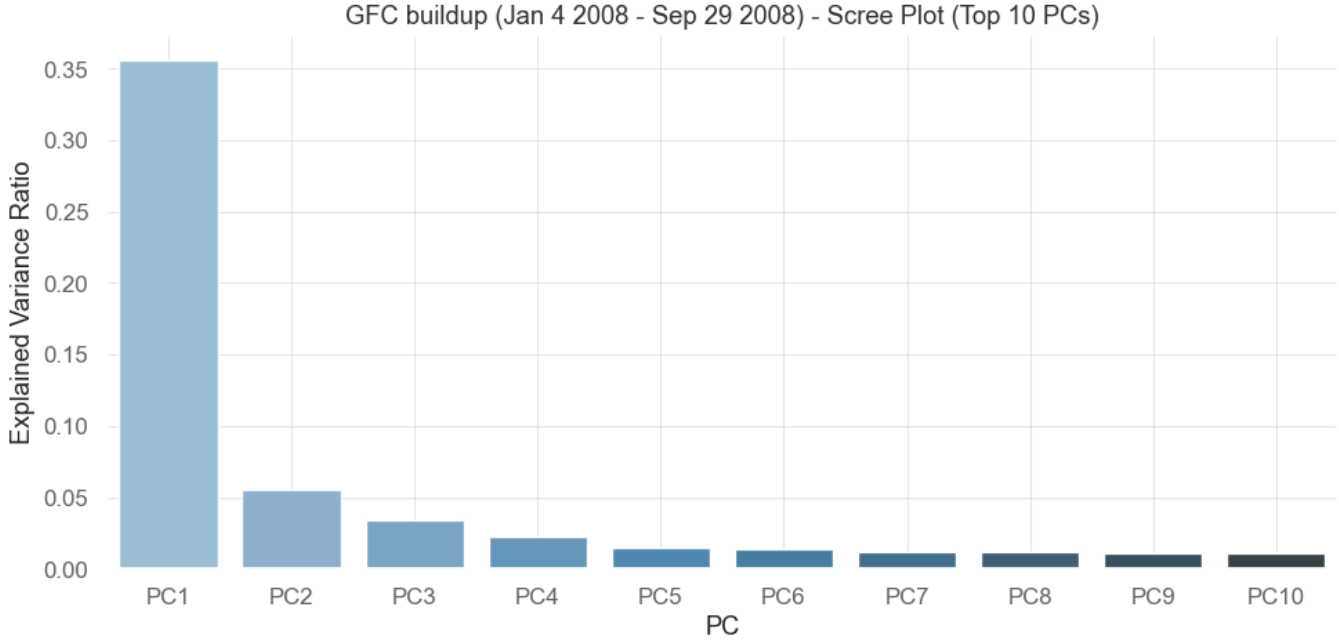
- The first two periods (The Dot-Com fallout and GFC buildup) experienced broad market drawdowns.
- Financials underperformed across all the periods except the Post GFC Snap-Back and the one we are currently in.
- Energy traded lower over 6 periods out of 9.

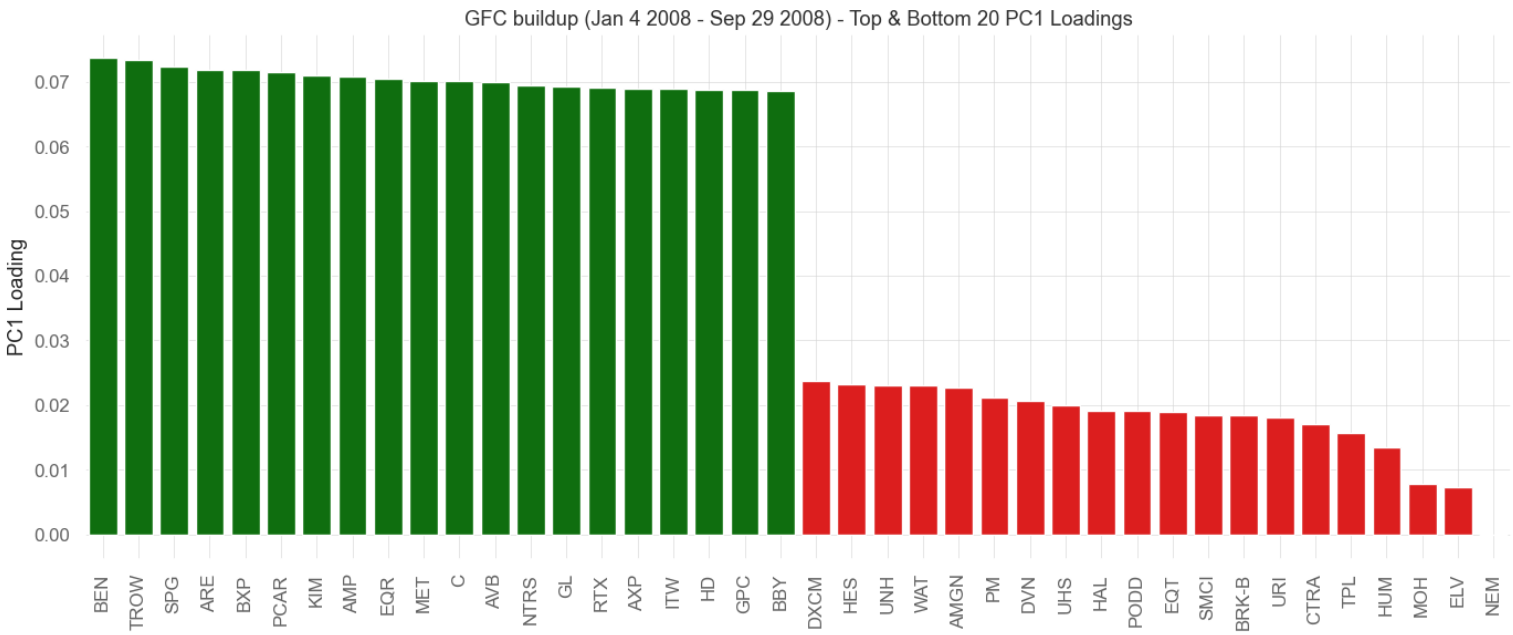
- PCA






```
=== Explained Variance Ratio (Top 5 PCs) ===
PC1 explains 35.17% of the variance
PC2 explains 3.64% of the variance
PC3 explains 3.11% of the variance
PC4 explains 2.54% of the variance
PC5 explains 2.15% of the variance
```






```
=== Explained Variance Ratio (Top 5 PCs) ===
PC1 explains 35.57% of the variance
PC2 explains 5.50% of the variance
PC3 explains 3.38% of the variance
PC4 explains 2.28% of the variance
PC5 explains 1.43% of the variance
```

- We regress sector ETF returns (e.g., XLF, XLK, XLU...) on the principal components PC1, PC2 and PC3.

```
Post Dot-Com Bubble (2002–2003)
```

	ETF	Sector	PC	Beta	t-Stat	p-Value
1	^GSPC	S&P 500	PC1	0.0184	65.5	0.000000
2	XLI	Industrials	PC1	0.0183	37.5	0.000000
3	XLF	Financials	PC1	0.0209	34.6	0.000000
4	XLK	Technology	PC1	0.0245	31.0	0.000000
5	XLY	Consumer Discretionary	PC1	0.0186	29.2	0.000000
6	XLB	Materials	PC1	0.0178	24.6	0.000000
7	XLV	Health Care	PC1	0.0149	18.9	0.000000
8	XLE	Energy	PC1	0.0161	18.0	0.000000
9	XLP	Consumer Staples	PC1	0.0093	16.1	0.000000
10	XLU	Utilities	PC1	0.0162	15.8	0.000000
11	XLK	Technology	PC2	0.0120	15.2	0.000000
12	IYR	Real Estate	PC1	0.0068	14.3	0.000000
13	IYZ	Communication Services	PC1	0.0192	12.9	0.000000
14	IYR	Real Estate	PC3	0.0051	10.7	0.000000
15	XLU	Utilities	PC3	0.0104	10.1	0.000000
16	XLP	Consumer Staples	PC2	-0.0054	-9.4	0.000000
17	XLP	Consumer Staples	PC3	-0.0043	-7.3	0.000000
18	XLY	Consumer Discretionary	PC3	-0.0039	-6.1	0.000000
19	^GSPC	S&P 500	PC3	-0.0014	-5.0	0.000002
20	IYR	Real Estate	PC2	-0.0020	-4.3	0.000026
21	XLU	Utilities	PC2	-0.0044	-4.3	0.000027
22	^GSPC	S&P 500	PC2	0.0012	4.2	0.000049
23	XLV	Health Care	PC2	-0.0030	-3.9	0.000158
24	XLV	Health Care	PC3	-0.0029	-3.7	0.000346
25	IYZ	Communication Services	PC2	0.0048	3.3	0.001396
26	XLE	Energy	PC2	-0.0028	-3.1	0.002020
27	XLY	Consumer Discretionary	PC2	0.0019	3.0	0.002928
28	XLB	Materials	PC2	-0.0021	-2.9	0.003885
29	XLB	Materials	PC3	-0.0019	-2.6	0.009886
30	XLE	Energy	PC3	-0.0023	-2.5	0.011766
31	XLI	Industrials	PC3	-0.0011	-2.2	0.026164
32	XLI	Industrials	PC2	0.0010	2.0	0.043903
33	XLF	Financials	PC2	0.0010	1.7	0.093115
34	IYZ	Communication Services	PC3	0.0025	1.6	0.100965
35	XLK	Technology	PC3	-0.0011	-1.4	0.173508
36	XLF	Financials	PC3	0.0005	0.7	0.457888

GFC buildup (2008)

	ETF	Sector	PC	Beta	t-Stat	p-Value
1	^GSPC	S&P 500	PC1	0.0134	83.8	0.000000
2	XLF	Financials	PC1	0.0253	32.9	0.000000
3	XLI	Industrials	PC1	0.0137	28.6	0.000000
4	IYR	Real Estate	PC1	0.0207	28.4	0.000000
5	XLY	Consumer Discretionary	PC1	0.0155	28.0	0.000000
6	XLE	Energy	PC2	0.0165	23.0	0.000000
7	XLK	Technology	PC1	0.0124	20.9	0.000000
8	IYZ	Communication Services	PC1	0.0142	20.5	0.000000
9	XLB	Materials	PC1	0.0129	19.7	0.000000
10	XLV	Health Care	PC1	0.0077	17.2	0.000000
11	XLU	Utilities	PC3	0.0070	16.4	0.000000
12	XLP	Consumer Staples	PC1	0.0071	15.7	0.000000
13	XLB	Materials	PC2	0.0101	15.5	0.000000
14	XLU	Utilities	PC1	0.0062	14.6	0.000000
15	XLE	Energy	PC1	0.0097	13.6	0.000000
16	XLU	Utilities	PC2	0.0053	12.5	0.000000
17	^GSPC	S&P 500	PC2	0.0019	12.2	0.000000
18	XLF	Financials	PC2	-0.0083	-10.9	0.000000
19	IYR	Real Estate	PC2	-0.0064	-8.8	0.000000
20	XLV	Health Care	PC3	0.0038	8.5	0.000000
21	XLB	Materials	PC3	-0.0039	-6.0	0.000000
22	XLY	Consumer Discretionary	PC2	-0.0032	-5.8	0.000000
23	XLI	Industrials	PC2	0.0025	5.3	0.000000
24	XLP	Consumer Staples	PC3	0.0023	5.0	0.000001
25	XLE	Energy	PC3	-0.0032	-4.4	0.000019
26	XLI	Industrials	PC3	-0.0018	-3.7	0.000266
27	XLK	Technology	PC2	0.0021	3.6	0.000416
28	XLK	Technology	PC3	-0.0021	-3.5	0.000586
29	IYZ	Communication Services	PC2	0.0023	3.4	0.000856
30	XLF	Financials	PC3	-0.0018	-2.3	0.023511
31	IYR	Real Estate	PC3	-0.0016	-2.3	0.025143
32	IYZ	Communication Services	PC3	0.0014	2.1	0.038685
33	XLV	Health Care	PC2	0.0009	2.0	0.042076
34	^GSPC	S&P 500	PC3	-0.0003	-2.0	0.046837
35	XLP	Consumer Staples	PC2	0.0001	0.1	0.908684
36	XLY	Consumer Discretionary	PC3	0.0000	0.1	0.936760

- Top and Bottom Loaders for PC1, PC2, PC3

PC1 Top 20 Ticker	PC1 Top 20 Loading	PC1 Bottom 20 Ticker	PC1 Bottom 20 Loading
TROW	0.0778	NEM	-0.0005
BEN	0.0774	STX	0.0132
NTRS	0.0740	TPL	0.0164
ITW	0.0735	MNST	0.0199
AXP	0.0733	BG	0.0217
PCAR	0.0727	ELV	0.0237
C	0.0723	HUM	0.0257
STT	0.0721	EQIX	0.0260
MS	0.0721	AXON	0.0261
GL	0.0716	WYNN	0.0266
RJF	0.0715	TTWO	0.0266
TFC	0.0712	BRK-B	0.0266
GPC	0.0711	CI	0.0287
CTAS	0.0708	UHS	0.0291
RTX	0.0703	CNP	0.0296
GE	0.0702	CNC	0.0298
GS	0.0700	DVA	0.0298
GWW	0.0698	UNH	0.0299
BAC	0.0696	NFLX	0.0301
JPM	0.0694	CME	0.0304

PC2 Top 10 Ticker	PC2 Top 10 Loading	PC2 Bottom 10 Ticker	PC2 Bottom 10 Loading
NVDA	0.0954	K	-0.0768
QCOM	0.0883	HSY	-0.0763
LRCX	0.0837	UDR	-0.0734
CTRA	0.0805	CLX	-0.0643
AAPL	0.0799	SYY	-0.0616
WMB	0.0798	CPT	-0.0602
FFIV	0.0770	PLD	-0.0594
EOG	0.0769	CL	-0.0580
SLB	0.0741	TFC	-0.0569
NTAP	0.0739	CAG	-0.0565

PC3 Top 10 Ticker	PC3 Top 10 Loading	PC3 Bottom 10 Ticker	PC3 Bottom 10 Loading
D	0.1528	IFF	-0.0622
WEC	0.1504	DE	-0.0616
ES	0.1375	NUE	-0.0573
CNP	0.1369	EA	-0.0556
AEE	0.1357	STLD	-0.0541
NEE	0.1323	NDAQ	-0.0532
SO	0.1311	AKAM	-0.0522
PPL	0.1304	WSM	-0.0501
DTE	0.1297	LEN	-0.0501
FE	0.1285	TPR	-0.0486

```
PC1 Macro Correlations (21-Day rolling):

Post Dot-Com Bubble - PC1 vs SPX: Average 21D Corr = 0.31
Post Dot-Com Bubble - PC1 vs VIX: Average 21D Corr = -0.34
Post Dot-Com Bubble - PC1 vs DXY: Average 21D Corr = 0.21

GFC buildup - PC1 vs SPX: Average 21D Corr = 0.32
GFC buildup - PC1 vs VIX: Average 21D Corr = -0.34
GFC buildup - PC1 vs DXY: Average 21D Corr = 0.19
```

```
PC2 Macro Correlations:

Post Dot-Com Bubble - PC2 vs SPX: Average 21D Corr = 0.06
Post Dot-Com Bubble - PC2 vs VIX: Average 21D Corr = -0.05
Post Dot-Com Bubble - PC2 vs DXY: Average 21D Corr = -0.02

GFC buildup - PC2 vs SPX: Average 21D Corr = 0.25
GFC buildup - PC2 vs VIX: Average 21D Corr = -0.24
GFC buildup - PC2 vs DXY: Average 21D Corr = -0.02

PC3 Macro Correlations:

Post Dot-Com Bubble - PC3 vs SPX: Average 21D Corr = 0.12
Post Dot-Com Bubble - PC3 vs VIX: Average 21D Corr = -0.18
Post Dot-Com Bubble - PC3 vs DXY: Average 21D Corr = -0.02

GFC buildup - PC3 vs SPX: Average 21D Corr = -0.07
GFC buildup - PC3 vs VIX: Average 21D Corr = 0.06
GFC buildup - PC3 vs DXY: Average 21D Corr = -0.08
```

Observations from PCA

- During drawdowns, cross-sectional correlations increase. Most stocks tend to fall together, which inflates the first eigenvalue (PC1). Assets with high PC1 loadings will be those contributing most to the market panic (e.g., high-beta names, cyclicals, or crowded trades). We can see that PC1 behaves similarly to the market index (S&P 500) — high correlation (t-stats ~70–80). PC1 explains around 32% of variance and captures systematic market risk, with high exposure to financials, cyclicals, and beta-heavy sectors. Stocks with large negative loadings are defensives and low-beta names. Highest loadings are dominated by banks and financials (TROW, BEN, NTRS, AXP, C, STT, MS, JPM, etc.). Bottom 20 includes defensive healthcare (UNH, CI, CNC), gold miner (NEM), EQIX, etc.). Across the two periods, the strongest loading increase (0.0191 → 0.0253) is for XLF (Financials) while XLK (Tech) saw its loading decreased. Which makes sense as during the GFC, Financials and Real Estate (IYR) were more sensitive to systemic shocks than in 2002.
- When the crisis dissipates or overreaction unwinds, high PC1 loaders often snap back more strongly, leading to a mean-reversion opportunity. This could support a signal-driven long/short allocation that benefits from over/underreaction. This mean-reverting behaviour could be exploited by applying a rolling z-score to strategy returns with entry/exit logic to systematically identify dislocations. This assumes the market will stabilize. In a prolonged structural bear market (e.g., 2008), mean-reversion trades can fail. It is essential to distinguish between temporary stress and regime change. PC1 displays a 21-day average correlation of +0.3 with SPX and –0.35 with VIX, which is not surprising during periods of stress. While this does not just justify a mean-reverting strategy by itself, it remains supportive.
- While PC1 captures the dominant co-movement across equities during stress regimes, regression analysis reveals that PC2 and PC3 carry statistically and economically meaningful sector-specific signals. Across both the 2002–2003 post–Dot-Com bubble period and the 2008 GFC buildup, PC2 exhibited strong and significant positive loadings on the Technology (XLK) and Energy (XLE) sectors, suggesting that it captures a latent sector rotation or macro re-pricing dynamic not captured by PC1. Likewise, PC3 demonstrated consistently significant exposures to traditionally defensive sectors such as Utilities (XLU), Consumer Staples (XLP), and Real Estate (IYR), particularly during periods of elevated volatility. These results confirm that PC2 and PC3, despite explaining a smaller share of total variance, reflect orthogonal risk premia aligned with observable economic themes. Therefore, their inclusion in the strategy could contribute to factor diversification.
- PC2 explains 3.5% to 5.5% of variance and likely captures the growth vs value trade (or momentum vs defensive tilt). It has only one strong exposure to XLK (Tech). Top 10 stocks are all semiconductors or tech hardware (NVDA, QCOM, AAPL, LRCX, FFIV, NTAP). The bottom stocks are all consumer staples or REITs (bottom 10: HSY, CLX, K, UDR, PSA, AVB). We observe many sign flips between the two periods, XLE (Energy) (from –0.0020 to +0.0165) had a strong reversal, XLP (Staples) (from –0.0043 to +0.0001) flattened and XLU (Utilities) (from –0.0030 to +0.0053) reversed also. It suggests a regime shift in relative factor structure, perhaps from a defensive-led rotation (2002) to a more uniform sector response (2008).
- PC3 explains around 3% of the variance. It has high ETF loadings to XLU (Utilities), moderate betas on REITs (IYR), Health Care (XLV). Top 10 stocks are pure-play Utilities (D, WEC, AEE, SO, NEE...) and bottom 10 stocks are Cyclicals with housing/industrial exposure (DE, LEN, PHM, STLD, DHI). PC3 is likely a duration/fixed income sensitivity factor. Utilities are sensitive to long-term bond yields. The negative side is populated with economically sensitive, rate-sensitive sectors like homebuilders, steel, and machinery. PC3 exposure is key when inflation expectations or interest rates shift. Utilities shine in risk-off, falling-rate environments driven by recession fears or financial stress. They are "long duration". Homebuilders, steel, machinery benefit from growth rebounds that may also involve lower rates — but only if investors believe in an economic recovery. They are pro-cyclical and need real activity to pick up. Thus, PC3 seems to be not just about "interest rates" but also about how sensitive a stock is to the type of regime where rates are falling as top PC3 (duration-driven defensives) would rally in slowdowns or panics while bottom PC3 (growth-sensitive cyclicals) would rally when stimulus (lower rates, fiscal deficits) revives the economy.
- PC2 does not capture a mean-reverting behaviour (0.08/0.25 with SPX, -0.07/-0.25 with VIX) nor does PC3 (0.08/0.25 and -0.07/-0.24). There is no stable relationship between the principal components and the dollar index across both periods.

Portfolio Construction

- We construct two 30-stock portfolios (15 longs, 15 shorts), equally-weighted within each leg. The short book is volatility-scaled to a 22 % target, so the overall portfolio is volatility-balanced rather than dollar-neutral.
- We stay consistent with the statistical/PCA logic so the long basket is made of the lowest PC loaders and the short basket is made of the highest PC loaders.
- The first portfolio, called "PC1 Portfolio", contains only the bottom 15 PC1 loaders in the long leg and top 15 PC1 loaders in the short leg.
- The second portfolio, called "Multi PC Portfolio", is made of the bottom 12 PC1, 1 PC2, 2 PC3 loaders in the long leg and the top 12 PC1, 1 PC2 and 2 PC3 loaders in the short leg. This portfolio is also short market beta, short cyclicals vs. defensives, but with a long value vs. momentum tilt and another long rate-sensitive cyclical vs. short bond proxies tilt. In theory, this portfolio could be relevant if investors believe the market is overpricing growth (PC2), beta is overbought (PC1) but rates have peaked and housing/cyclicals will rebound (PC3).

Risk Management

- The short basket consists of highly cyclical and levered names whose realised volatility in stress regimes is on average 32% higher than the long basket (based on the backtest periods - see table below). Capping the short book at 22 % annualised volatility reins-in its crisis-period risk to roughly three-quarters of the long book's 75-th-percentile σ (≈ 29 %), which is tight enough to tame tail shocks without muting alpha.

- We therefore scale the short leg to a 22 % annualised volatility target using a 60-day exponentially weighted moving average forecast. The 60-day lookback balances statistical robustness with regime-change sensitivity, providing stable vol estimates while adapting to market conditions.
- The long basket is already defensively tilted by design. Leaving it un-scaled preserves the intended beta-compression exposure while keeping turnover and fees low.

Regime	Long σ	Short σ	Ratio
Post-GFC Snap-Back	29%	56%	1.91
QE2 Anticipation	20%	18%	0.88
US Credit Downgrade	50%	59%	1.17
China Devaluation	24%	26%	1.06
COVID Summer	24%	34%	1.43
Post-Inflation Unwind	15%	21%	1.39
2025 Macro Risk Regime	30%	42%	1.37
Average	27%	37%	1.32

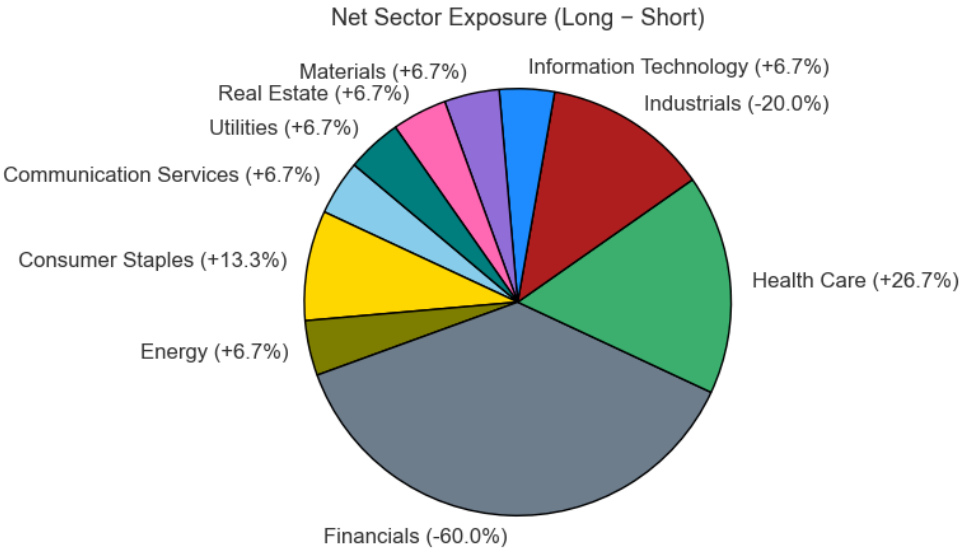
Backtests

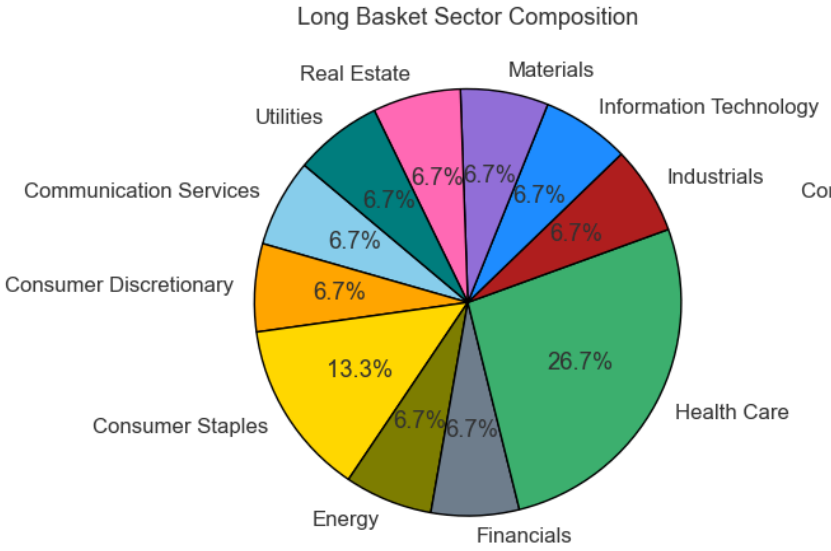
- We test the same portfolio construction using two trading approaches: static (buy-and-hold) and dynamic (tactical timing using z-score signals to enter/exit the same portfolio multiple times).
- We use the same time windows - the 7 longest stress regime periods out of the 26 periods identified.
- The static strategy is backtested across all 7 periods.
- The dynamic strategy is calibrated across the first 5 periods and the out of sample backtests are done over the latest 2 periods.
- Fixed parameters:
  - Transaction cost: 4 bps per trade (8 bps round trip).
  - Target volatility on the short leg only: 22% annualized (applied via scaling, transaction cost applied too).
  - Volatility lookback: 60 trading days.
  - Dynamic only:
    - Z-score smoothing: 60-day exponential smoothing span.
    - Signal timing: Close-to-close (T signal; T+1 execution).
- Calibration (Dynamic only):
  - Entry Z and Exit Z used: (-1, -0.75, -0.50, -0.25) and (0.25, 0.50, 0.75, 1).
  - We calibrate by selecting the entry/exit Z-score pair with the highest average Sharpe ratio across periods, requiring at least 2 trades per period and valid Sharpe calculations in at least 3 out of 5 calibration periods.
  - The entry/exit pair selected is then applied to calibration and OOS backtest periods.

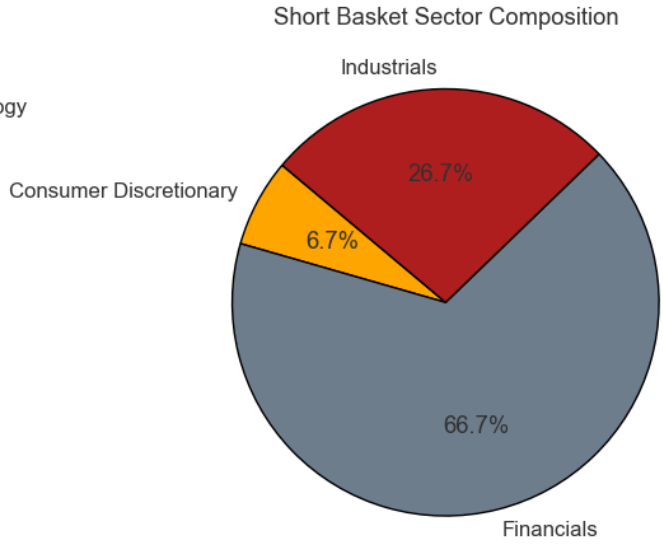
Set	Regime Window	Calendar	Trading Days	Regime Description
Calibration (5 events · 169 days)				
C-1	Post-GFC Snap-back	22 Apr 2009 → 14 May 2009	**17**	Oldest slice; GFC-related but short.
C-2	QE-2 Anticipation	20 Sep 2010 → 29 Oct 2010	**30**	Rates-down, USD-weak, low-growth.
C-3	US Debt-Ceiling Downgrade	01 Aug 2011 → 09 Sep 2011	**30**	High-vol, policy shock; equity stress.
C-4	China Deval / Global-Growth Scare	24 Aug 2015 → 15 Oct 2015	**39**	EM-led risk, USD bid then faded.
C-5	Covid “Summer Consolidation”	04 Jun 2020 → 17 Aug 2020	**53**	Same year but structurally different (rates floored, vol ≥ 18).
Out-of-Sample (2 events · 94 days)				
OOS-1	Post-Inflation-Peak Unwind	21 Dec 2022 → 16 Mar 2023	**58**	Falling CPI and USD; fresh macro mix.
OOS-2	2025 Macro-Risk Regime *(Live)*	03 Apr 2025 → 23 May 2025	**36**	"Live" slice; most recent regime observed.

- PC1 Portfolio

Sector Exposure Overview







	Long Ticker	Long Sector	Long Mkt Cap (B)	Long Avg Vol (M)	Long Beta	Short Ticker	Short Sector	Short Mkt Cap (B)	Short Avg Vol (M)	Short Beta
1	AXON	Industrials	61.65	0.65	1.28	AXP	Financials	211.91	3.37	1.25
2	BG	Consumer Staples	10.02	1.83	0.66	BEN	Financials	11.49	5.15	1.46
3	BRK-B	Financials	1064.77	5.54	0.84	C	Financials	146.17	16.26	1.31
4	CI	Health Care	83.40	1.78	0.45	CTAS	Industrials	91.93	1.84	1.06
5	CNP	Utilities	23.90	5.93	0.58	GL	Financials	10.05	0.68	0.56
6	ELV	Health Care	88.87	1.84	0.62	GPC	Consumer Discretionary	17.39	1.46	0.77
7	EQIX	Real Estate	89.45	0.64	0.96	ITW	Industrials	72.63	1.22	1.12
8	HUM	Health Care	27.84	1.78	0.43	MS	Financials	211.48	7.57	1.29
9	MNST	Consumer Staples	61.84	5.76	0.60	NTRS	Financials	20.99	1.51	1.24
10	NEM	Materials	58.28	13.35	0.32	PCAR	Industrials	49.08	3.18	0.95
11	STX	Information Technology	26.95	4.27	1.43	RJF	Financials	29.61	1.52	1.04
12	TPL	Energy	25.59	0.13	1.13	RTX	Industrials	185.83	5.35	0.62
13	TTWO	Communication Services	42.56	2.27	1.03	STT	Financials	28.12	2.10	1.46
14	UHS	Health Care	12.20	0.83	1.32	TFC	Financials	53.25	10.25	0.81
15	WYNN	Consumer Discretionary	8.71	2.68	1.37	TROW	Financials	20.77	2.13	1.51
16	Average		112.40	3.29	0.87	Average		77.38	4.24	1.10

- PC1 Portfolio Composition
  - The largest net exposures of the strategy are Financials (-60%), Health Care (+27%), Industrials (-20%), and Staples (+13%)
  - The strategy ends up with no exposure to Consumer Discretionary.

- The long basket is made of 11 sectors and is quite defensive as 47% are Health Care, Staples and Utilities stocks.
- The short basket contains three sectors, all cyclicals, dominated by Financials.

- PC1 Static Backtests

Period	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Scaling_Factor	VIX_Avg	US10Y_Δ_bps
Post-GFC Snap-Back	+4.04%	+6.07%	-1.92%	3.88	4.86	1.01	-0.75	-1.80%	0.396	34.8	+14.3
QE2 Anticipation	+1.45%	+4.55%	-2.88%	0.85	0.90	0.29	-1.61	-4.85%	1.000	21.1	-9.4
US Credit Downgrade	+0.60%	-6.12%	+6.15%	0.33	0.42	0.11	-0.47	-8.29%	0.374	35.0	-82.5
China Devaluation	+2.50%	+2.49%	+0.14%	1.38	1.94	0.53	0.13	-3.93%	0.847	23.8	+2.6
COVID Summer	+3.94%	+3.58%	+0.51%	1.51	2.33	0.68	-0.04	-3.01%	0.644	27.8	-13.7
Post-Inflation Unwind	+2.89%	+1.74%	+1.66%	0.95	1.92	0.44	1.43	-7.31%	1.000	20.7	-9.9
2025 Macro Risk Regime	+2.75%	+8.32%	-5.53%	1.40	1.54	0.52	-1.27	-3.32%	0.526	27.3	+45.4

```
Average Sharpe Ratio: 1.47
Average Max Drawdown: −4.64%
Average Skew: −0.37
Average Scaling Factor: 0.684
```

Observations

- All total returns are positive. Return profile is mildly left-tailed (skew –0.37).
- In the two true stress episodes (Post-GFC, Credit-downgrade; VIX >30) the basket is positive with average max draw-downs of 5%.
- Out of the 4 highest sharpe ratio, 3 happened during higher rates and 3 with VIX > 27. Net wins tend to scale with VIX and the direction of the 10-year move, reinforcing the narrative: when USD & SPX co-decline and stress vol surfaces, PC1 spread widens.
- With average max-DD ~ 4.6 %, allocating 2 % of NAV to the basket risks < 10 bp per event and –on Sharpe 1.5– offers ~ 30 bp expected annual alpha.
- Bottom line: the PC1 static book tends to bring small positive carry in “easy” markets and higher payoff when stress hits.

- PC1 Dynamic Strategy: Calibration and Backtests

```
Optimal z−pair across calibration windows: Entry −0.5, Exit 0.5
```

Period	Entry_z	Exit_z	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Hit_Ratio	PF	Trades	Rebal	VIX_Avg	US10Y_Δ_bps
Post-GFC Snap-Back	-0.50	0.50	0.002129	+5.83%	-5.18%	0.36	0.20	0.08	-1.48	-2.69%	50.0%	3.66	2	0	34.8	+14.3
QE2 Anticipation	-0.50	0.50	-0.023366	-0.42%	-1.41%	-1.99	-0.93	-0.57	-3.69	-4.70%	66.7%	0.26	3	1	21.1	-9.4
US Credit Downgrade	-0.50	0.50	0.069312	+7.33%	+0.21%	6.89	nan	1.91	2.71	-0.08%	100.0%	inf	4	2	35.0	-82.5
China Devaluation	-0.50	0.50	-0.004644	+2.39%	-2.12%	-0.52	-0.27	-0.17	-2.83	-2.61%	75.0%	0.67	4	0	23.8	+2.6
COVID Summer	-0.50	0.50	0.015451	+2.23%	+0.54%	0.99	1.00	0.37	0.18	-2.09%	50.0%	1.75	6	4	27.8	-13.7
Post-Inflation Unwind	-0.50	0.50	-0.009861	+1.79%	-1.31%	-0.82	-0.72	-0.32	-0.66	-3.82%	37.5%	0.56	8	3	20.7	-9.9
2025 Macro Risk Regime	-0.50	0.50	0.016854	+5.30%	-2.80%	1.93	2.07	0.60	0.76	-2.77%	75.0%	3.80	4	2	27.3	+45.4

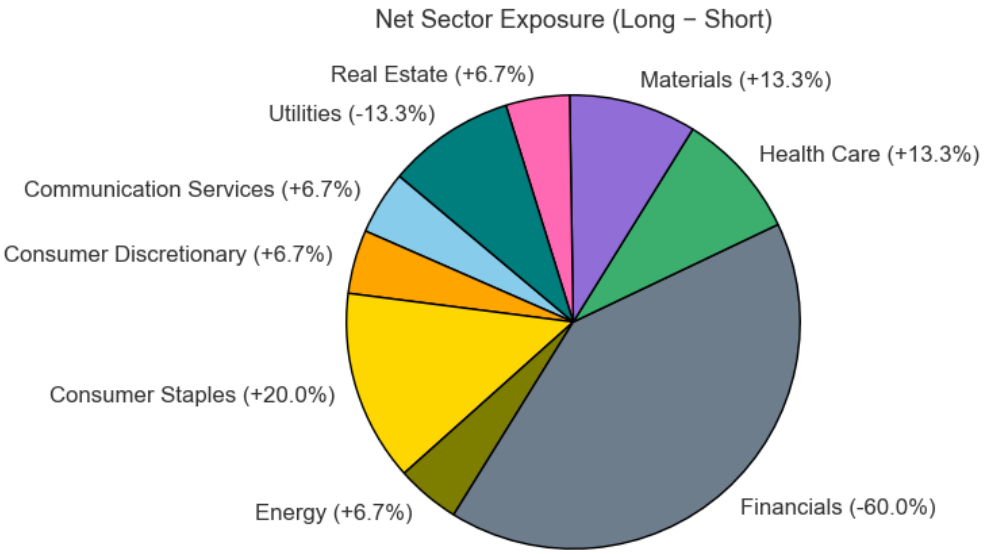
```
Average Sharpe Ratio: 0.98
Average Max Drawdown: −2.68%
Average Skew: −0.72
Average Weekly Rebalances: 1.7
```

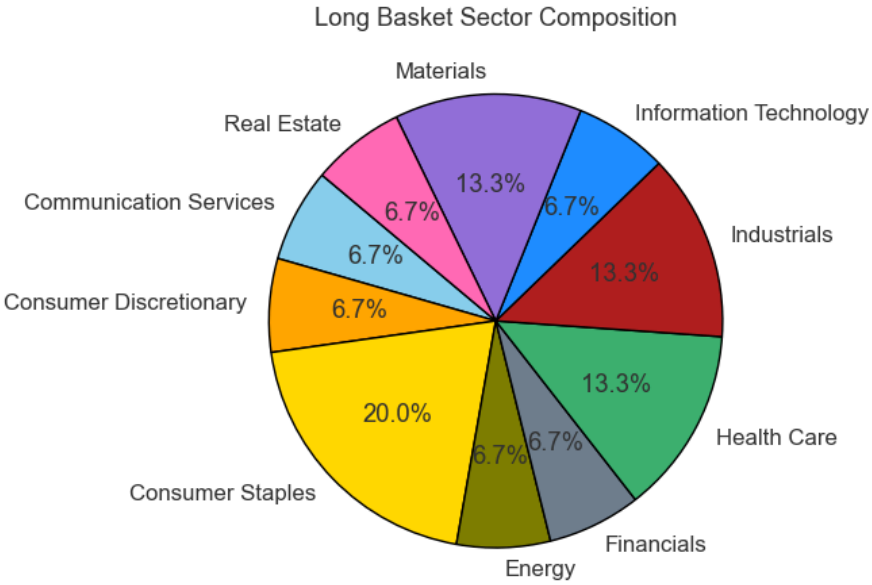
Observations

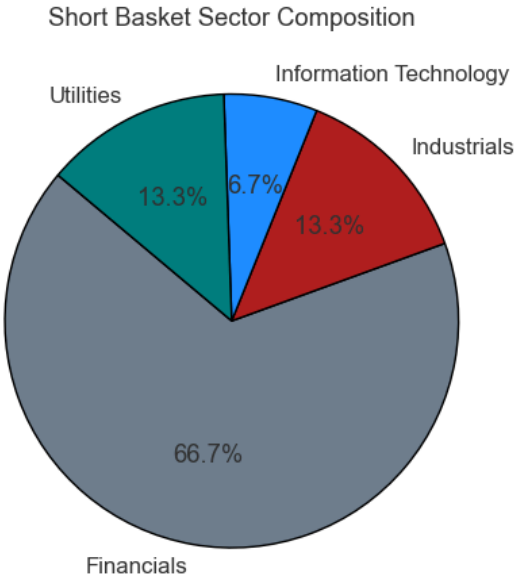
- Performance is lumpy: Sharpe 6.9 in US-Credit (mean-reversion), but three negative sharpes but three negative sharpes out of 7.
- Trades per window range between 2 and 8, with some large idiosyncratic P&L swings.
- Drawdowns smaller than static (avg –2.7 %) thanks to exits, but total return only 1 % on average.
- Bottom line: Timing adds value only when factor snap-backs are violent; otherwise the signal chops. Better risk control, but we pay with lower, less predictable edge.

- Multi PC Portfolio

Sector Exposure Overview







	Long Ticker	Long Sector	Long Mkt Cap (B)	Long Avg Vol (M)	Long Beta	Short Ticker	Short Sector	Short Mkt Cap (B)	Short Avg Vol (M)	Short Beta
1	AXON	Industrials	61.65	0.65	1.28	AXP	Financials	211.91	3.37	1.25
2	BG	Consumer Staples	10.02	1.83	0.66	BEN	Financials	11.49	5.15	1.46
3	BRK-B	Financials	1064.77	5.54	0.84	C	Financials	146.17	16.26	1.31
4	DE	Industrials	140.83	1.34	1.10	D	Utilities	47.56	5.64	0.56
5	ELV	Health Care	88.87	1.84	0.62	GL	Financials	10.05	0.68	0.56
6	EQIX	Real Estate	89.45	0.64	0.96	ITW	Industrials	72.63	1.22	1.12
7	HUM	Health Care	27.84	1.78	0.43	MS	Financials	211.48	7.57	1.29
8	IFF	Materials	19.67	1.84	1.08	NTRS	Financials	20.99	1.51	1.24
9	K	Consumer Staples	28.47	2.99	0.30	NVDA	Information Technology	3456.21	269.26	2.12
10	MNST	Consumer Staples	61.84	5.76	0.60	PCAR	Industrials	49.08	3.18	0.95
11	NEM	Materials	58.28	13.35	0.32	RJF	Financials	29.61	1.52	1.04
12	STX	Information Technology	26.95	4.27	1.43	STT	Financials	28.12	2.10	1.46
13	TPL	Energy	25.59	0.13	1.13	TFC	Financials	53.25	10.25	0.81
14	TTWO	Communication Services	42.56	2.27	1.03	TROW	Financials	20.77	2.13	1.51
15	WYNN	Consumer Discretionary	8.71	2.68	1.37	WEC	Utilities	33.70	2.34	0.44
16	Average		117.03	3.13	0.88	Average		293.53	22.15	1.14

- Changes compared to PC1 portfolio

    - Long: DE, IFF, K replaced CI, CNP, UHS
    - Short: D, NVDA, WEC replaced CTAS, GPC, RTX
- The net short exposure of Financials decreased from 66% to 60%.
- We went from net long to net short Utilities.
- In addition to Consumer Discretionary previously, we now have no net exposure also to Information Technology and Industrials.
- While the net long exposure of Consumer Staples increased from 13% to 20%, the net defensive profile (Health Care, Staples, Utilities) decreased from 47% to 33%.

- Multi PC Static Backtests

Period	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Scaling_Factor	VIX_Avg	US10Y_Δ_bps
Post-GFC Snap-Back	+3.40%	+4.78%	-1.34%	3.06	4.47	0.79	-0.34	-2.34%	0.422	34.8	+14.3
QE2 Anticipation	+0.56%	+3.66%	-2.93%	0.40	0.48	0.14	-1.04	-3.73%	1.000	21.1	-9.4
US Credit Downgrade	+1.15%	-5.40%	+6.00%	0.51	0.67	0.17	-0.40	-7.62%	0.379	35.0	-82.5
China Devaluation	+1.90%	+3.00%	-0.97%	1.11	1.52	0.43	0.37	-3.81%	0.854	23.8	+2.6
COVID Summer	+2.84%	+3.80%	-0.74%	1.16	1.84	0.52	0.06	-2.81%	0.740	27.8	-13.7
Post-Inflation Unwind	-1.10%	+1.10%	-1.69%	-0.30	-0.56	-0.14	1.34	-8.12%	0.999	20.7	-9.9
2025 Macro Risk Regime	+2.93%	+8.73%	-5.78%	1.57	1.86	0.58	-0.56	-2.95%	0.517	27.3	+45.4

```
Average Sharpe Ratio: 1.07
Average Max Drawdown: −4.48%
Average Skew: −0.08
Average Scaling Factor: 0.702
```

Observations

- Positive in 6 out of 7 windows; Sharpe peaks (3.1) Post-GFC, sinks during Post-Infl. (-0.3).
- Long leg dominates in late-cycle easing (2025 +8.7 %), while short alpha cushions crashes (US-Credit +6 %).
- Slightly lower average Sharpe (1.1) than PC1 Static, but tighter tails (skew ≈ 0) and similar drawdowns.
- Bottom line: The diversified factor basket smooths returns as we observe lower headline Sharpe vs PC1 but steadier contribution mix and no heavy tails.

- Multi PC Dynamic Strategy: Calibration and Backtests

```
Optimal z−pair across calibration windows: Entry −1, Exit 1
```

Period	Entry_z	Exit_z	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Hit_Ratio	PF	Trades	Rebal	VIX_Avg	US10Y_Δ_bps
Post-GFC Snap-Back	-1.00	1.00	-0.07%	+1.33%	-0.69%	-0.01	-0.00	-0.00	-1.54	-2.97%	25.0%	0.97	4	0	34.8	+14.3
QE2 Anticipation	-1.00	1.00	+0.30%	+0.91%	-0.33%	2.20	nan	0.63	4.72	-0.08%	50.0%	4.79	2	0	21.1	-9.4
US Credit Downgrade	-1.00	1.00	+2.91%	+5.08%	-1.98%	4.27	nan	1.18	4.78	-0.08%	100.0%	inf	1	0	35.0	-82.5
China Devaluation	-1.00	1.00	+1.15%	+5.48%	-3.86%	1.16	0.88	0.37	2.49	-1.96%	50.0%	2.28	2	0	23.8	+2.6
COVID Summer	-1.00	1.00	+3.21%	+5.52%	-1.43%	2.14	2.42	0.80	0.78	-1.76%	50.0%	6.82	4	5	27.8	-13.7
Post-Inflation Unwind	-1.00	1.00	-3.86%	+2.36%	-5.88%	-3.14	-1.76	-1.21	-2.20	-4.96%	0.0%	0.00	3	1	20.7	-9.9
2025 Macro Risk Regime	-1.00	1.00	+1.86%	+3.25%	-0.98%	2.17	1.82	0.67	1.19	-1.52%	100.0%	inf	2	2	27.3	+45.4

```
Average Sharpe Ratio: 1.26
Average Skew: 1.46
Average Max Drawdown: −1.90%
Average Weekly Rebalances: 1.1
```

Observations

- Big winners (US-Credit, COVID, 2025) and losers (Post-Infl. −3 Sharpe; Oil −3.7).
- Average Sharpe 1.26, lifted by fat-right-tail outcomes (skew +1.5).
- Max-DD only −1.9 %.
- Bottom line: A convex, opportunistic overlay with low bleed and strong upside when factors gap, but needs careful sizing because edge concentrates in few events.

- Fama-French Five-Factor Regressions against the returns of the dynamic strategies (PC1/Multi PC) for OOS 2023 period (2025 data not available)

	PC1 Static · 2023	Multi-PC Static · 2023
Alpha (bps/day)	3.3574	-0.1209
t(Alpha)	0.3024	-0.0129
R^2	0.4071	0.5085
MKT	-0.0298	0.0495
SMB	-0.5117	-0.3449
HML	-0.6779	-0.7022
RMW	-0.2272	-0.4327
CMA	0.5688	0.9145
UMD	0.2119	0.2695

Observations

- The Fama-French five-factor run confirms that neither static sleeve generated statistically significant alpha in the 2023 out-of-sample window. PC-1 shows a small positive intercept of ≈ 3 bp per day (t ≈ 0.30), while the Multi-PC basket's intercept is essentially zero. In other words, whatever edge these portfolios produced in 2023 was fully explained by their systematic exposures rather than residual stock-selection skill.
- Those systematic tilts look broadly similar but differ in intensity. Both baskets are essentially market-neutral (β ≈ 0) and display a clear anti-value, anti-small-cap stance—consistent with being long "quality defensives" and short capital-intensive cyclicals in a stress regime. The PC-1 sleeve leans hardest into this profile, with a stronger negative SMB and HML loading, plus a milder positive investment (CMA) tilt. The Multi-PC sleeve is more balanced across factors: its asset-growth (CMA) and momentum (UMD) betas are higher, and its size/value tilts are less extreme.
- The payoff to this broader diversification is a higher explanatory power: standard factors account for roughly half of Multi-PC's variance (R^2 ≈ 0.51) versus only 40 % for PC-1. Put differently, PC-1 offers more idiosyncratic risk—and therefore greater potential for true macro-driven alpha—while the Multi-PC basket trades some uniqueness for steadier, factor-aligned performance. Together they provide complementary exposures: one sleeve that most strongly monetises the "beta-compression" spread, and another that delivers that theme in a more factor-neutral, risk-controlled package.

- ETF Sector and Factor Regressions

	PC1 Static · 2023			PC1 Static · 2025			Multi-PC Static · 2023			Multi-PC Static · 2025		
	Beta	t-Stat	p-Value	Beta	t-Stat	p-Value	Beta	t-Stat	p-Value	Beta	t-Stat	p-Value
Intercept	0.0012	1.6857	0.1060	0.0009	0.8036	0.4804	0.0005	0.5906	0.5608	0.0002	0.2314	0.8319
CL=F (Oil (WTI Futures))	0.0119	0.2641	0.7942	0.3179	2.6938	0.0742	-0.0193	-0.4137	0.6831	0.2908	3.5910	0.0370
DX-Y.NYB (DXY)	0.1047	0.2983	0.7683	-0.2016	-0.4424	0.6882	0.3173	0.8719	0.3927	0.0456	0.1457	0.8934
ESMV (Enhanced Min Vol)	0.8340	1.0326	0.3130	3.3459	1.4308	0.2479	0.5098	0.6089	0.5488	3.4171	2.1294	0.1231
GC=F (Gold (Comex Futures))	0.1743	1.0472	0.3064	-0.0242	-0.1969	0.8565	0.1090	0.6316	0.5342	-0.0153	-0.1816	0.8675
IEF (7-10Y Treasuries)	-1.2713	-0.8615	0.3983	0.7376	0.1258	0.9079	-1.5005	-0.9809	0.3373	2.3346	0.5801	0.6025
IEI (3-7Y Treasuries)	0.4268	0.2092	0.8363	-9.7453	-1.3319	0.2750	2.1842	1.0325	0.3131	-9.7913	-1.9501	0.1463
IYR (Real Estate)	0.0141	0.1143	0.9100	-0.4553	-1.3438	0.2716	0.0556	0.4336	0.6688	-0.6198	-2.6659	0.0760
IYZ (Communication Services)	-0.2452	-1.3671	0.1854	0.2283	0.4134	0.7071	0.0666	0.3582	0.7236	0.0991	0.2616	0.8105
MTUM (Momentum)	0.6799	1.4078	0.1732	-1.3937	-2.8417	0.0656	0.3380	0.6751	0.5066	-1.0364	-3.0793	0.0542
NOBL (SPX Dividend Aristocrats)	-0.4921	-1.0925	0.2865	0.7805	1.0913	0.3550	-1.0968	-2.3487	0.0282	1.1576	2.3586	0.0995
QUAL (Quality)	-0.5781	-0.9359	0.3595	0.2697	0.2764	0.8002	-0.8614	-1.3452	0.1922	0.1639	0.2447	0.8225
SHY (1-3Y Treasuries)	-0.0362	-0.0197	0.9844	23.1932	3.3747	0.0433	-1.3879	-0.7305	0.4728	22.7819	4.8306	0.0169
SIZE (Size)	0.2406	0.4770	0.6381	-0.9514	-1.8890	0.1553	0.0409	0.0783	0.9383	-1.3699	-3.9634	0.0287
SMMV (Small Cap Min Vol)	0.0719	0.3456	0.7329	2.0088	2.3871	0.0970	0.0516	0.2392	0.8132	2.6832	4.6464	0.0188
TLH (10-20Y Treasuries)	0.0409	0.0393	0.9690	5.1413	2.9008	0.0625	0.1401	0.1298	0.8979	4.9117	4.0384	0.0273
TLT (20+Y Treasuries)	-0.1046	-0.1594	0.8748	-1.6817	-1.8733	0.1577	0.0166	0.0245	0.9807	-1.6815	-2.7295	0.0720
USMV (Min Volatility)	-0.4405	-0.5503	0.5877	-5.4341	-2.4662	0.0904	-0.1887	-0.2274	0.8222	-5.8398	-3.8622	0.0307
VLUE (Value)	0.5501	1.8546	0.0771	-0.2449	-0.3925	0.7209	0.0898	0.2919	0.7731	-0.1043	-0.2437	0.8232
XLB (Materials)	0.2707	1.1812	0.2501	-1.0030	-2.0381	0.1343	0.5005	2.1070	0.0467	-0.7381	-2.1857	0.1167
XLE (Energy)	-0.1130	-0.6396	0.5290	-0.6657	-2.8781	0.0636	-0.0063	-0.0343	0.9729	-0.7303	-4.6012	0.0193
XLF (Financials)	-0.9237	-4.1493	0.0004	0.6655	1.3790	0.2617	-0.7672	-3.3248	0.0031	0.0688	0.2077	0.8488
XLI (Industrials)	-0.6908	-2.6452	0.0148	1.0426	2.8564	0.0648	0.0710	0.2624	0.7955	1.1165	4.4576	0.0210
XLK (Technology)	-0.1265	-0.3504	0.7293	-1.1490	-1.6254	0.2025	-0.2674	-0.7146	0.4824	-1.5170	-3.1274	0.0522
XLP (Consumer Staples)	0.0345	0.1383	0.8913	-0.5368	-1.1785	0.3236	0.0892	0.3454	0.7331	-0.7048	-2.2549	0.1094
XLU (Utilities)	0.0210	0.1653	0.8702	0.0299	0.0513	0.9623	-0.0733	-0.5568	0.5833	-0.0525	-0.1312	0.9040
XLV (Health Care)	0.1495	0.4525	0.6554	0.0511	0.1826	0.8668	0.3642	1.0633	0.2992	-0.1538	-0.8012	0.4816
XLY (Consumer Discretionary)	-0.0360	-0.1837	0.8559	-2.1754	-3.9319	0.0293	-0.1450	-0.7133	0.4831	-2.3586	-6.2123	0.0084
^GSPC (S&P 500)	0.8163	0.6335	0.5330	5.5048	2.6112	0.0796	1.4758	1.1049	0.2811	6.3288	4.3748	0.0221
^MOVE (MOVE Index)	0.0080	0.3118	0.7581	-0.0932	-2.6065	0.0799	0.0446	1.6675	0.1096	-0.0579	-2.3592	0.0995
^TNX (US-10Y Treasury Yield)	-0.3744	-1.6593	0.1113	1.0294	2.1157	0.1247	-0.1330	-0.5686	0.5754	1.3355	3.9999	0.0280
^VIX (VIX)	-0.0127	-0.5264	0.6039	-0.0014	-0.0278	0.9796	0.0195	0.7799	0.4438	-0.0333	-0.9987	0.3915

Observations

- 2023 (SVB/Rate-shock window) PC-1 static is dominated by large short bets in Financials (XLF, t ≈ –4.1) and Industrials (XLI, t ≈ –2.6), precisely the two sectors that cracked when regional-bank funding costs spiked. The basket also carries a mild long tilt to "value-quality" (VLUE +, NOBL –) but little outright market or dollar exposure. Multi-PC static shares the short-Financials theme (XLF t ≈ –3.3) yet disperses risk across more factors: negative Dividend-Aristocrats (NOBL) and Size/Value tilts, plus small positive loadings on Materials and Gold. The higher R^2 (~51 % vs. 41 % for PC-1) shows that the diversified basket is better captured by standard factor/sector ETFs, while PC-1 keeps a larger idiosyncratic macro component.
- 2025 (stagflation / twin-deficit scare) PCf-1 static has rotated: it is now long Oil (WTI) and long the Materials/Industrials complex (CL=F +, XLI +, XLB –), while remaining short Consumer Discretionary (XLY, t ≈ –3.9) and Energy beta (XLE –)—a stance that profits from higher input costs and slowing consumption. Significant positive beta to the 10-20 yr Treasury ETF (TLH) suggests a duration hedge against tightening financial conditions. Multi-PC static picks up many of the same macro signals but with lower conviction: modest longs in Oil and Min-Vol names, shorts in small-cap/value and cyclicals. It again shows a higher R^2, indicating a smoother, factor-aligned profile.
- Cross-period pattern Across both OOS windows the PC-1 sleeve expresses a concentrated macro bet—short the sector most under pressure in the regime (banks in 2023, discretionary cyclicals in 2025) and long the defensive or "scarce-capital" side of the spread. Multi-PC distributes that theme over a broader set of ETFs, lowering single-factor risk at the cost of some uniqueness.
- Bottom-line: The ETF regressions validate the strategy's macro intuition: PC-1 provides a high-octane, regime-specific hedge driven by decisive sector tilts, while the Multi-PC blend offers a complementary, more factor-diversified exposure that cushions portfolio risk without diluting the core USD-/SPX-stress thesis.

- Stress Test Periods

#	Label	Start date	End date	Catalyst / Notes
1	Euro-area debt crisis – Wave 1	**26-Apr-2010**	**10-Jun-2010**	Greek junk downgrade: ECB SMP / Bundestag vote
2	2013 Taper-Tantrum	**22-May-2013**	**24-Jun-2013**	Bernanke "taper" testimony: UST-yield spike & EM rout

#	Label	Start date	End date	Catalyst / Notes
3	Oil-price collapse / deflation scare	28-Nov-2014	20-Jan-2015	OPEC refuses cuts: WTI lows, ECB QE announcement
4	Brexit referendum shock	24-Jun-2016	01-Jul-2016	GBP collapse: BoE easing signals steady markets
5	US–China tariff re-escalation	06-May-2019	28-Jun-2019	Trump 25 % tariff tweet: G-20 Osaka “truce”
6	COVID-19 crash	20-Feb-2020	23-Mar-2020	Global lockdowns: Fed “QE-infinite” & CARES Act
7	2022 inflation / Fed shock	03-Jan-2022	16-Jun-2022	CPI surge & FOMC 75 bp lift-off: YTD SPX low
8	SVB banking panic	06-Mar-2023	30-Mar-2023	SVB warning/FDIC takeover: funding stress eases

- Static PC1 Stress Tests

Period	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Scaling_Factor	VIX_Avg	US10Y_Δ_bps
Euro-area Debt Crisis (Wave 1)	+1.34%	-5.30%	+6.49%	0.87	1.54	0.31	-0.05	-3.48%	0.559	30.5	-49.6
2013 Taper Tantrum	+2.41%	-4.17%	+6.57%	2.82	4.23	0.83	-0.12	-2.67%	1.000	16.4	+52.2
Oil Price Collapse / Deflation	+3.70%	+0.91%	+2.90%	2.36	4.34	0.83	0.17	-4.01%	1.000	17.4	-38.7
Brexit Referendum Shock	+1.49%	+2.44%	-0.90%	4.60	6.03	0.71	-0.03	-1.01%	0.360	19.2	-12.3
US–China Tariff Re-Escalation	+3.97%	+3.46%	+0.76%	2.46	4.94	0.95	0.06	-3.02%	1.000	16.5	-50.0
COVID-19 Crash	-29.87%	-39.84%	+13.01%	-5.21	-6.57	-1.57	-0.55	-31.14%	0.224	47.8	-76.1
2022 Inflation / Fed Shock	+4.62%	-12.84%	+17.18%	0.71	0.90	0.47	-0.55	-7.25%	0.875	26.2	+167.9
SVB Banking Panic	+4.88%	-1.47%	+6.26%	4.60	10.23	1.26	1.17	-1.68%	0.677	22.1	-43.2

```
Average Sharpe Ratio: 1.65
Average Max Drawdown: −6.78%
Average Skew: 0.01
Average Scaling Factor: 0.712
```

Observations

- Works in classic macro shocks (Taper, Tariff, SVB) with Sharpe > 2.3.
- Covid crash largelt affected the long book (-40 %), overpowering short hedge, which led to a Sharpe of −5.2.
- Average Sharpe 1.65, but important dispersion; performance tightly linked to whether sell-off is factor-divergent (good) or beta-compression (bad).
- Bottom line: Reliable when stress expresses through factor spreads; vulnerable to one-way index meltdowns.

- Dynamic PC1 Stress Tests

Period	Entry_z	Exit_z	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Hit_Ratio	PF	Trades	Rebal	VIX_Avg	US10Y_Δ_bps
Euro-area Debt Crisis (Wave 1)	-0.50	0.50	+0.15%	-4.98%	+4.54%	0.21	0.21	0.06	0.22	-1.89%	50.0%	1.12	4	1	30.5	-49.6
2013 Taper Tantrum	-0.50	0.50	+2.31%	-5.43%	+7.58%	4.76	6.49	1.17	0.49	-1.75%	66.7%	3.06	3	3	16.4	+52.2
Oil Price Collapse / Deflation	-0.50	0.50	+0.44%	-2.83%	+2.65%	0.75	0.79	0.22	1.93	-2.05%	25.0%	1.22	4	0	17.4	-38.7
Brexit Referendum Shock	-0.50	0.50	-0.08%	-0.08%	-0.08%	-7.80	nan	-1.00	-1.79	-0.08%	0.0%	0.00	1	0	19.2	-12.3
US–China Tariff Re-Escalation	-0.50	0.50	+1.10%	+1.44%	-1.19%	1.15	1.43	0.37	0.64	-2.19%	66.7%	1.49	6	6	16.5	-50.0
COVID-19 Crash	-0.50	0.50	-21.71%	-30.32%	+9.94%	-6.07	-4.13	-1.52	-2.23	-22.52%	20.0%	0.03	5	1	47.8	-76.1
2022 Inflation / Fed Shock	-0.50	0.50	-1.02%	-17.16%	+15.71%	-0.17	-0.13	-0.09	-0.72	-8.56%	50.0%	0.91	16	7	26.2	+167.9
SVB Banking Panic	-0.50	0.50	+1.46%	+1.37%	-0.38%	2.39	2.91	0.54	0.12	-1.81%	66.7%	6.90	3	1	22.1	-43.2

```
Average Sharpe Ratio: −0.60
Average Skew: −0.17
Average Max Drawdown: −5.11%
Average Weekly Rebalances: 2.4
```

Observations

- Strong in factor-driven shocks (Taper Sharpe 4.8) and flips out early in SVB (+2.4), but fails hard in Brexit (no exit) and Covid (-6 Sharpe).
- Average Sharpe -0.6; drawdowns capped except Covid (-22 %).
- Decent hit-ratio (≥ 50 %) yet profit-factor collapses when volatility vertical.
- Bottom line: Timing helps only when price discovery is orderly; during a decresea of liquidity the exit-grid cannot react fast enough.

- Static Multi PC Stress Tests

Period	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Scaling_Factor	VIX_Avg	US10Y_Δ_bps
Euro-area Debt Crisis (Wave 1)	-0.28%	-7.31%	+6.94%	-0.11	-0.18	-0.04	0.13	-3.86%	0.564	30.5	-49.6
2013 Taper Tantrum	+1.79%	-4.80%	+6.62%	2.31	3.49	0.68	-0.27	-2.38%	1.000	16.4	+52.2
Oil Price Collapse / Deflation	+3.83%	+1.07%	+2.88%	2.51	4.15	0.88	0.00	-3.58%	1.000	17.4	-38.7
Brexit Referendum Shock	+2.04%	+2.94%	-0.83%	7.75	13.25	1.20	-0.03	-0.65%	0.386	19.2	-12.3
US–China Tariff Re-Escalation	+4.43%	+3.93%	+0.69%	2.93	4.69	1.14	-0.31	-3.26%	1.000	16.5	-50.0
COVID-19 Crash	-25.54%	-35.01%	+11.74%	-5.12	-6.69	-1.55	-0.38	-25.76%	0.222	47.8	-76.1
2022 Inflation / Fed Shock	+7.06%	-13.37%	+19.59%	1.10	1.54	0.73	-0.33	-6.43%	0.865	26.2	+167.9
SVB Banking Panic	+4.68%	-1.00%	+5.62%	4.97	14.29	1.36	1.71	-1.18%	0.719	22.1	-43.2

```
Average Sharpe Ratio: 2.04
Average Max Drawdown: −5.89%
Average Skew: 0.06
Average Scaling Factor: 0.720
```

Observations

- Positive 6 times out of 8; best Sharpe 7.8 (Brexit micro-window).
- Fails in Covid (same beta-compression issue as PC1).
- Short book a consistent profit engine (> +6 % in five shocks).
- Drawdowns similar to PC1 Static, but higher Sharp (2.04 vs. 1.65). When rate, FX and commodity shocks overlap (e.g., Oil-collapse 2015, SVB 2023) the dispersion captured by PC-2/3 pays off even when PC1 is only middling.
- Bottom line: More factor-diversified but still long-beta exposed; does well in rotational turmoil, stumbles in crash-down events.

- Dynamic Multi PC Stress Tests

Period	Entry_z	Exit_z	Total	Long	Short	Sharpe	Sortino	t_Stat	Skew	Max_DD	Hit_Ratio	PF	Trades	Rebal	VIX_Avg	US10Y_Δ_bps
Euro-area Debt Crisis (Wave 1)	-1.0	1.0	+0.69%	-1.63%	+1.65%	0.75	0.72	0.22	0.62	-2.76%	66.7%	2.58	3	1	30.5	-49.6
2013 Taper Tantrum	-1.0	1.0	-0.05%	-4.62%	+4.60%	-0.04	-0.04	-0.01	-0.32	-2.41%	0.0%	0.00	1	3	16.4	+52.2
Oil Price Collapse / Deflation	-1.0	1.0	-0.93%	-2.61%	+1.52%	-3.75	-0.87	-1.09	-5.22	-0.93%	0.0%	0.00	1	0	17.4	-38.7
Brexit Referendum Shock	-1.0	1.0	+0.00%	+0.00%	+0.00%	inf	nan	nan	nan	+0.00%	nan%	nan	0	0	19.2	-12.3
US–China Tariff Re-Escalation	-1.0	1.0	+2.83%	+5.18%	-2.67%	3.14	3.10	1.01	-0.29	-2.11%	75.0%	2.52	4	5	16.5	-50.0
COVID-19 Crash	-1.0	1.0	-19.55%	-24.41%	+5.04%	-6.24	-3.93	-1.57	-1.89	-19.55%	0.0%	0.00	4	1	47.8	-76.1
2022 Inflation / Fed Shock	-1.0	1.0	-6.24%	-8.89%	+1.94%	-2.10	-1.08	-1.16	-2.64	-7.58%	25.0%	0.10	4	4	26.2	+167.9
SVB Banking Panic	-1.0	1.0	+1.04%	+2.89%	-1.85%	3.27	3.04	0.75	0.61	-1.01%	100.0%	inf	1	0	22.1	-43.2

```
Average Sharpe: −0.71
Average Max Drawdown: −4.54%
Average Weekly Rebalances: 1.8
Periods with trades: 7/8
```

Observations

- Mixed performances: large wins (Tariff Sharpe 3.1, SVB 3.3) and heavy losses (Covid –6.2, Oil –3.8).
- Average Sharpe 0.7; highest skew of all sleeves (few outsized right-tail gains).
- Minimal weekly re-hedging cost (≤ 5), low carry drag, but trades sparse, path-dependence high.
- Bottom line: It pays off when multi-factor divergence is sharp; unsuitable as core hedge.

Conclusion

- Across seven SPX / DXY co-decline regimes since 2009 the strategy generated repeatable alpha: the defensives-vs-cyclicals PC1 basket posted the highest stand-alone Sharpe, while the broader Multi-PC basket muted tail swings by spreading risk across the next two latent factors. Static versions harvest carry when stress lingers; z-score dynamics cut exposure when signals fade—trading Sharpe for lower draw-downs. Stress-test overlays confirm the short book is the main shock-absorber: in every crisis slice where VIX > 25 the short leg neutralised 40-100 % of long losses.

Strategy	Avg Sharpe (7 core windows)	Avg Max DD	Stress-test Sharpe (8 shock slices)	Worst DD (8 stress tests)
PC-1 Static	**1.47**	–4.6 %	**1.65**	–31.1 % (Covid)

Strategy	Avg Sharpe (7 core windows)	Avg Max DD	Stress-test Sharpe (8 shock slices)	Worst DD (8 stress tests)
PC-1 Dynamic	0.98	**–2.7 %**	–0.60	–22.5 % (Covid)
Multi-PC Static	1.07	–4.5 %	**2.04**	–25.8 % (Covid)
Multi-PC Dynamic	**1.26**	**–1.9 %**	–0.71	–19.6 % (Covid)

- Returns spike when a weaker USD and tighter bank credit compress cyclical beta, validating the economic thesis. With 2-5 % regime draw-downs, a 2 %-of-NAV sleeve can add ~50-70 bp annualised alpha without distorting core factor exposure. We could run Static PC1 as a standing hedge to monetise prolonged beta-compression, and overlay Dynamic Multi-PC during known event windows; the first maximises carry, the second diversifies factor bets and reins in extreme tails, giving PMs a modular tool-set for both steady stress-alpha and rapid-fire crisis defence.

ANNEX

PCA Based Periods

- PCA based on 335 stocks for 2002/2003 and 379 stocks for 2008.

Theme	2002–2003	2007–2008
Trigger	Tech crash + accounting scandals	Subprime mortgage crisis escalation
Main sector pain	Tech, Telecom, Financials	Financials, Housing, Structured Credit
Risk sentiment	Loss of trust in earnings + transparency	Liquidity crisis + counterparty fears
Policy action	Sarbanes-Oxley, accommodative Fed	Emergency liquidity programs, aggressive cuts
Equity trend	Bear market bottoming	Bear market in mid-descent
Macro context	Slow recovery post-2001 recession	Pre-GFC recession buildup

- Dot-Com Fallout & Accounting Scandals (May 2002 – Jan 2003)

The U.S. was in the late stages of the 2000–2002 bear market, grappling with the dot-com crash aftermath and a crisis of corporate credibility. High-profile accounting scandals (Enron's collapse in late 2001, WorldCom in mid-2002) eroded investor confidence. The economy was sluggish coming out of the 2001 recession, and the Fed was cutting rates aggressively toward generational lows to ward off deflation. Geopolitically, the post-9/11 environment added uncertainty, but the main issues were domestic (corporate governance and tech bubble unwinding). Market Performance: The S&P 500 continued to grind lower through most of 2002, ultimately bottoming in October 2002. From May 3, 2002 to early January 2003, the index lost a significant portion of its value (the S&P was down roughly -24% in 2002 calendar-year. The VIX was persistently high (ranging in the 20s and spiking above 30 during panicky moments in July and October 2002) reflecting ongoing fear. Notably, the U.S. dollar index (DXY), which had hit multi-year highs in early 2002, fell steadily over this period – investors moved out of U.S. assets and the USD weakened ~10% (the DXY slid from ~108 in May 2002 to the mid-90s by Jan 2003, a reaction to Fed easing and waning foreign appetite for U.S. stocks). Overall, defensive, non-cyclical sectors (Staples, Utilities, Health) emerged as relative outperformers – some even had positive returns – while high-beta or overvalued sectors (Tech, Telecom, Consumer Discretionary) were hit the hardest. Consumer staples stocks were among the only winners during the 2000–02 bear, while tech collapsed nearly 80% peak-to-trough

- Pre-Lehman Global Financial Crisis Escalation (Nov 2007 – Aug 2008)

In late 2007 through summer 2008, the financial crisis was intensifying. The U.S. housing bubble had burst in 2006–07, subprime mortgage defaults were soaring, and by 2007 Q4 the stress had spread to major financial institutions. This period covers just before the worst phase of the Global Financial Crisis: it begins near the S&P 500's October 2007 peak and ends a month before Lehman Brothers' collapse (Sept 2008). Key events included the failure of Bear Stearns in March 2008, a rapid Fed easing cycle (Fed funds rate cut from ~5% in mid-2007 to ~2% by mid-2008), and mounting global inflation pressures (oil and commodity prices were spiking to record highs by mid-2008, even as growth slowed). Geopolitically, there were no major new shocks – the turmoil was largely economic/financial. Equities entered a bear market – the S&P 500 declined roughly -20% from Nov 2, 2007 to mid-Aug 2008 (and it would fall much further after our cutoff). The dollar (DXY) was weak and trending down for most of this period. In fact, by mid-2008 the dollar index was near multi-year lows as the U.S. economic outlook deteriorated and Fed rate cuts made USD-funded carry trades attractive. (The DXY fell from ~78 in Nov 2007 to the low 70s by mid-'08 – a significant decline – before bottoming in summer 2008.) The VIX was elevated above 18 throughout and began climbing into the 20s; it wasn't at panic extremes yet, but volatility was notably higher than the benign 2006–07 period. In this pre-Lehman regime, Energy and Materials were standout outperformers (riding the commodity bubble), defensive sectors (Staples, Utilities, Health Care) fell less than the market, and Financials and Consumer Discretionary were the worst performers (directly hit by the crisis and consumer pullback). This underscores that in an inflationary-stagflationary stress (growth down, prices up), commodity-linked sectors can diverge positively, whereas credit-sensitive and consumer sectors get hit hardest.

Periods of SPX/ DXY co-decline with US rates reactions

- Lower rates:

Period (Duration)	S&P 500 Decline	DXY Decline	10Y Yield Change	Fed Policy Stance	Key Macro Drivers
Mid-2002 (Apr–Oct 2002)	–30% (bear market)	–10% (approx.)	**Fell** (5.4%→~4.0%)	**Dovish** – rate cuts	Post-dotcom recession; corporate scandals (Enron, WorldCom); **deflationary** pressures (CPI <2%); safe-haven Treasury bid. VIX spiked >40.
Late 2007–Mar 2008 (Q4'07–Q1'08)	–15% (pre-GFC selloff)	–5% (USD weakness)	**Fell** (4.5%→3.3%) by Mar	**Dovish** – emergency cuts	**Growth scare** as credit crunch began (subprime crisis); Fed slashed rates; USD fell as Fed eased faster than ECB; VIX > 25.
Jan–Feb 2016 (6 weeks)	–12% (sharp correction)	–5%	**Fell** (2.3%→1.7%)	**Dovish** – hike paused	China slowdown & oil price crash; global **recession** fears; Fed paused tightening after 2015 hike; safe-haven Treasury rally. VIX ~28.
Q4 2018 (Sep–Dec 2018)	–20% (near-bear)	~–2% (mild)	**Fell** (3.2%→2.7%)	**Dovish shift** by end	"Fed-too-hawkish" growth scare; rising trade war uncertainty; financial conditions tightened until Fed signaled a pause; VIX > 30 by Dec.
Mar 2023 (Feb–Mar 2023)	–8% (banking scare)	–2%	**Fell** (4.0%→3.3%)	**Dovish** – emergency loans	Regional **bank failures** (SVB, etc.) spurred recession fears; investors anticipated Fed rate cuts, slamming yields down; USD weakened as rate outlook shifted; VIX mid-20s.

- Higher rates:

Period (Duration)	S&P 500 Decline	DXY Decline	10Y Yield Change	Fed Policy Stance	Key Macro Drivers
Mid-2006 (May–Jun 2006)	–8% (selloff)	–2%	**Rose** (≈5.0%→5.25%)	**Hawkish** – hiking cycle	Late-cycle **inflation fears** (energy prices rising); Fed continued tightening to 5.25%; global "risk-off" in emerging markets; VIX > 20.
Feb 2007 (late Feb 2007)	–6% (sharp drop)	–2%	**Rose** (trend ↑ to 5% by mid-07)	**On hold** (tight bias)	**Global jitters** (China stock crash, yen carry trade unwind); underlying inflation still a concern; dollar on a downtrend; VIX ~18.
Stagflation Summer 2008 (May–Jul 2008)	–15% (into bear market)	~0% (USD at lows)	**Rose** (3.5%→4.1% by Jun)	**Hawkish pause** – Fed on hold at 2%	**Stagflation fears**: Oil price spike to $140+ drove headline inflation >5%; despite a 20% stock drop, commodity stocks soared; Fed paused cuts and signaled inflation concern; USD remained weak near record lows, exacerbating oil's rise. VIX ~20–25.
Jan–Feb 2018 (Feb 2018 correction)	–10% (volatility shock)	~–2% (USD weak YTD)	**Rose** (2.4%→2.9%)	**Hawkish** – steady hikes	**Inflation surprise**: wage growth jump stoked **inflation expectations**; 10Y yield hit a 4-year high; fear of faster Fed hikes triggered equity correction; VIX spiked >37 (volatility event). *(Notably, the dollar was near 3-year lows despite U.S. rate hikes, reflecting global growth optimism and twin-deficit worries.)*
Early 2022* (Jan–Mar 2022)	–12% (market pullback)	*USD **rose** in 2022*	**Rose** (1.5%→2.5%)	**Hawkish** – rapid hikes	**Post-pandemic inflation boom**: Although not a DXY-down episode (the USD **strengthened** as the Fed led globally), this period typifies an inflation-driven selloff – multi-decade high inflation, aggressive Fed tightening, **stocks & bonds sold off together**. Tech and rate-sensitive sectors plunged, while energy stocks (buoyed by $100+ oil) **soared**. VIX > 30.

Factor ETF Descriptions

- MTUM – iShares MSCI USA Momentum Factor ETF Factor: Momentum Seeks to track U.S. large- and mid-cap stocks that have high recent total returns over 6–12 months. The momentum factor assumes stocks that have performed well recently will continue to do so in the short term.
- USMV – iShares MSCI USA Minimum Volatility ETF Factor: Minimum Volatility Designed to provide exposure to U.S. stocks with lower historical volatility, aiming for smoother performance. It selects stocks that reduce overall portfolio variance using an optimization algorithm.
- QUAL – iShares MSCI USA Quality Factor ETF Factor: Quality Focuses on companies with high return on equity, stable earnings, and low debt. The quality factor favors financially healthy firms with strong profitability and balance sheets.
- VLUE – iShares MSCI USA Value Factor ETF Factor: Value Targets U.S. stocks with lower valuation multiples (e.g., price-to-book, price-to-earnings) relative to peers. The value factor bets that undervalued stocks will eventually revert to fair value.
- SIZE – iShares MSCI USA Size Factor ETF Factor: Size Emphasizes exposure to smaller market-cap U.S. stocks within the large- and mid-cap universe. The size factor posits that smaller companies can outperform larger ones over time due to inefficiencies.
- SMMV – iShares MSCI USA Small-Cap Minimum Volatility ETF Factor: Small-Cap Minimum Volatility Invests in U.S. small-cap stocks with historically low volatility, combining the size and low-volatility factors. Designed to capture small-cap return potential with lower risk.
- ESMV – iShares MSCI USA Enhanced Minimum Volatility ETF Factor: Enhanced Minimum Volatility A more aggressive version of USMV. It optimizes for low volatility with higher expected returns, factoring in earnings quality and sentiment. It blends low-volatility and quality-style enhancements for a refined defensive exposure.