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Global Research

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Multi-Asset, Multi-Factor Systematic Premia

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The big picture

Three premia: Carry · Momentum · Value

Two methodologies within asset classes: Cross-Sectional · Time-Series

Four asset classes:

- Commodities
- Gov't Bonds
- FX Rates
- Equity Indices

Two asset allocation methodologies across asset classes: Volatility-Parity · Risk-Parity

Multi-Asset,
Multi-Factor

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Section 1

The Systematic Premia and Trading Signals

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The overarching framework

	Carry	Momentum / Trend	Value / LT Reversals
Dynamics	Extract yield out of higher yielding assets both cross-sectionally and in the time-series.	Capture return continuation both cross-sectionally and in the time-series	Capturing return out of cross-sectionally under-valued assets
Market State	Sideways market *"the income one receives if the price stays the same"*	Trending market	Turning ("inflection") points

- A multi-factor / multi-asset allocation should benefit from:
  - Market state diversification
  - Asset class diversification
  - "Time" diversification (conditional directional dependence)

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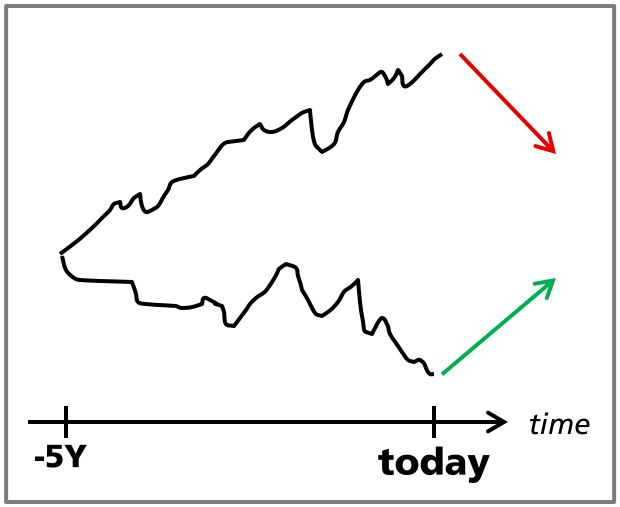
Three markets to generate three signals

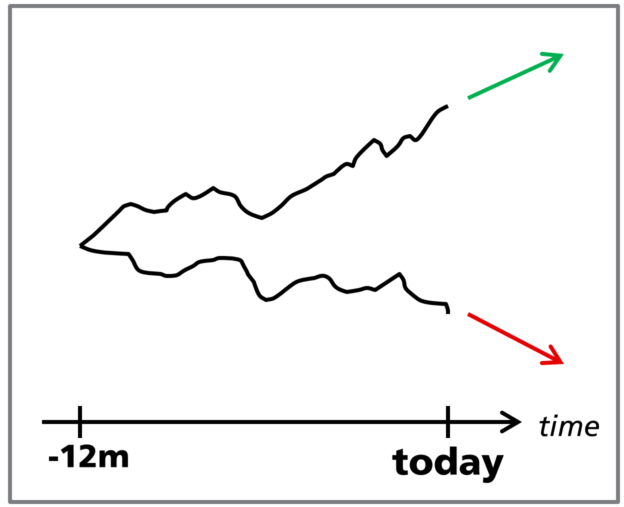
Spot Market



Value / LT Reversal:

- Long undervalued, long-term (5Y) losers
- Short overvalued, long-term (5Y) winners

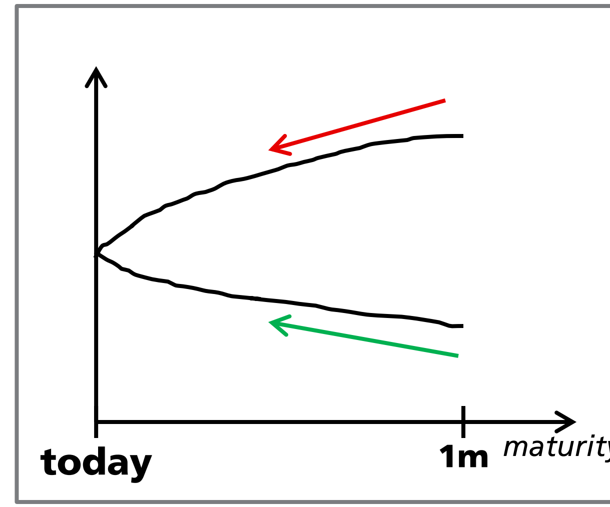
Front Futures Price



Momentum:

- Long recent (past-year) winners
- Short recent (past-year) losers

Futures Term Structure



Carry:

- Long most "backwardated" assets
- Short least "backwardated" (or "contangoed") assets

Source: UBS Quantitative Research

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What is driving the premia?

	Commodities	Government Bonds	FX Rates	Equity Indices
Momentum	*Behavioural:* Under-reaction, overconfidence, window-dressing, and many more			
Value	*Risk:* Distress risk			*Risk:* Distress risk *Behavioural:* Growth extrapolation
Carry	*Risk:* Short supply shocks (conv. yld) Hedging premium paid by producers	*Risk:* Duration risk (term premium)	*Risk:* Volatility risk Funding liq. risk, Political risk	Resembles Equity Value

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Calculation details for each asset class

	Commodities	Government Bonds	FX Rates	Equity Indices
Momentum	Past 12-month return of front futures contract			
Value	Past 5-year log-return of the spot price	Past 5-year change in the 10-year yield	Past 5-year log real return of the spot rate	Book-to-Price ratio of MSCI country indices
Carry	Slope of the futures curve			
	1st vs. 2nd Fut. (12m seasonally adjusted)	Spot vs. Futures (synthesised using ZCB data)	Spot vs. Fwd	1st vs. 2nd Fut. (12m seasonally adjusted)

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Volatility-adjusting the value scores before ranking

A few stylised facts:

- Low risk patterns are strong within Equity Indices and Gov. Bonds.
  - See *Low-Risk Investing: perhaps not everywhere* (July 2015)
- Reversals are stronger within a low-volatility universe.
  - See *Twin alphas: Price reversals and low risk* (Sept. 2013)

Combining these facts:

- Volatility-adjust the value metrics of Equity Indices and Gov. Bonds:

	Commodities	**Government Bonds**	**FX Rates**	**Equity Indices**
Value	Past 5-year log-return of the spot price	Past 5-year change in the 10-year yield over Volatility	Past 5-year log real return of the spot rate	Book-to-Price ratio of MSCI country indices over Volatility

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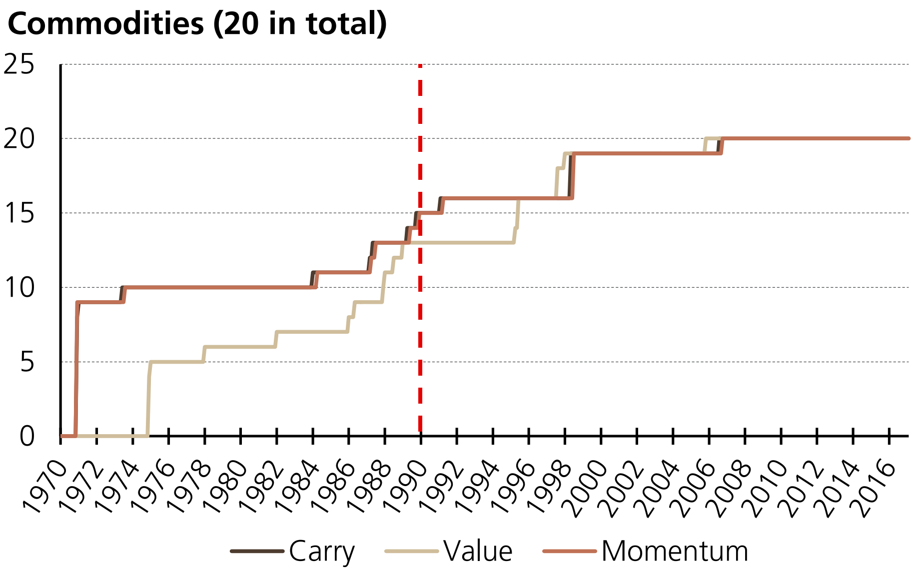
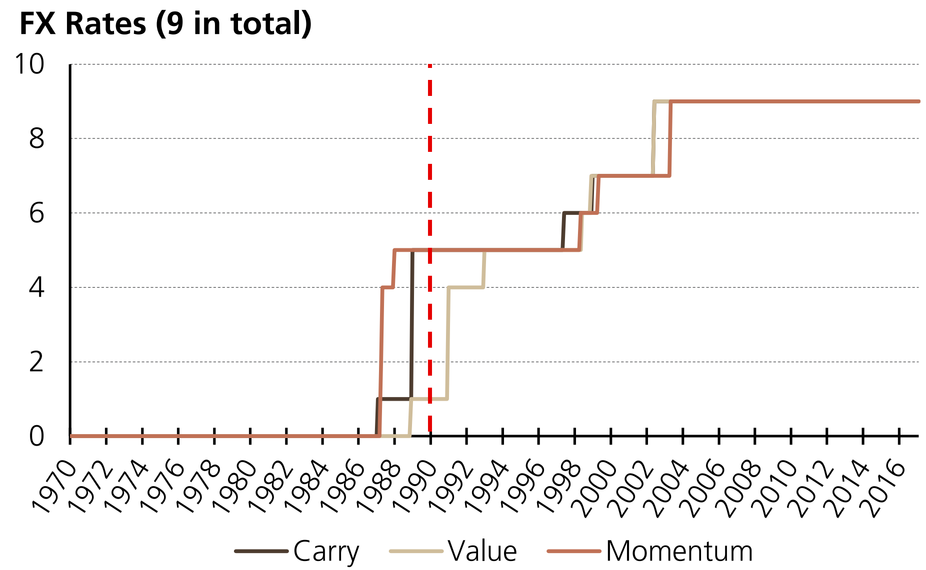
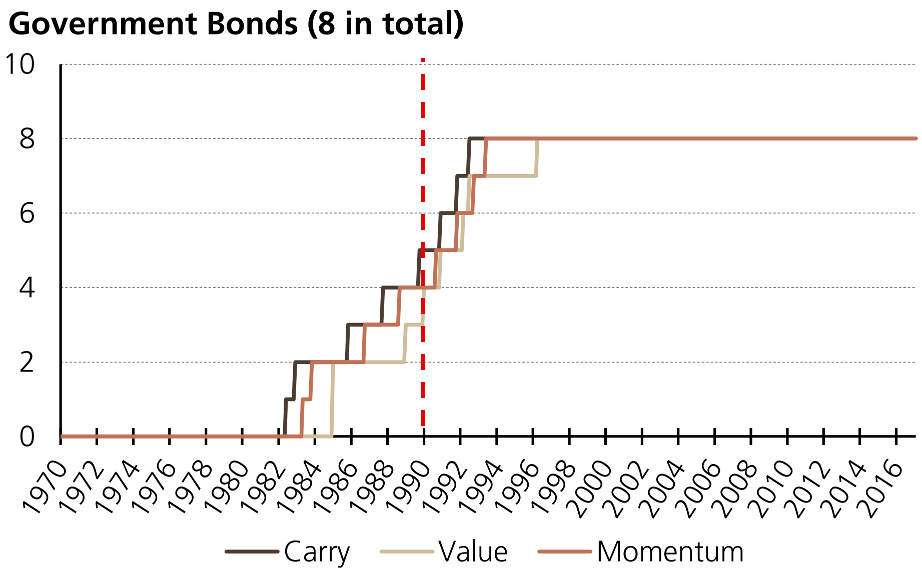
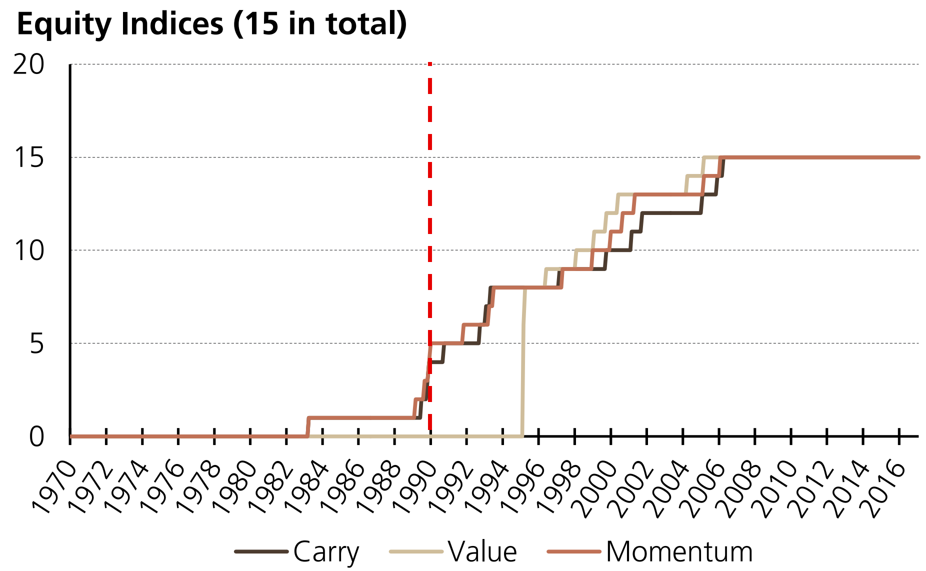
Number of Assets per asset class









Source: UBS Quantitative Research

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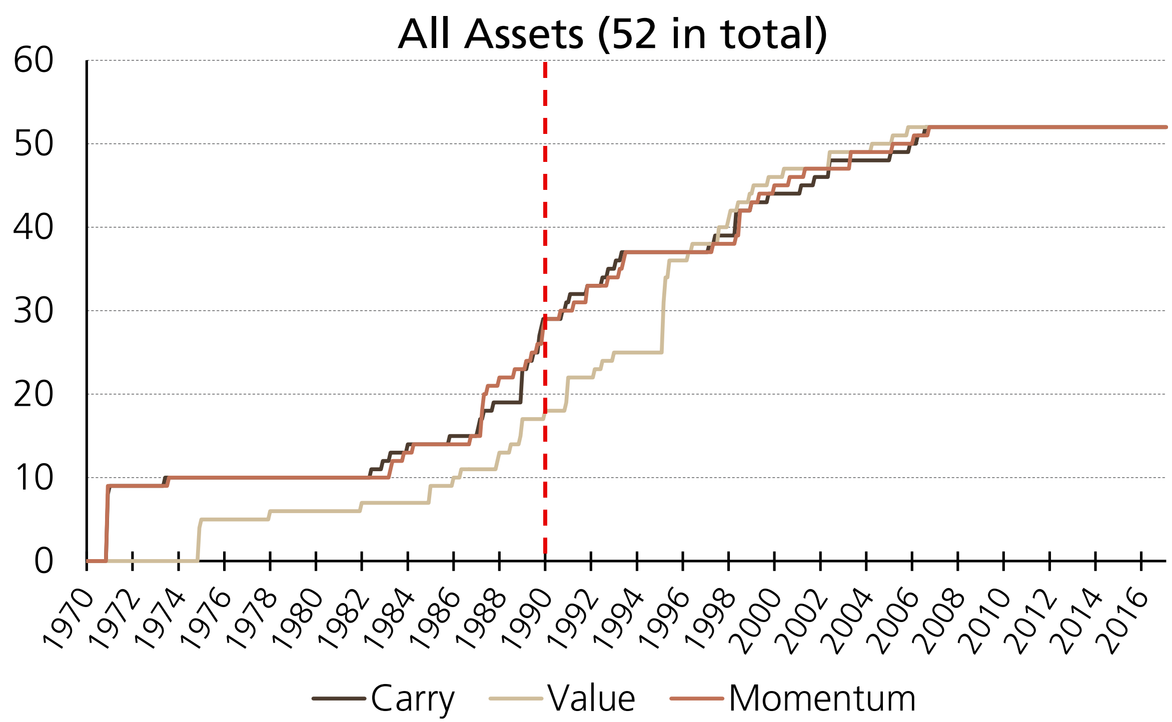
Number of Assets across asset classes



Source: UBS Quantitative Research

- Sample period for our analysis: January 1990 – February 2017.
- Monthly rebalancing.
- All strategies are constructed using rolling front futures contracts.
- Data sources: Bloomberg (futures), Datastream (spot and macro data).

Section 2

Cross-sectional Premia

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Cross-sectional Premia

Example: 9 assets, 6 with positive scores, 3 with negative scores

	Ranked Scores	XS weights
TOP	>0	+4/20
	>0	+3/20
	>0	+2/20
	>0	+1/20
	>0	0
	>0	-1/20
	<0	-2/20
	<0	-3/20
BOTTOM	<0	-4/20

Rank assets by their score

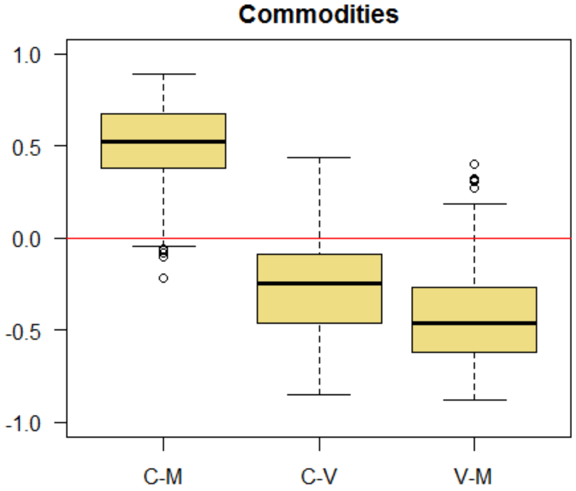
Subtract the average rank

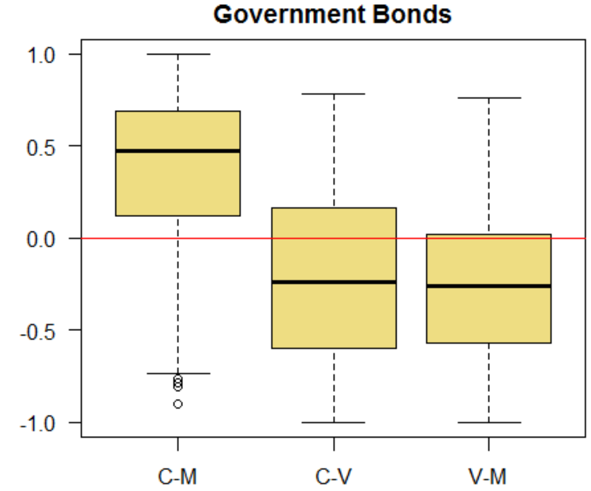
Rescale so that $\sum_i |w_i| = 1$

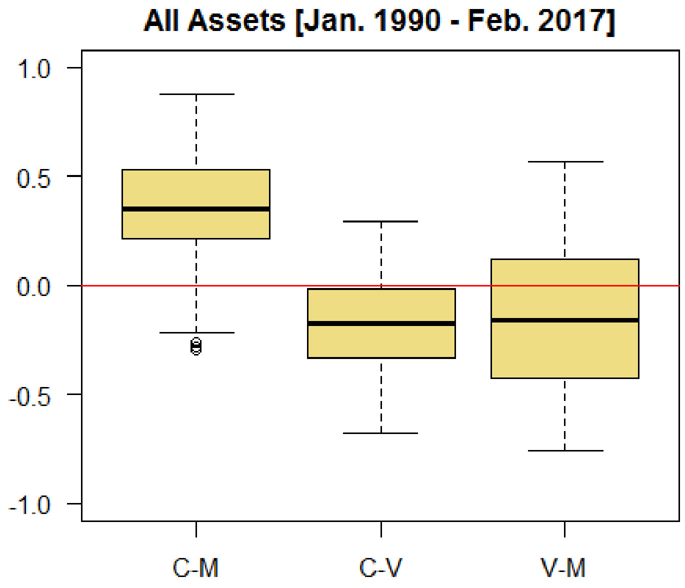
$$\boldsymbol{NET = 0}$$

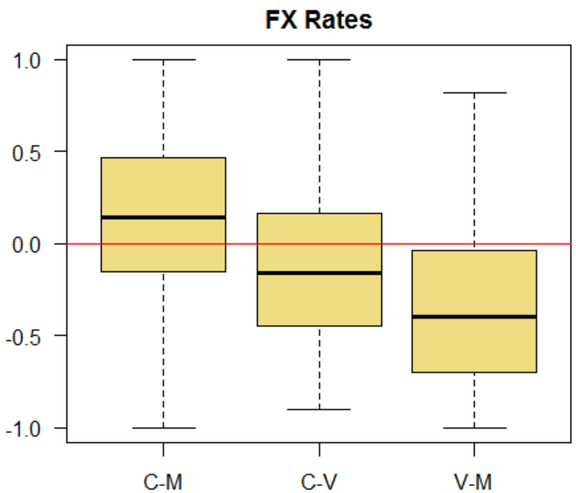
- Only the rank on the scores matters; not their sign.
- The strategy is always in zero net notional exposure.

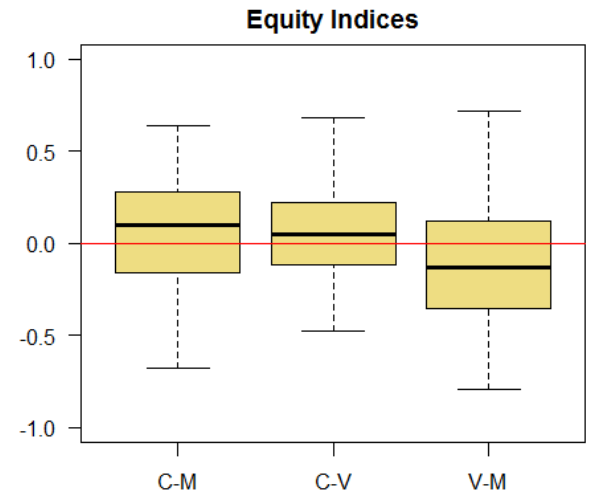
Rank Cross-Sectional Correlations











Source: UBS Quantitative Research
Note: For illustrative purposes only.

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Sharpe ratios [Jan. 1990 – Feb. 2017]

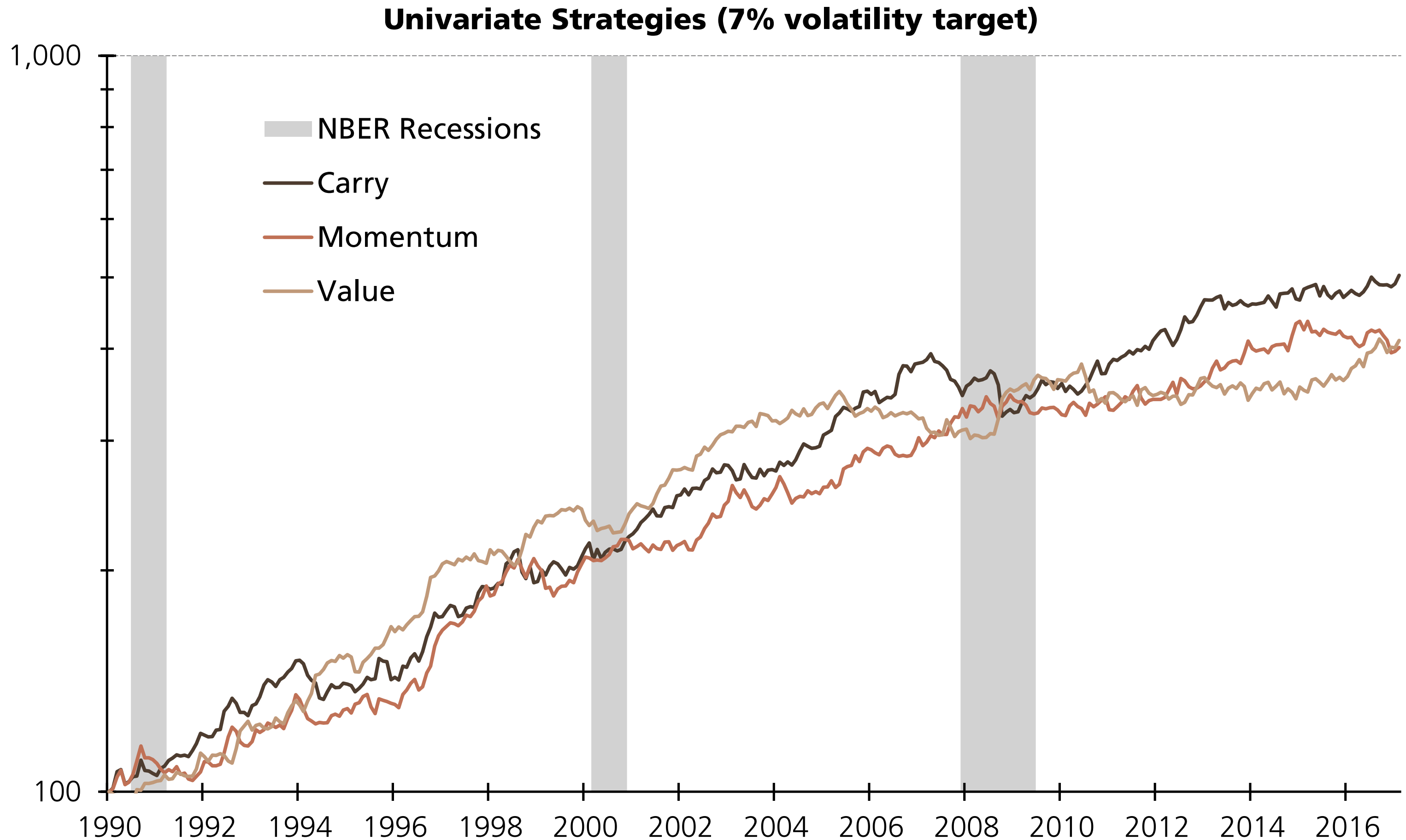
Sharpe Ratio (stat. signif. of mean return)	Commodities	Government Bonds	FX Rates	Equity Indices (*Value starting in Jan 1995*)	*Average*	Inverse-volatility Portfolio
Carry	0.20	0.82 (***)	0.46 (**)	0.44 (**)	*0.48*	**0.84 (***)**
Momentum	0.51 (***)	0.27	0.12	0.20	*0.28*	**0.58 (***)**
Value	0.26	0.79 (***)	0.48 (**)	0.33 (*)	*0.46*	**0.91 (***)**
Average	*0.33*	*0.63*	*0.35*	*0.32*	*0.41*	
Inverse-volatility Portfolio‡	**0.63 (***)**	**0.91 (***)**	**0.75 (***)**	**0.51 (***)**		Multi-Asset, Multi-Factor

‡ Combining premia within the same asset class on an equally-weighted basis leads to almost identical results, as the volatilities of the premia are very close.

Source: UBS Quantitative Research
Note: For illustrative purposes only.

Multi-asset Return Premia

- Let us now focus on the three multi-asset premia, formed using an inverse-volatility portfolio of the asset-class specific portfolios:



Source: UBS Quantitative Research
Note: For illustrative purposes only.

Notes: (a) inverse-volatility weighting scheme between asset classes
(b) volatility estimates based on a rolling window of 100 days
(c) sample: 1990M01-2017M02

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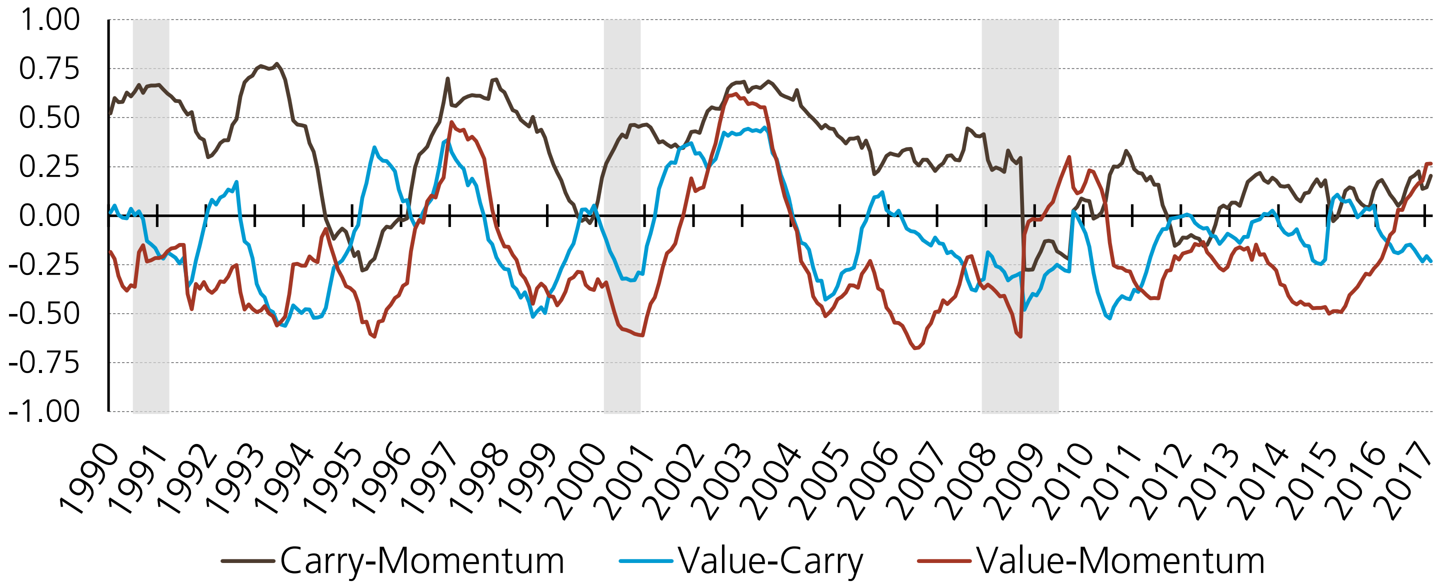
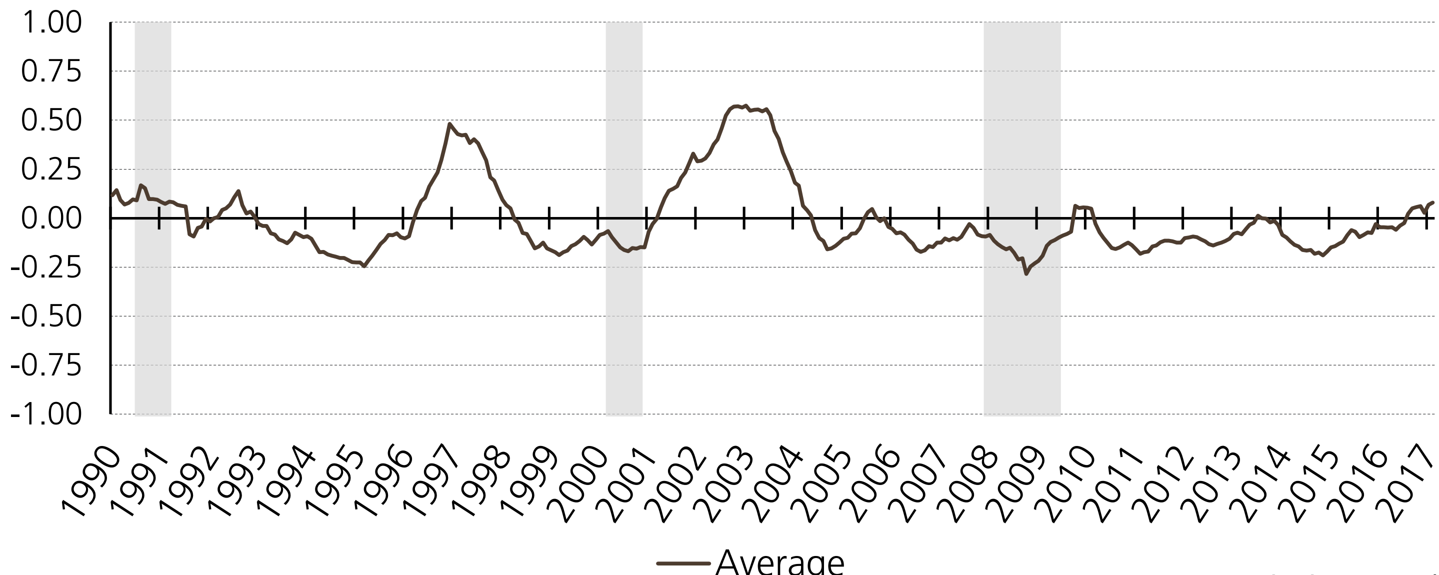
Correlation patterns (260-day rolling)





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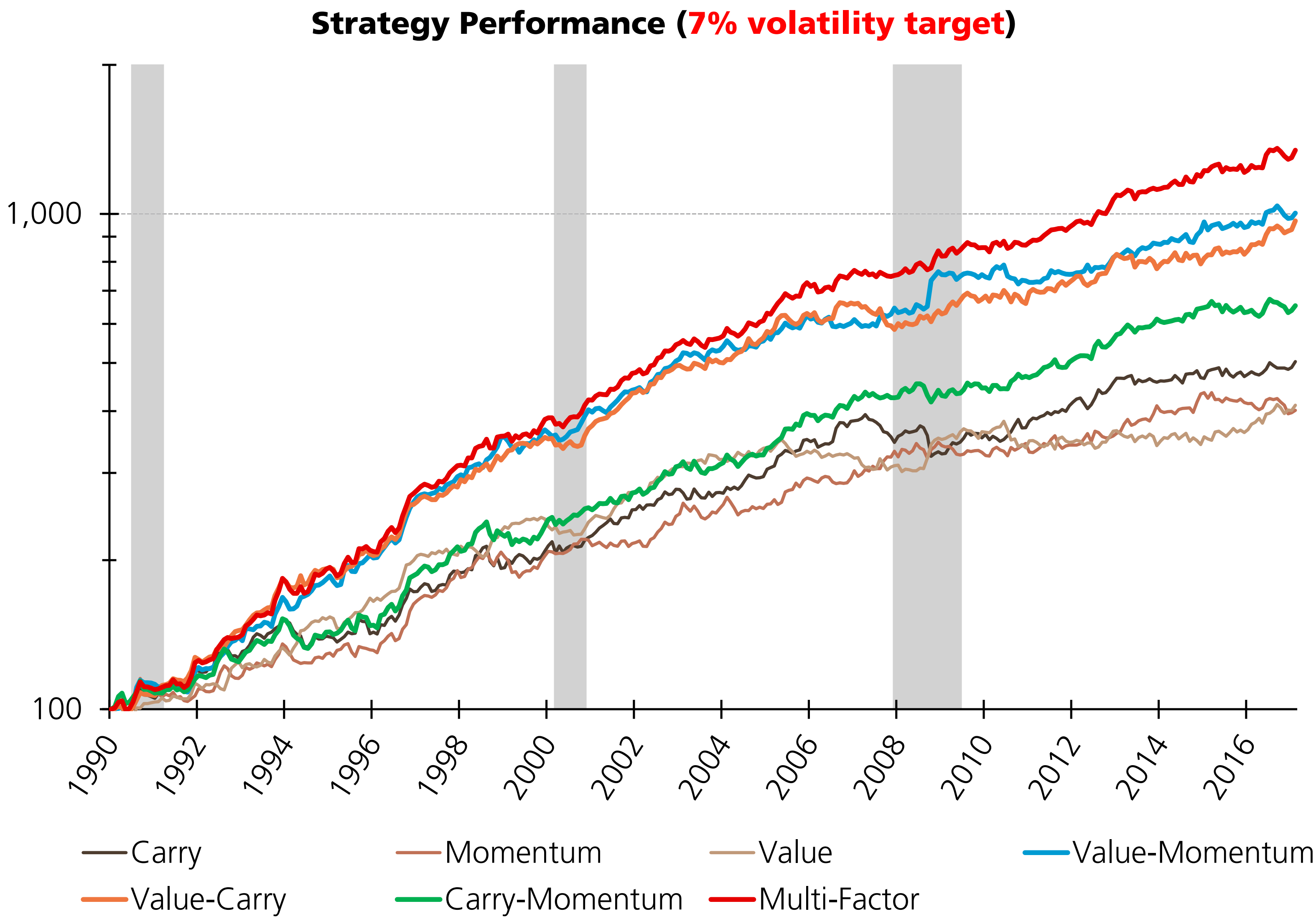
Source: UBS Quantitative Research
Note: For illustrative purposes only.

Multi-asset premia combinations



Source: UBS Quantitative Research
Note: For illustrative purposes only.

Notes: (a) inverse-volatility weighting scheme between asset classes and premia
(b) volatility estimates based on a rolling window of 100 days
(c) sample: 1990M01-2017M02

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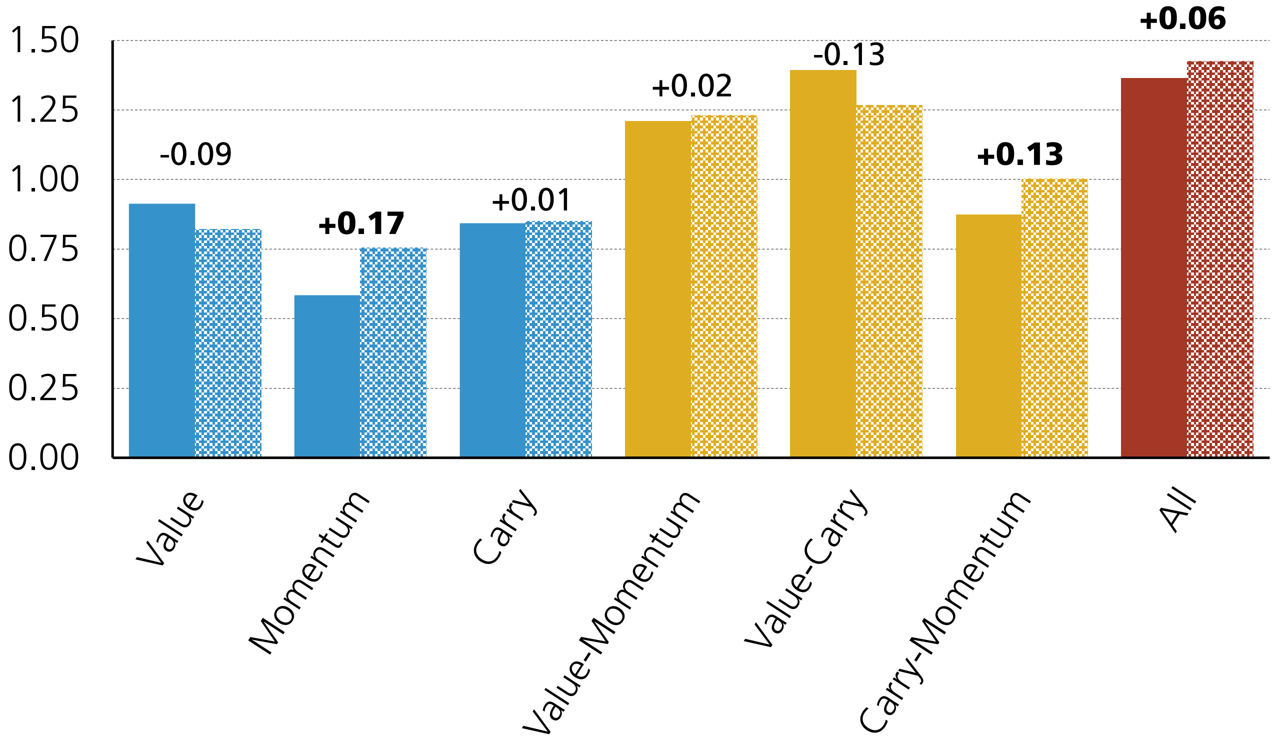
Multi-asset premia combinations

Multi-asset



Solid: Unlevered (100% gross exposure)
Pattern: Volatility-targeted

Source: UBS Quantitative Research
Note: For illustrative purposes only.

- Volatility-targeting strongly impacts the performance of Momentum strategies in line with (among others) Barroso and Santa-Clara (2015).

Notes: (a) inverse-volatility weighting scheme between asset classes and premia
(b) volatility estimates based on a rolling window of 100 days
(c) sample: 1990M01-2017M02

Section 3

Looking for unintended exposures

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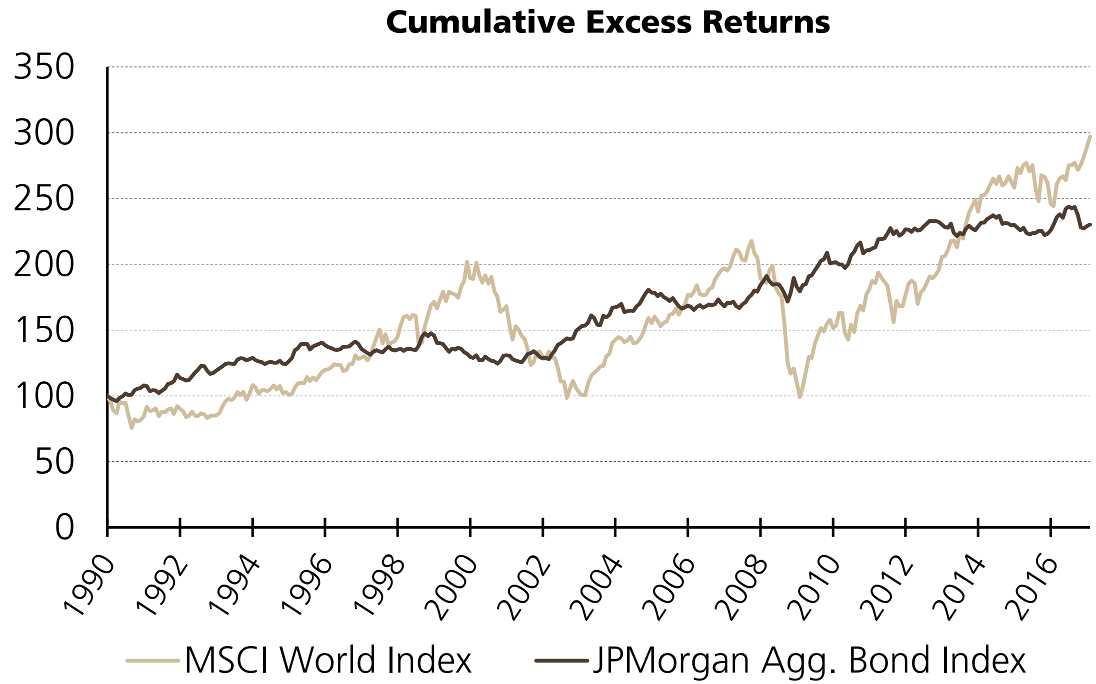
The Global Equity and Bond Markets



	JPM Agg.	MSCI Wld.
Avg. Excess Returns	3.25%	4.94%
Volatility	5.75%	14.94%
Skewness	0.13	-0.61
Kurtosis	3.52	4.32
Max. Drawdown	15.71%	54.52%
Sharpe Ratio	0.56	0.33
Sortino Ratio	0.92	0.47
Calmar Ratio	0.20	0.08

Note: Excess returns are constructed using the 3m T-bill rate.

Source: UBS Quantitative Research, Bloomberg.

- Are the various premia exposed to downside equity or bond market risk?

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Is it Crash Risk?

- We regress levered strategies (target volatility at 7%) against a number of factors $\boldsymbol{F}$:

$$r_t = const. + \boldsymbol{\beta}' \cdot \boldsymbol{F}_t + \epsilon_t$$

- Crash-risk proxies:
  - **Market returns squared, to capture co-skewness:**

$$r_{MKT,t,squared} = \left(r_{MKT,t}\right)^2$$

  - **Henrikson and Merton (1981) downside risk variable:**

$$r_{MKT,t,down} = -r_{MKT,t} \cdot \mathbb{I}\{r_{MKT,t} < 0\}$$

  - **Lettau, Maggiori and Weber (2014) tail risk variable:**

$$r_{MKT,t,tail} = -r_{MKT,t} \cdot \mathbb{I}\{r_{MKT,t} < -\sigma_{MKT}\}$$

  - **Changes in VIX:**

$$\Delta VIX_t = VIT_t - VIX_{t-1}$$

- For MKT, we consider MSCI World or the JPMorgan Agg. Bond Index.

Analysis against MSCI World and VIX

Value

$const.$	$MSCI$	$MSCI^2$	$MSCI_{dn}$	$MSCI_{tail}$	ΔVIX	$adj.R^2$
0.47***	-0.05*					1.20%
0.30**	-0.03	0.84**				2.64%
0.29*	0.01		0.11			1.18%
0.36***	0.00			0.10		1.62%
0.46***					0.06*	1.79%
0.46***	-0.02				0.05	1.29%

Momentum

$const.$	$MSCI$	$MSCI^2$	$MSCI_{dn}$	$MSCI_{tail}$	ΔVIX	$adj.R^2$
0.47***	-0.06**					1.58%
0.51***	-0.06**	-0.23				1.08%
0.62***	-0.11**		-0.09			1.38%
0.45***	-0.05			0.02		0.98%
0.45***					0.05	1.12%
0.47***	-0.05				0.02	1.11%

Carry

$const.$	$MSCI$	$MSCI^2$	$MSCI_{dn}$	$MSCI_{tail}$	ΔVIX	$adj.R^2$
0.51***	0.03					0.35%
0.64***	0.02	-0.68				0.81%
0.56**	0.01		-0.03			-0.20%
0.50***	0.03			0.00		-0.26%
0.52***					-0.07*	1.68%
0.53***	-0.02				-0.08*	1.20%

Multi-Factor

$const.$	$MSCI$	$MSCI^2$	$MSCI_{dn}$	$MSCI_{tail}$	ΔVIX	$adj.R^2$
0.83***	-0.04					0.65%
0.85***	-0.04	-0.09				0.06%
0.87***	-0.05		-0.02			0.07%
0.77***	-0.01			0.06		0.29%
0.82***					0.02	0.16%
0.83***	-0.05				-0.01	0.14%

Source: UBS Quantitative Research
Note: For illustrative purposes only.

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Note: the strategies used in this analysis are volatility-targeted at 7%.

Analysis against JPMorgan Agg. Bond Index

Value

$const.$	JPM	JPM^2	JPM_{dn}	JPM_{tail}	$adj.R^2$
0.44***	0.05				0.17%
0.35***	0.02	3.58			0.23%
0.30*	0.14		0.22		-0.11%
0.35***	0.13			0.25	0.29%

Momentum

$const.$	JPM	JPM^2	JPM_{dn}	JPM_{tail}	$adj.R^2$
0.43***	0.09				0.47%
0.51***	0.11	-3.12			0.30%
0.58***	-0.02		-0.24		0.21%
0.58***	-0.05			-0.43**	1.73%

Carry

$const.$	JPM	JPM^2	JPM_{dn}	JPM_{tail}	$adj.R^2$
0.49***	0.11				0.80%
0.63***	0.15*	-5.41			1.43%
0.81***	-0.10		-0.49*		1.56%
0.59***	0.03			-0.28	0.95%

Multi-Factor

$const.$	JPM	JPM^2	JPM_{dn}	JPM_{tail}	$adj.R^2$
0.79***	0.14*				1.30%
0.85***	0.16**	-2.60			1.01%
0.98***	0.01		-0.31		1.29%
0.90***	0.04			-0.31**	1.76%

Source: UBS Quantitative Research
Note: For illustrative purposes only.

Note: the strategies used in this analysis are volatility-targeted at 7%.

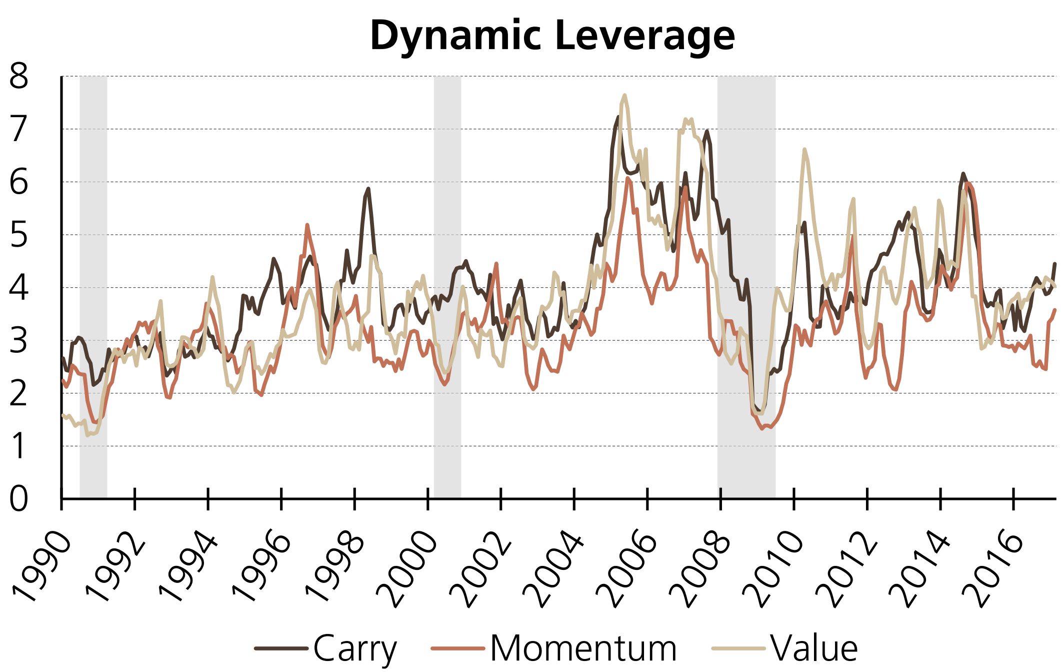
Leverage requirements

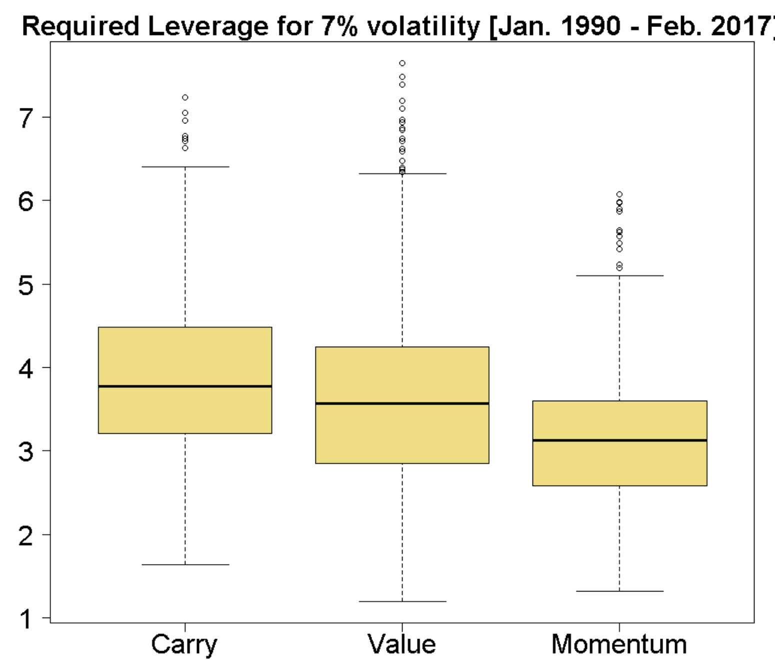
- The use of a volatility target implies the use of dynamic leverage:

$$r_{t,t+1}^{CVOL} = \underbrace{\frac{\sigma_{target}}{\sigma_t}}_{Leverage} \cdot r_{t,t+1}$$

1990M01-2017M02	Carry	Value	Momentum
Volatility	2.02	2.02	2.44

- This becomes critical when credit conditions worsen.





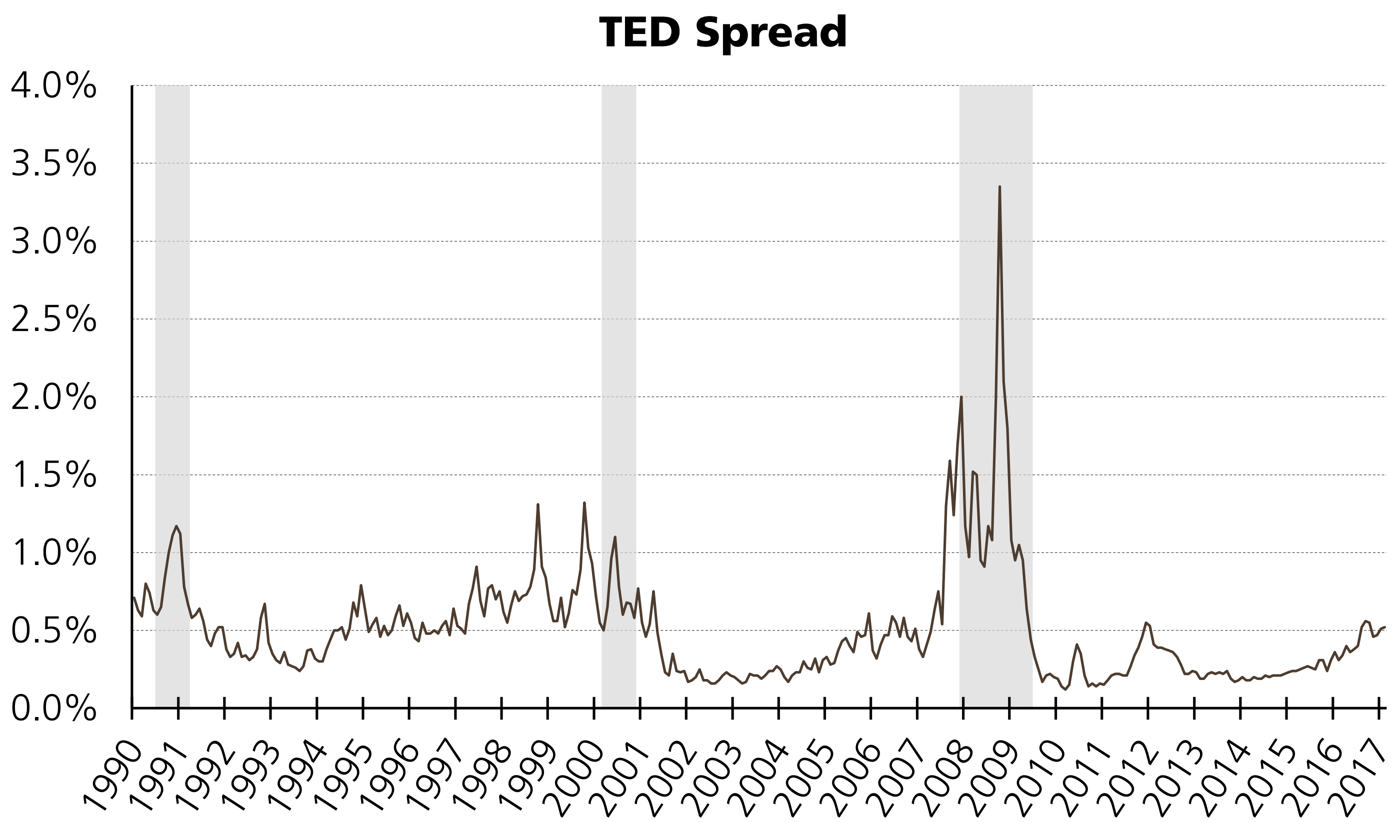
Source: UBS Quantitative Research
Note: For illustrative purposes only.

Is it funding liquidity risk?

- Use the TED spread as a proxy of credit conditions:

$$TED\ Spread = 3m\ Libor\ rate\ - 3m\ Tbill\ rate$$

- When the TED spread rises, the risk of default on interbank loans increases.



Source: Federal Reserve Bank of St. Louis.

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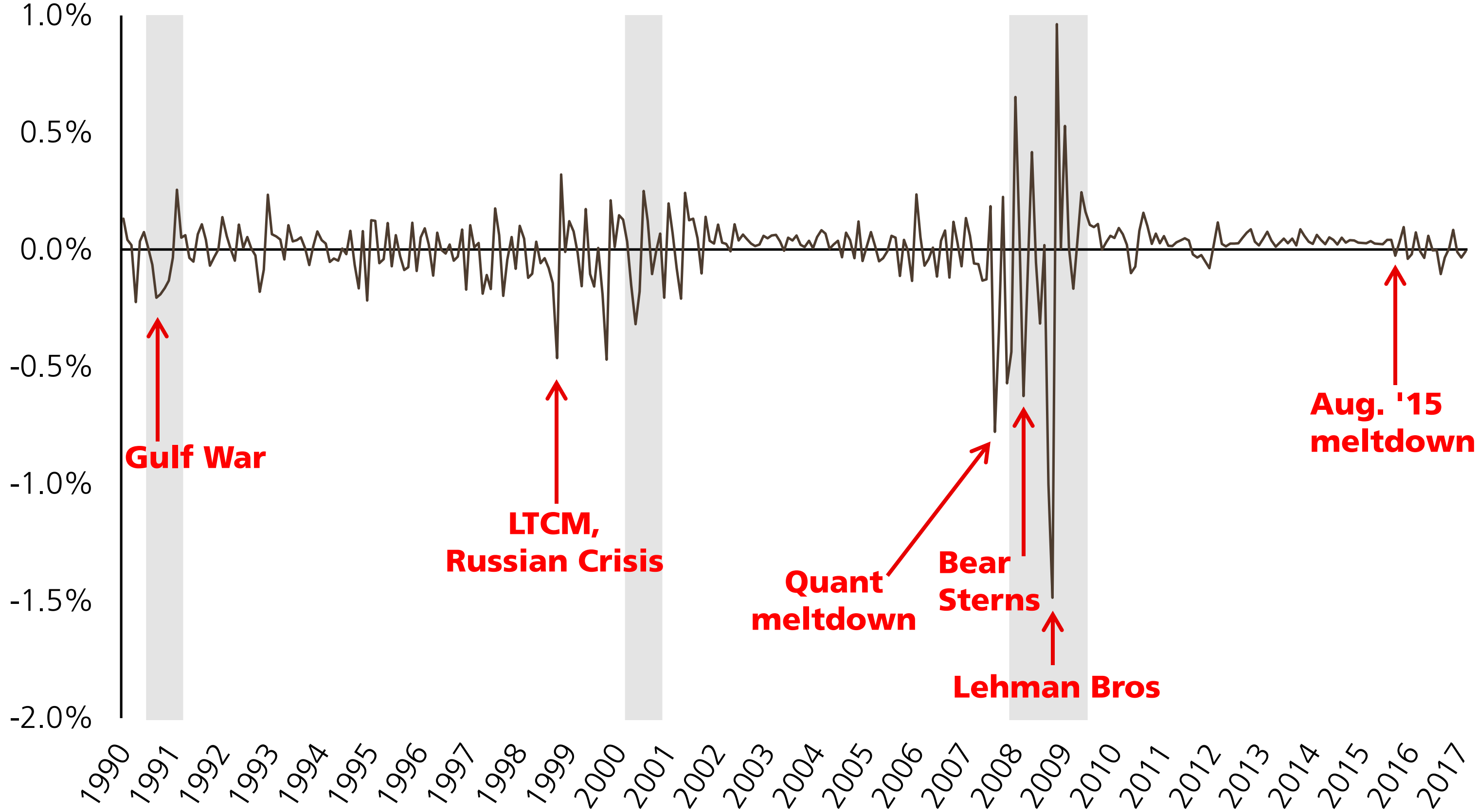
Extracting funding liquidity shocks

- We estimate the funding liquidity shocks as the AR(2) residuals of the (negative of the) TED spread (Korajczyk and Sadka 2008, Asness *et al.* 2013)

- Negative spikes are associated with worsening funding liquidity conditions.

AR (2) Residuals of TED Spread



Source: UBS Quantitative Research.

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Analysis on funding liquidity

- We regress unleveraged monthly returns of the strategies on:
  - Lagged (negative) TED spread
  - Monthly changed on the (negative of the) TED Spread
  - Residuals of an AR(2) model of the (negative) TED Spread

Value

const.	*MSCI*	*JPM*	*Lagged TED*	*Δ(TED)*	*AR(2) Resid.*	*adj.* R^2
0.03			-0.25**	-0.76***		6.01%
0.04	-0.01	0.03	-0.23**	-0.73***		6.98%
0.16***					-0.74**	4.80%

Momentum

const.	*MSCI*	*JPM*	*Lagged TED*	*Δ(TED)*	*AR(2) Resid.*	*adj.* R^2
0.08			-0.09	-0.13		0.23%
0.10	-0.04***	0.07**	-0.02	-0.04		5.78%
0.12***					-0.13	0.11%

Carry

const.	*MSCI*	*JPM*	*Lagged TED*	*Δ(TED)*	*AR(2) Resid.*	*adj.* R^2
0.23***			0.18*	0.83***		6.48%
0.23***	0.00	0.04*	0.19*	0.82***		7.51%
0.14***					0.82***	5.94%

Multi-Factor

const.	*MSCI*	*JPM*	*Lagged TED*	*Δ(TED)*	*AR(2) Resid.*	*adj.* R^2
0.13***			-0.03	0.07		0.23%
0.14***	-0.02***	0.04***	0.00	0.11		5.68%
0.14***					0.06	0.10%

Source: UBS Quantitative Research
Note: For illustrative purposes only.

Note: the strategies used in this analysis are unlevered (100% gross exposure).

Section 4

The timing ability of systematic premia

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Time-series Premia

Example: 9 assets, 6 with positive scores, 3 with negative scores

Scores	TS weights
>0	+1/9
>0	+1/9
>0	+1/9
>0	+1/9
>0	+1/9
>0	+1/9
<0	-1/9
<0	-1/9
<0	-1/9

Positive Score → Long

Negative Score → Short

Equal gross weights

$$NET = \sum_i w_i = +3/9$$

- Only the sign on the scores matters; not their rank.
- The strategy has in general non-zero net notional exposure.

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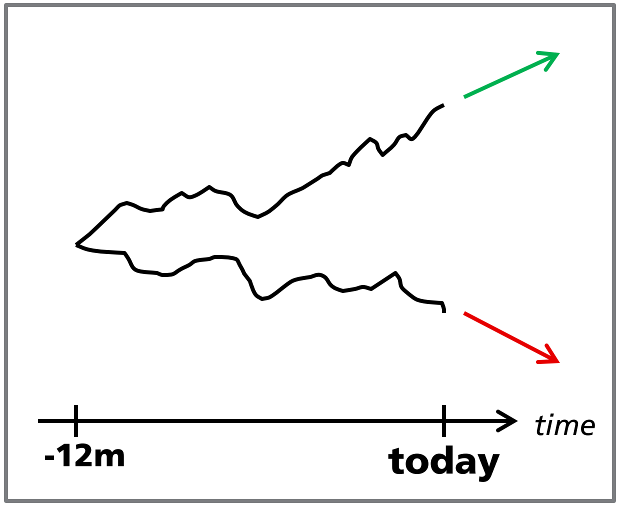
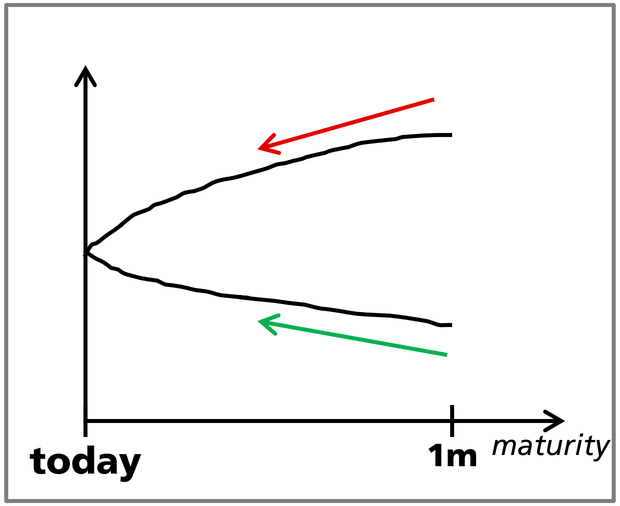
Source: UBS Quantitative Research

Two signals (no value on a time-series context)

Front Futures Price



Futures Term Structure



Momentum (a.k.a. Trend):

- Long assets with positive (past-year) return
- Short assets with negative (past-year) losers

Carry:

- Long assets in backwardation
- Short assets in contango

Source: UBS Quantitative Research

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Sharpe ratios [Jan. 1990 – Feb. 2017]

Sharpe Ratio (stat. signif. of mean return)	Commodities	Government Bonds	FX Rates	Equity Indices	*Average*	Inverse-volatility Portfolio
Carry	0.05	0.86 (***)	0.59 (**)	0.25	*0.44*	**0.98 (***)**
Momentum (a.k.a. Trend)	0.57 (***)	0.68 (***)	0.26	0.44 (**)	*0.49*	**0.90 (***)**
Average	*0.31*	*0.77*	*0.42*	*0.35*	*0.46*	
Inverse-volatility Portfolio‡	**0.44 (**)**	**0.82 (***)**	**0.52 (**)**	**0.47 (**)**		Multi-Asset, Multi-Factor

Source: UBS Quantitative Research
Note: For illustrative purposes only.

‡ Combining premia within the same asset class on an equally-weighted basis leads to almost identical results, as the volatilities of the premia are very close.

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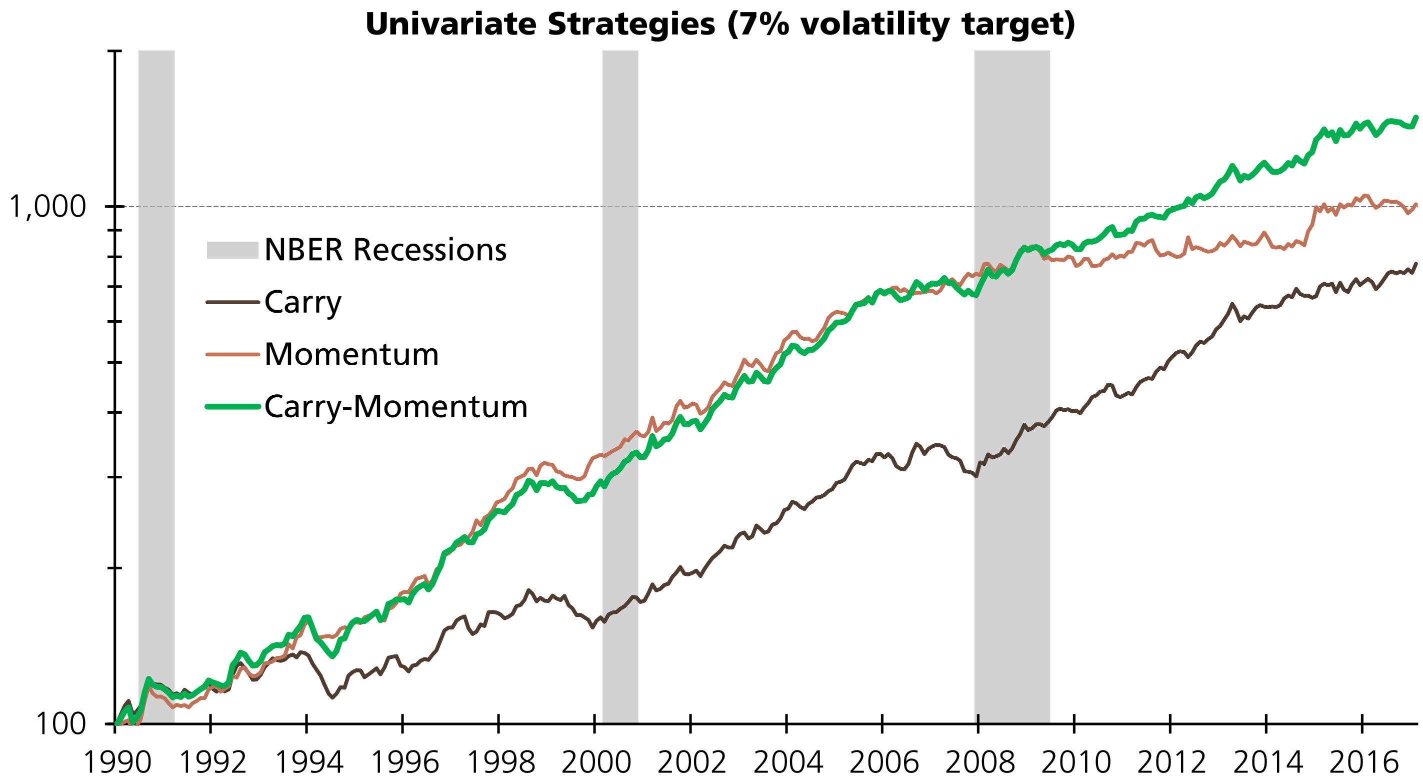
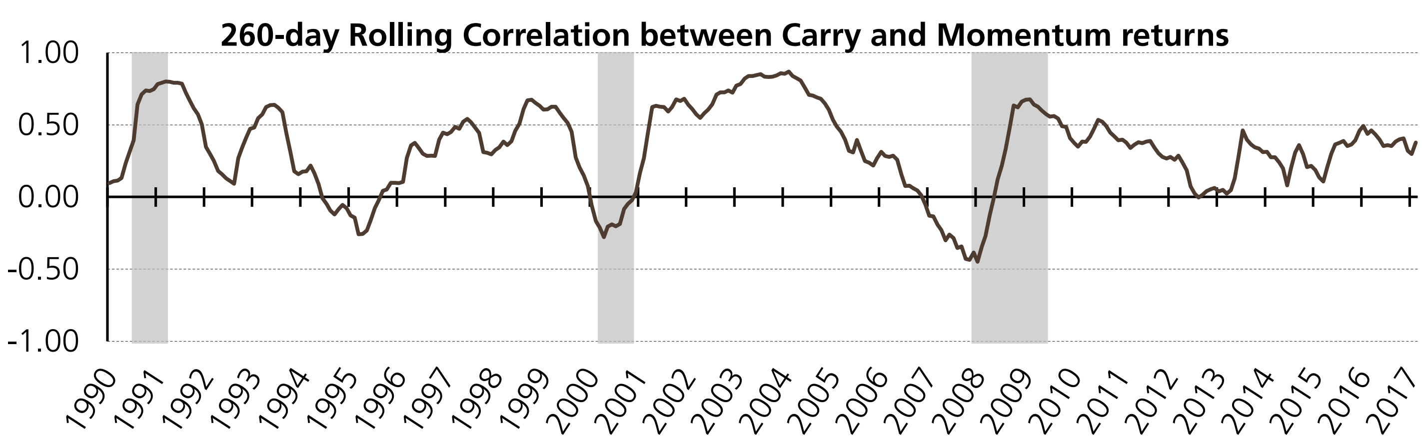
Multi-asset Return Premia





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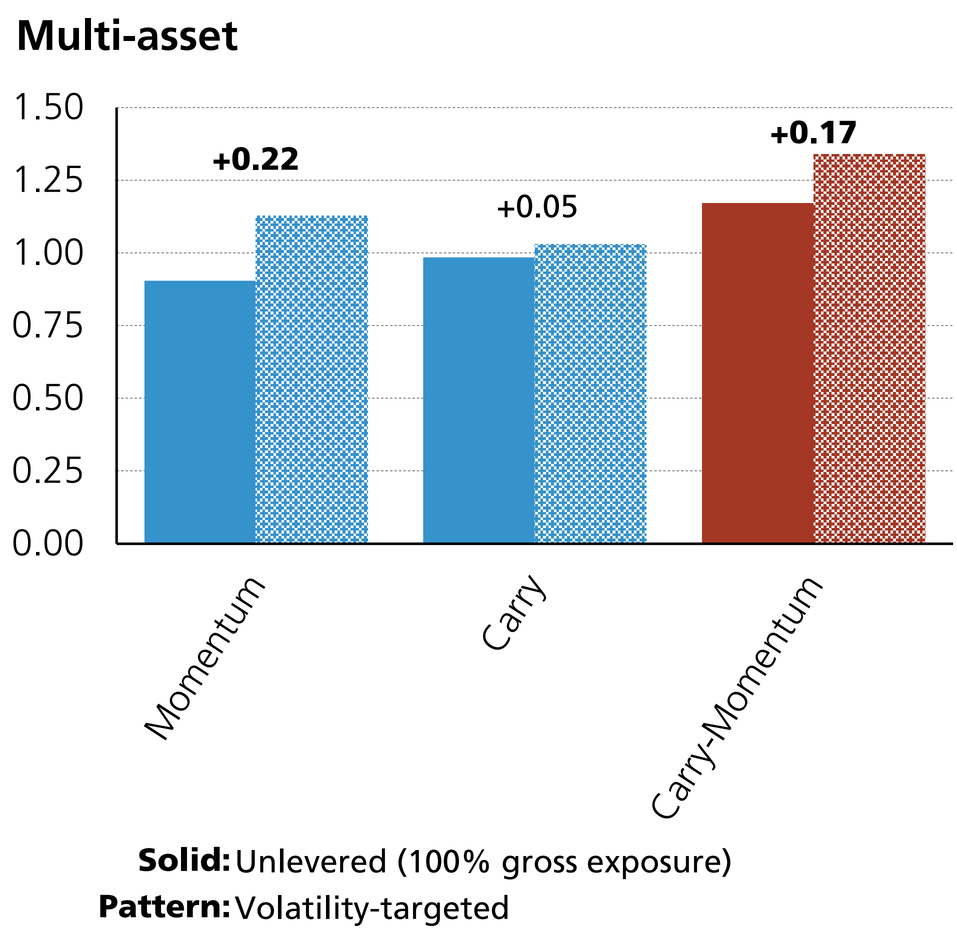
Source: UBS Quantitative Research
Note: For illustrative purposes only.

Multi-asset premia combinations

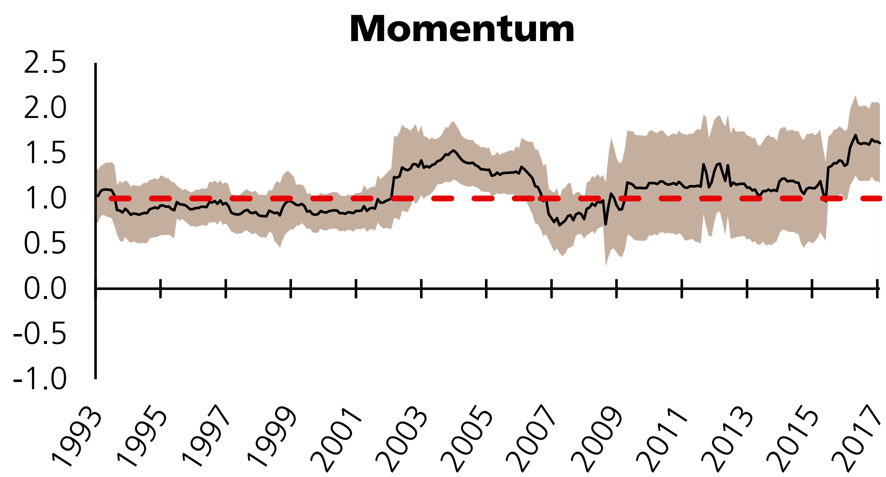


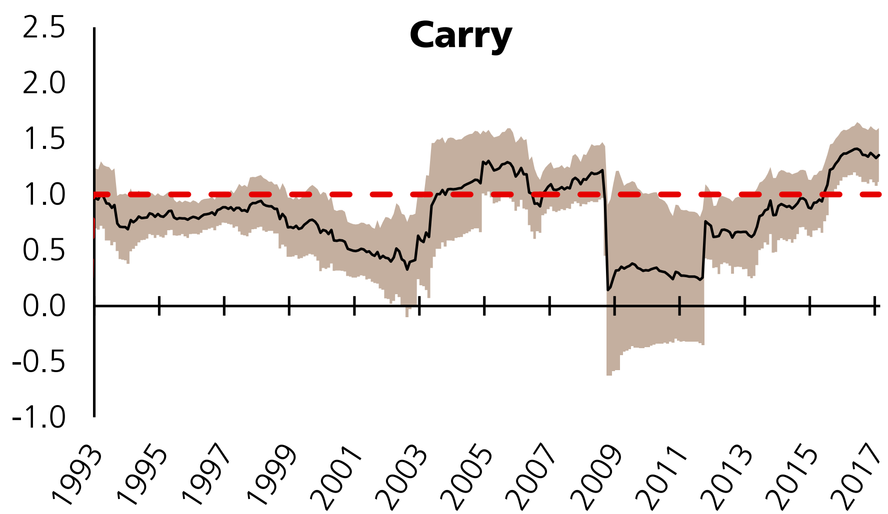
Source: UBS Quantitative Research
Note: For illustrative purposes only.

Notes: (a) inverse-volatility weighting scheme between asset classes and premia
(b) volatility estimates based on a rolling window of 100 days
(c) sample: 1990M01-2017M02

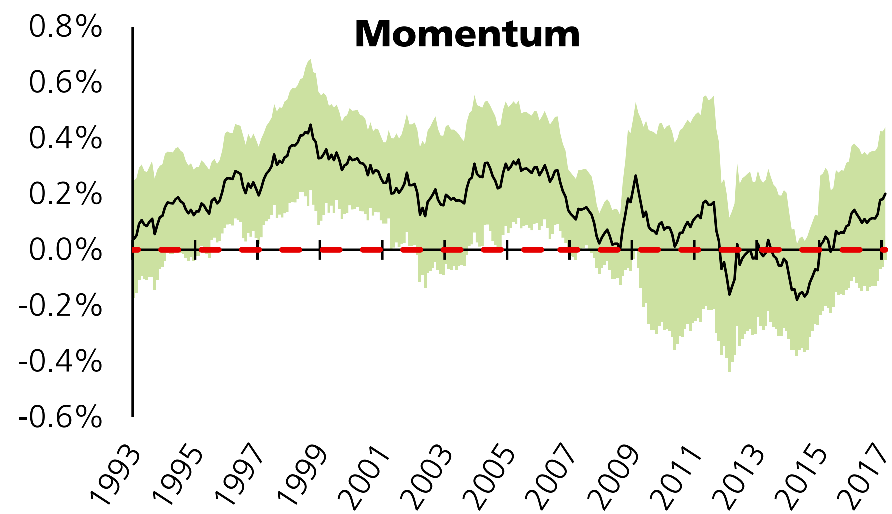
Time-series versus Cross-sectional

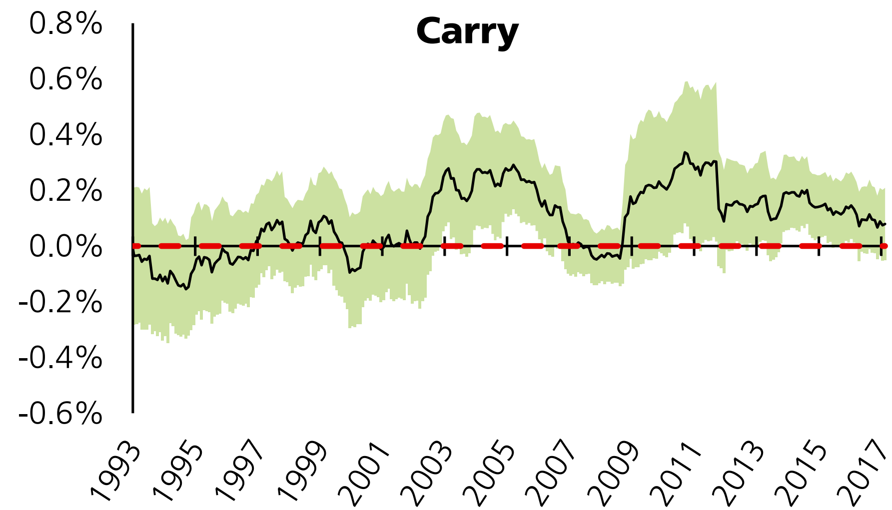
Rolling beta of TS on XS implementation





Rolling alpha of TS on XS implementation





Source: UBS Quantitative Research
Note: For illustrative purposes only.

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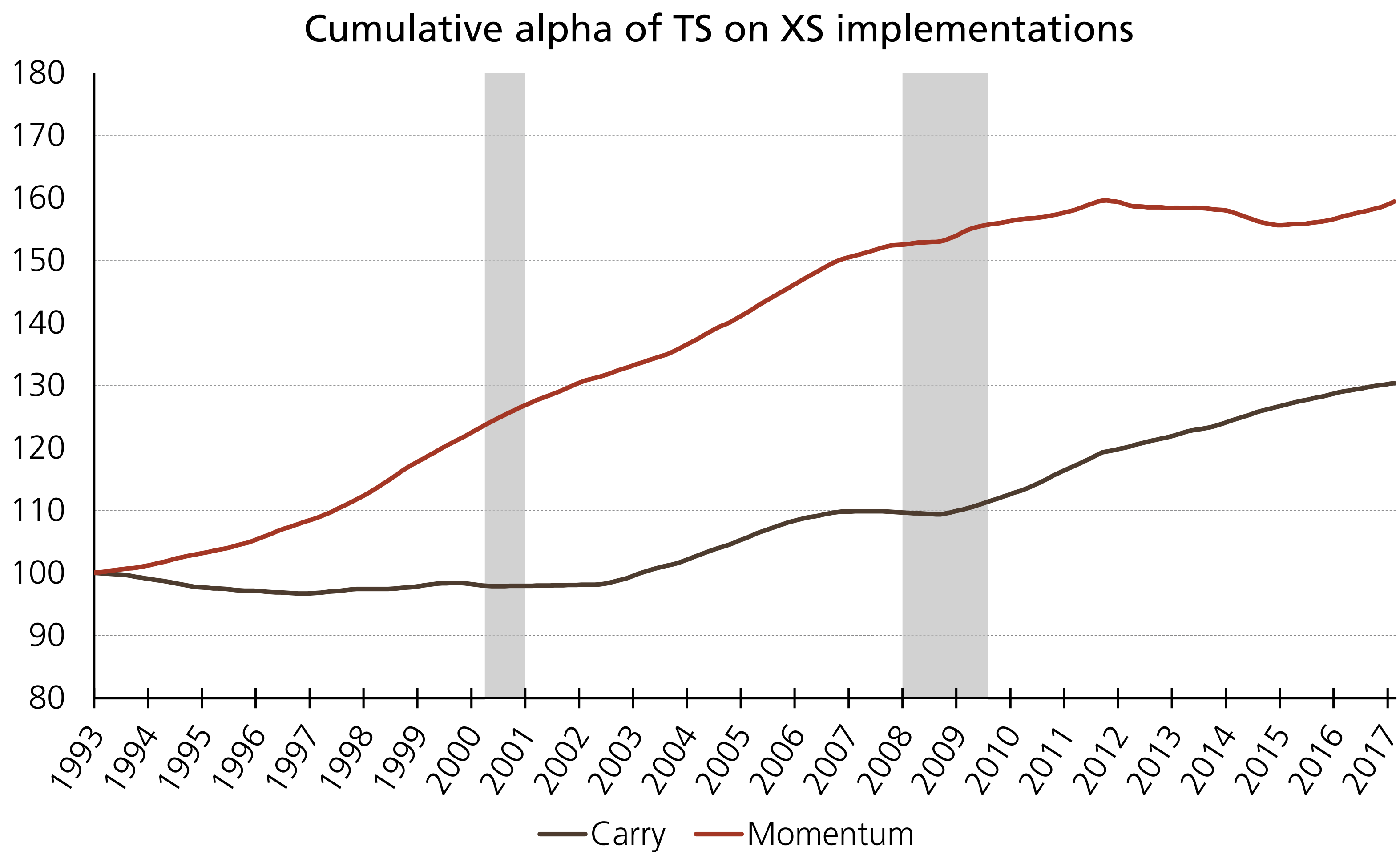
Note: the strategies used in this analysis are unlevered (100% gross exposure).

The value-add of time-series implementations



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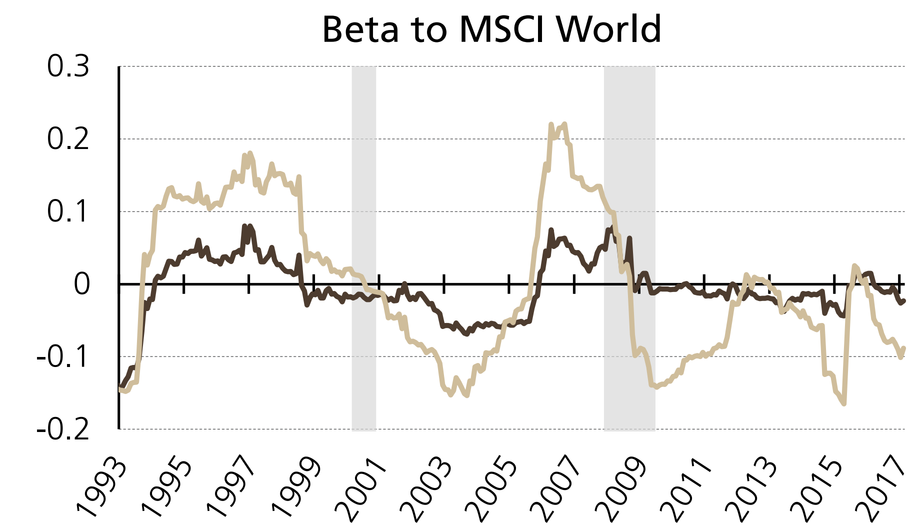
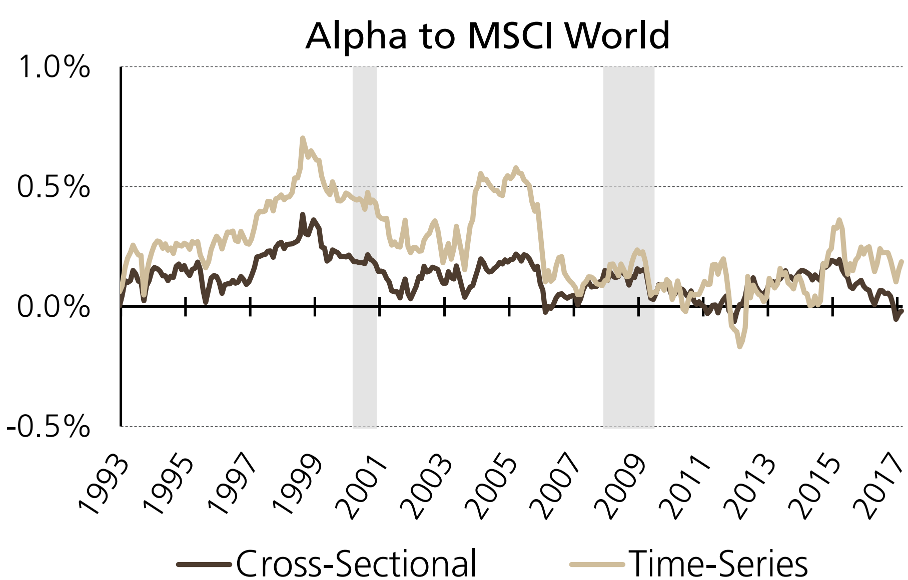
Note: the strategies used in this analysis are unlevered (100% gross exposure).

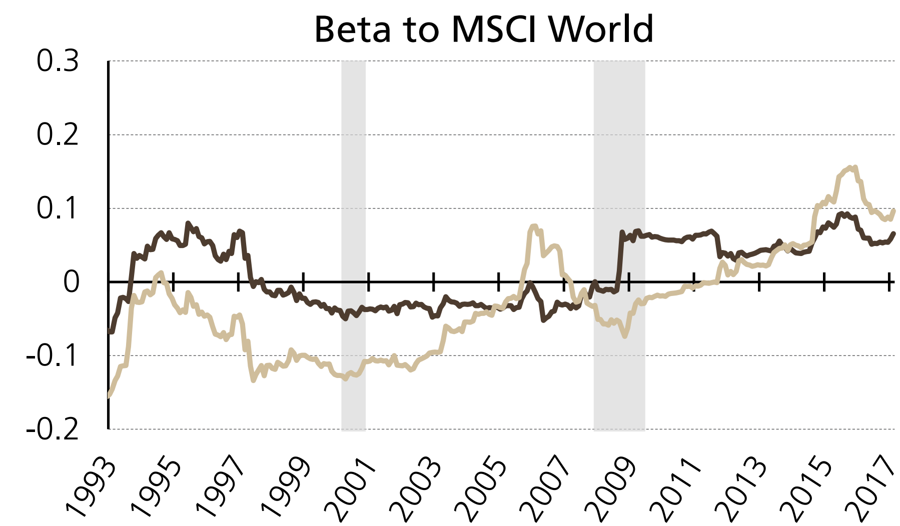
Rolling betas and alphas against MSCI World

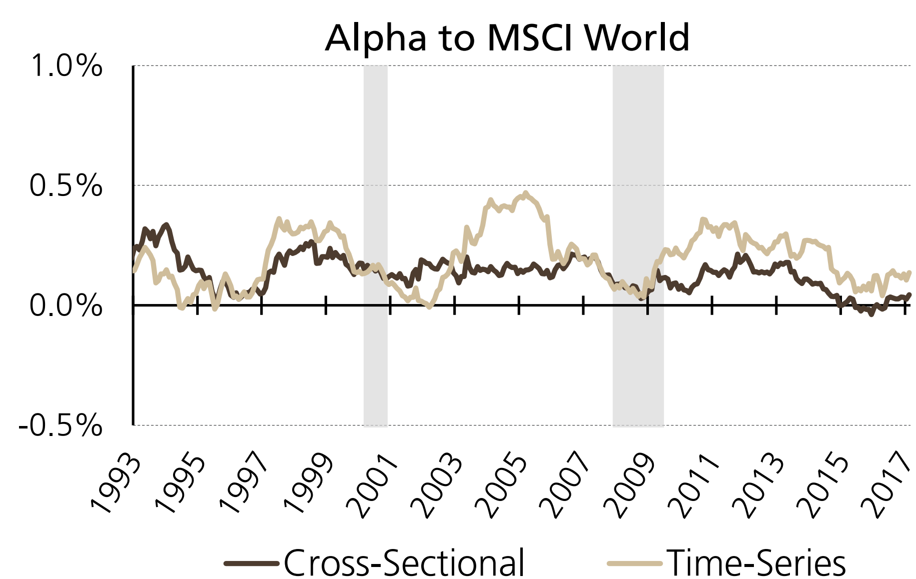
Momentum





Carry





Source: UBS Quantitative Research
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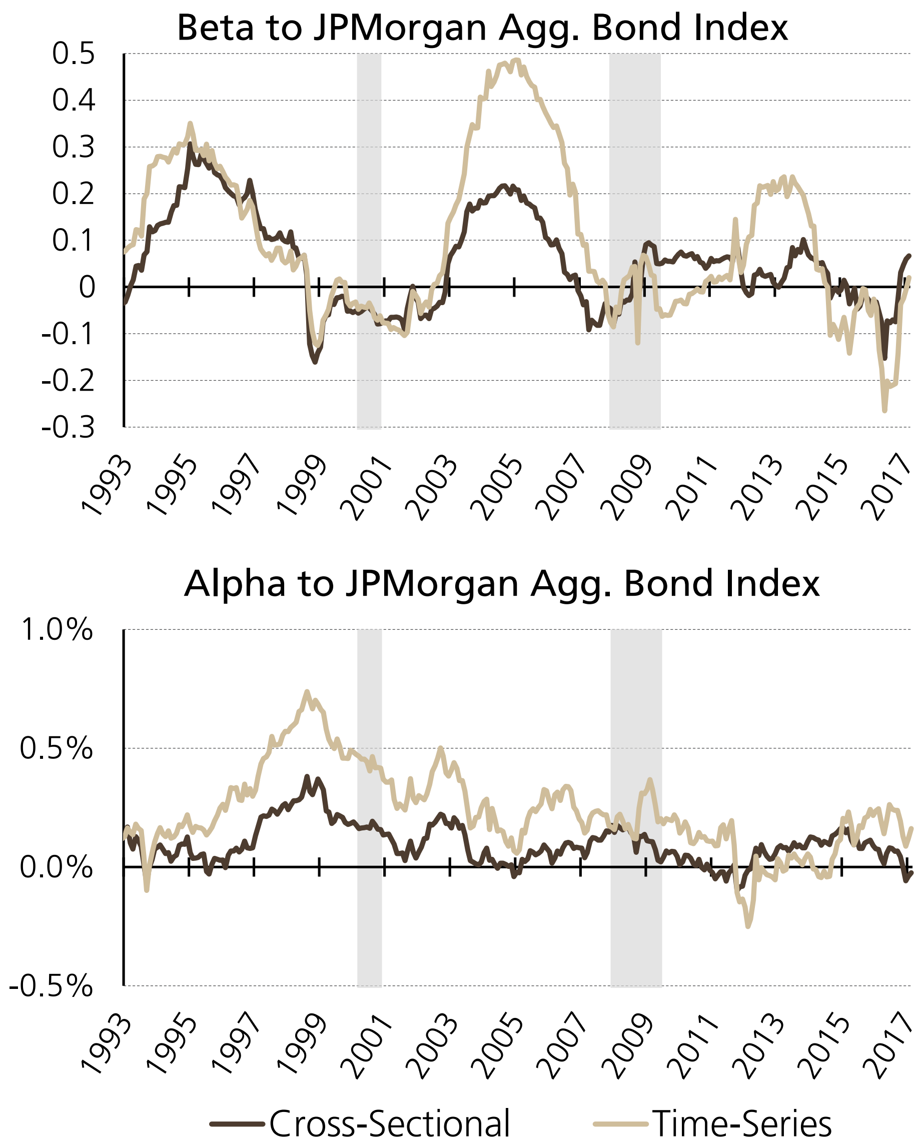
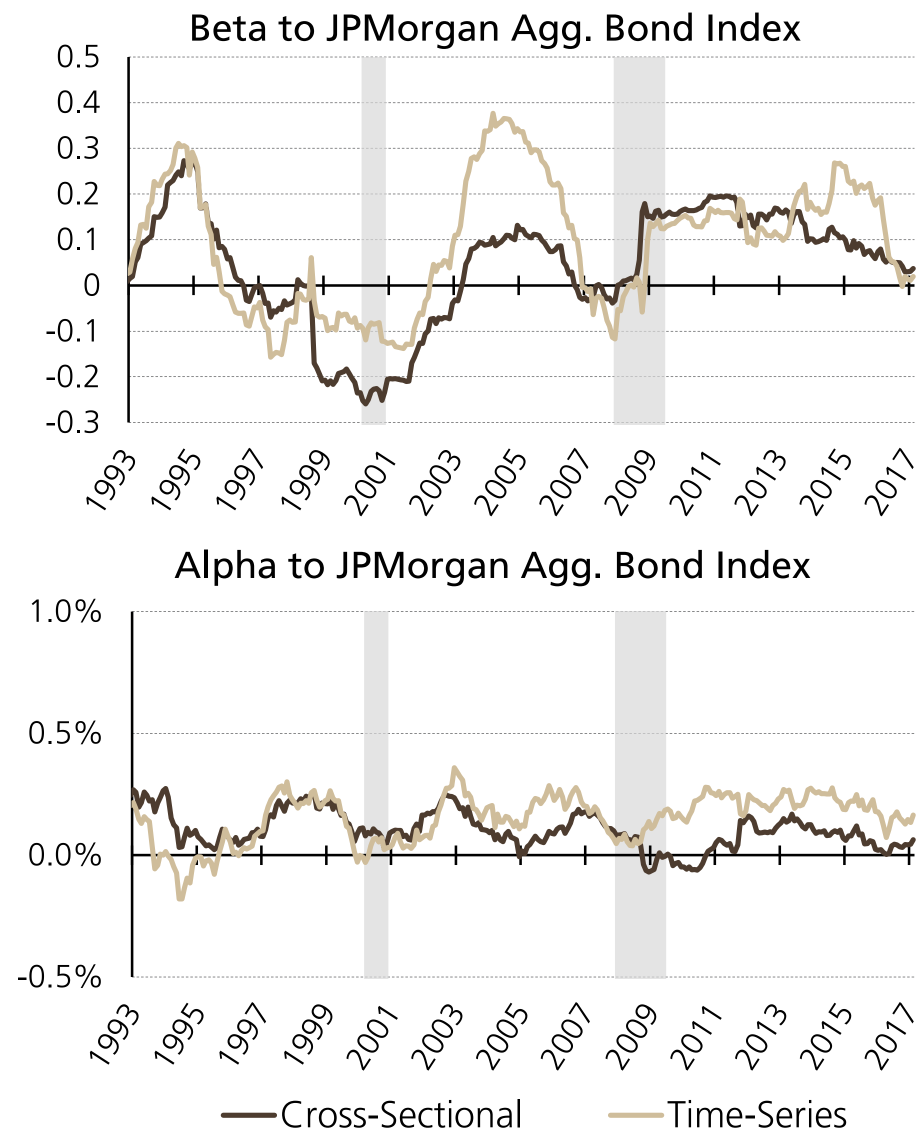
Note: the strategies used in this analysis are unlevered (100% gross exposure).

Rolling betas and alphas against JPM Agg. Bond

Momentum



Carry



Source: UBS Quantitative Research
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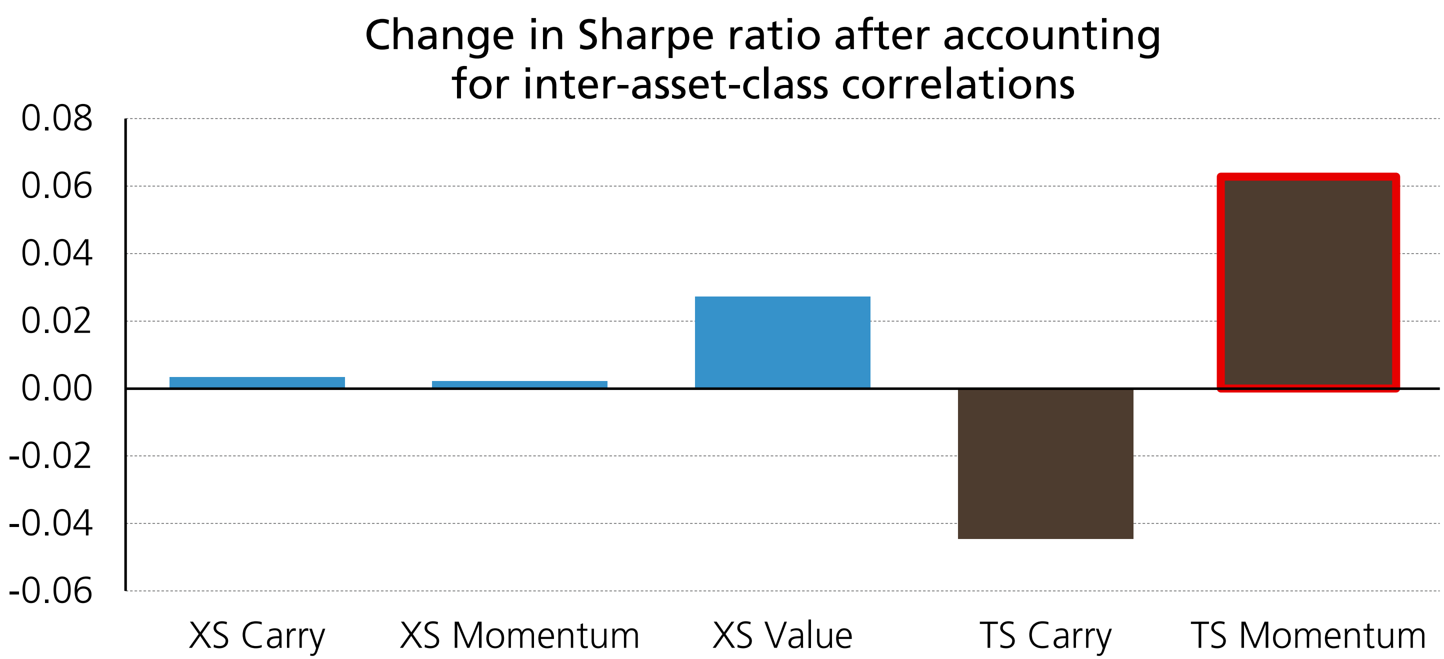
Note: the strategies used in this analysis are unlevered (100% gross exposure).

Section 5

The value-add of pairwise correlations

Is it worth using the correlations of the premia?

- In constructing multi-asset premia, we can incorporate correlations in a risk-parity setup (as opposed to *just* using inverse-volatility weights).



Source: UBS Quantitative Research
Note: For illustrative purposes only.

- The benefit is (only) prominent for TS Momentum, in line with our work *Trend-Following meets Risk-Parity* (Dec. 2013), and is mainly due to the post-2009 period.
- The benefit can become significantly stronger if the optimisation is run across assets (as opposed to asset class trend-following portfolios), as suggested by our work.

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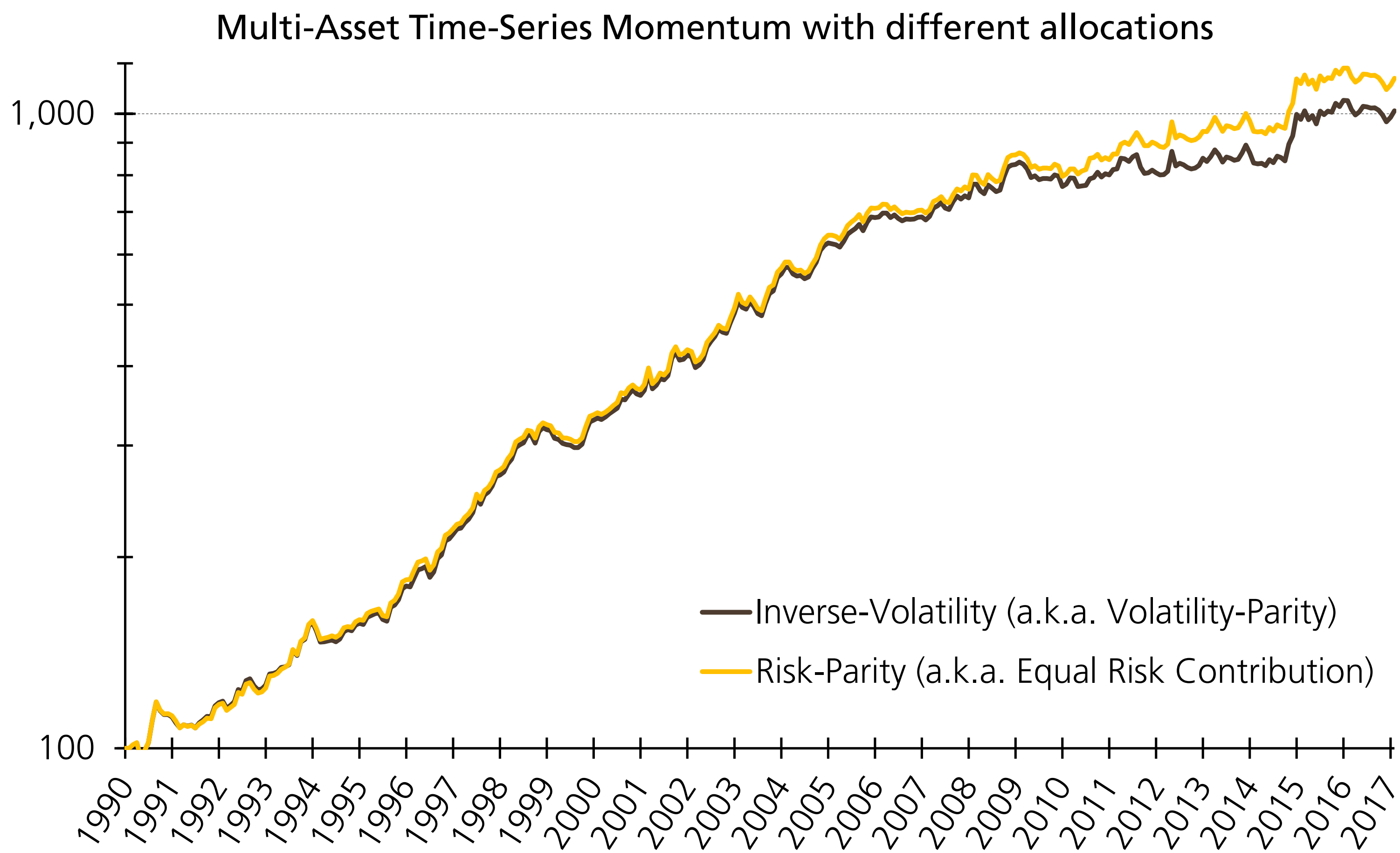
The impact of Risk-Parity on Multi-Asset Trend

- A picture (hopefully) familiar to our audience:



Source: UBS Quantitative Research
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Section 6

Final Stop: Putting it all together.

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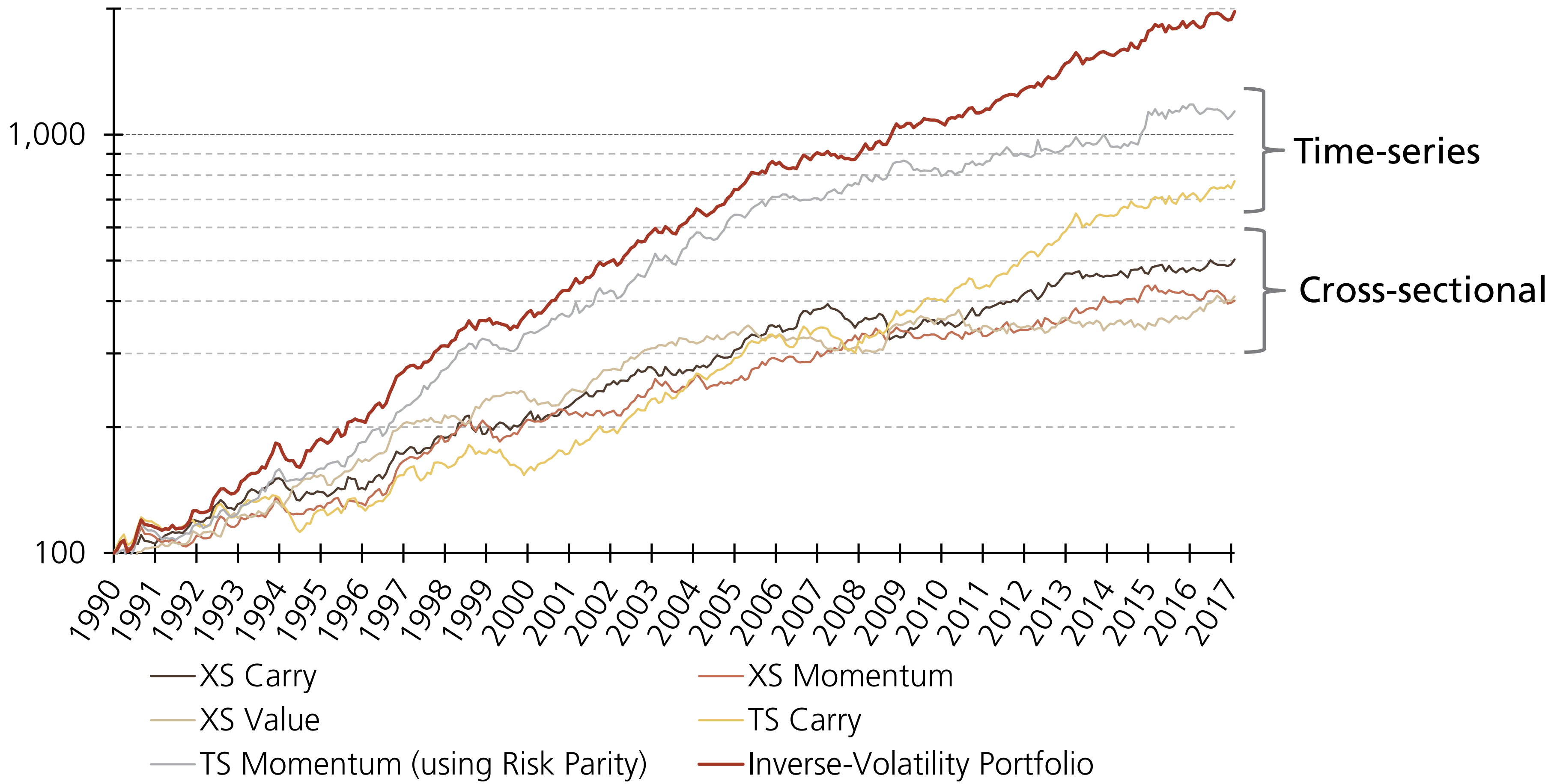
Multi-asset & Multi-factor

- Five return premia combined on an inverse-volatility basis:
  - Cross-sectional: Carry, Momentum, Value
  - Time-series: Carry, Momentum (with Risk-Parity)



Source: UBS Quantitative Research
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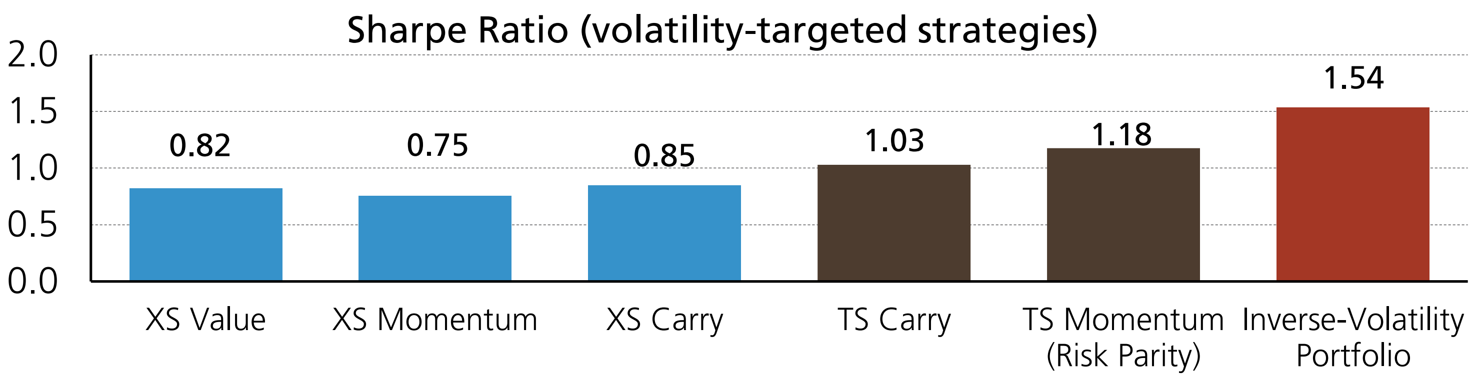
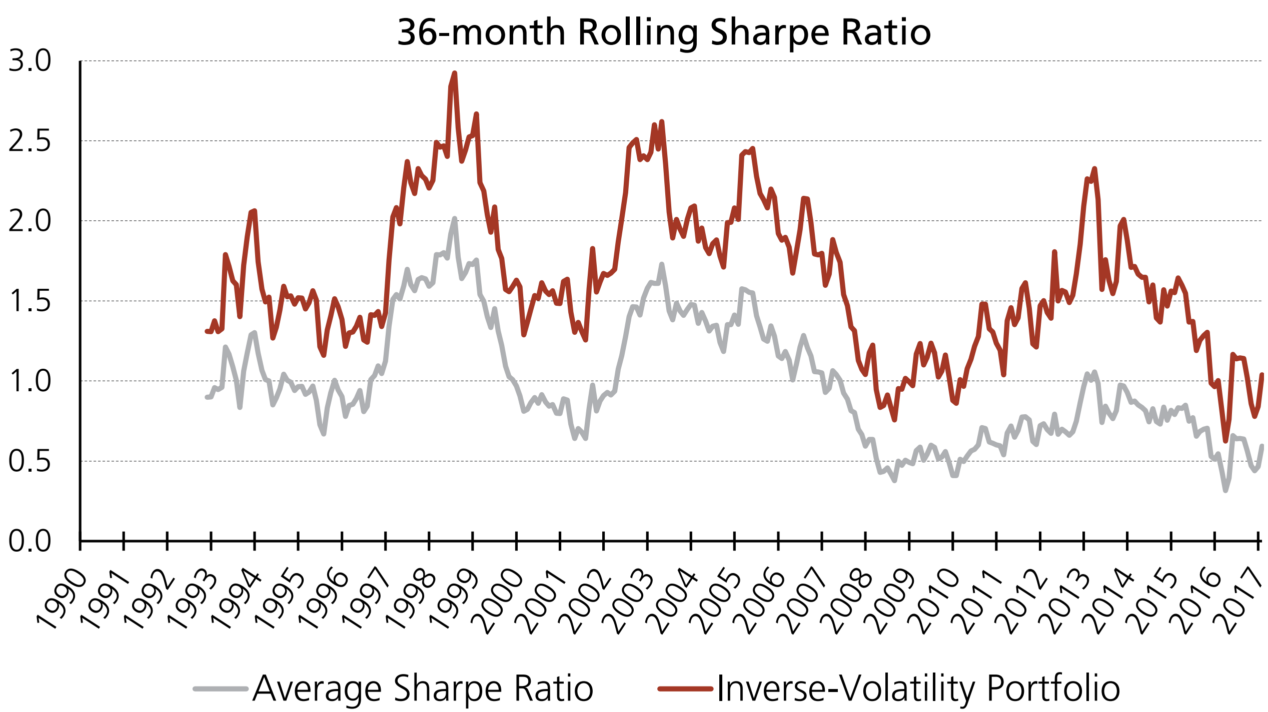
Risk-adjusted performance





- The 36m rolling Sharpe ratio of the portfolio is always larger than the average of the five constituents (due to diversification).
- It has fallen below one only a few times in the past.

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Source: UBS Quantitative Research
Note: For illustrative purposes only.

Section 7

Appendix & References

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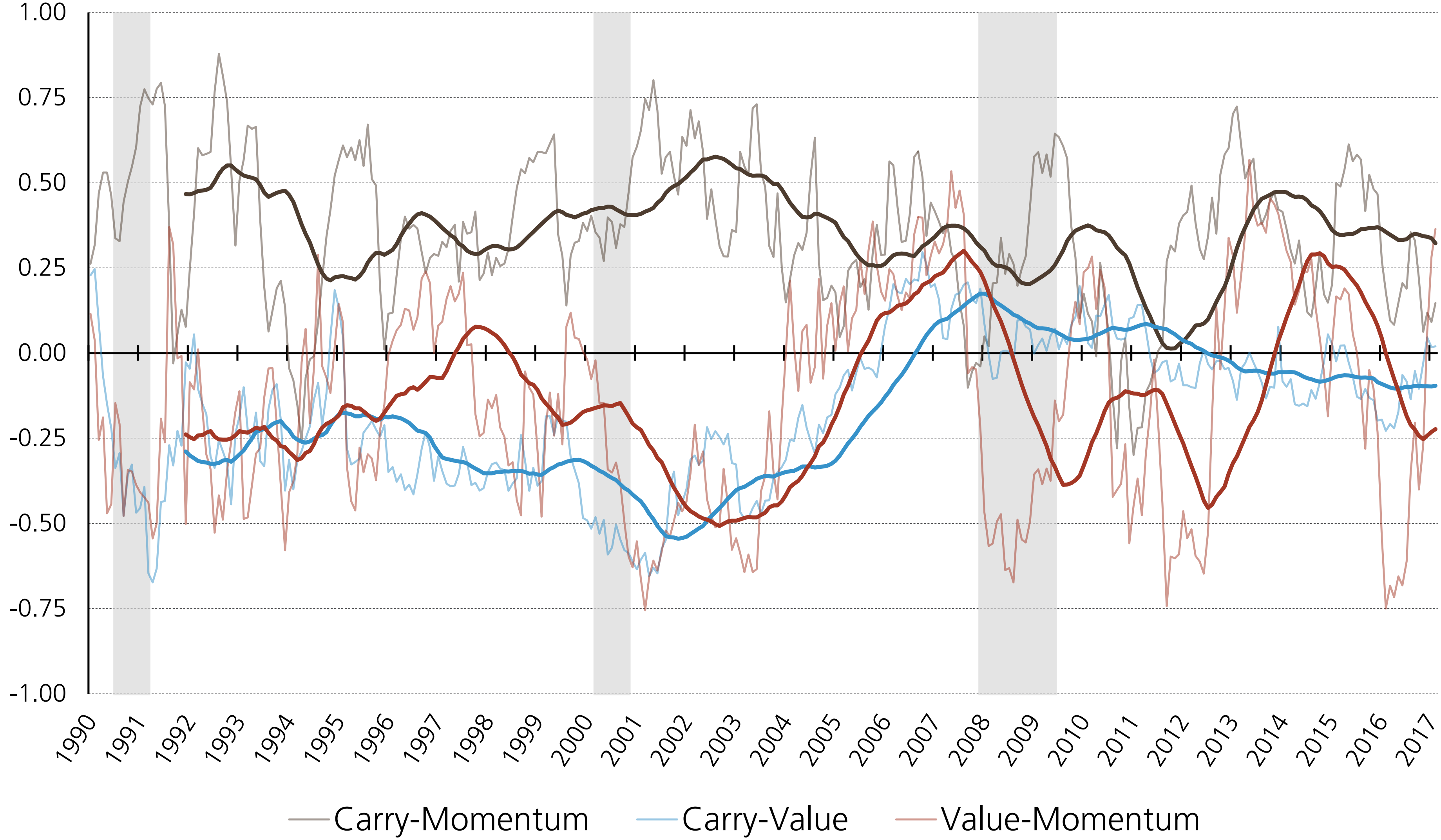
Appendix - Rank Cross-Sectional Correlations



Source: UBS Quantitative Research
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Appendix - The impact of Volatility-Targeting for XS Strategies

- **Report the ratio of Sharpe ratios after and before applying volatility-targeting on a monthly basis:**

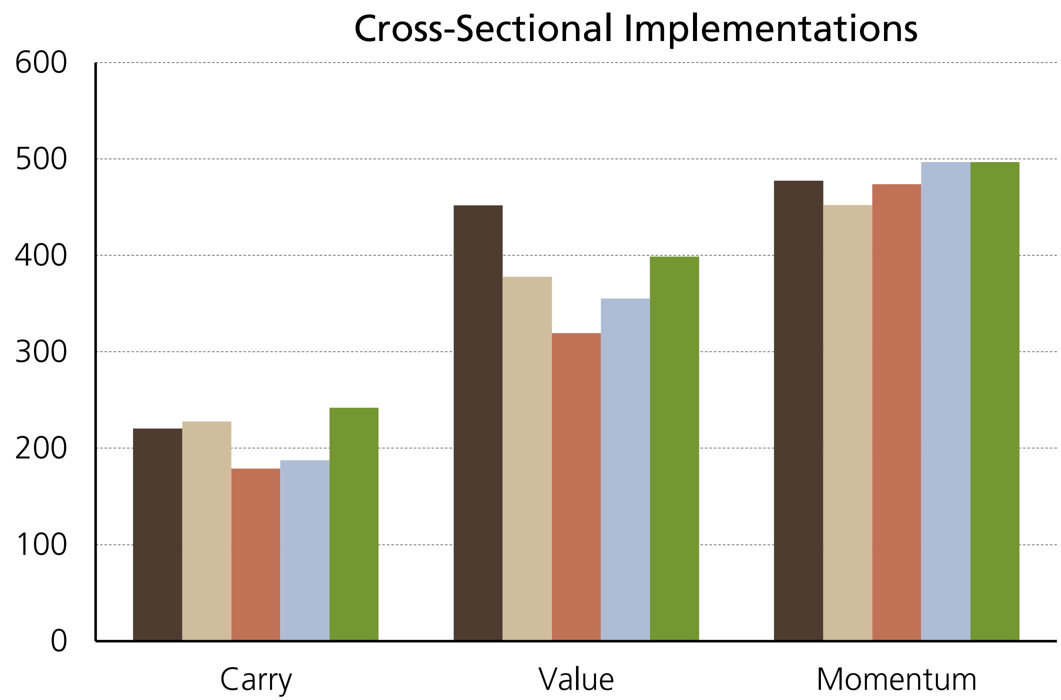
Ratio of SRs [difference in SRs]	Commodities	Government Bonds	FX Rates	Equity Indices	Inverse-volatility Portfolio
Carry	0.71 [-0.06]	1.14 [+0.12]	0.90 [-0.05]	0.70 [-0.13]	1.01 [+0.01]
Momentum	1.18 [+0.09]	1.50 [+0.14]	2.44 [+0.17]	1.44 [+0.09]	1.29 [+0.17]
Value	1.03 [+0.01]	1.02 [+0.02]	0.87 [-0.06]	0.60 [-0.13]	0.90 [-0.09]
Inverse-volatility Portfolio	1.08 [+0.05]	1.10 [+0.09]	0.74 [-0.19]	0.70 [-0.16]	

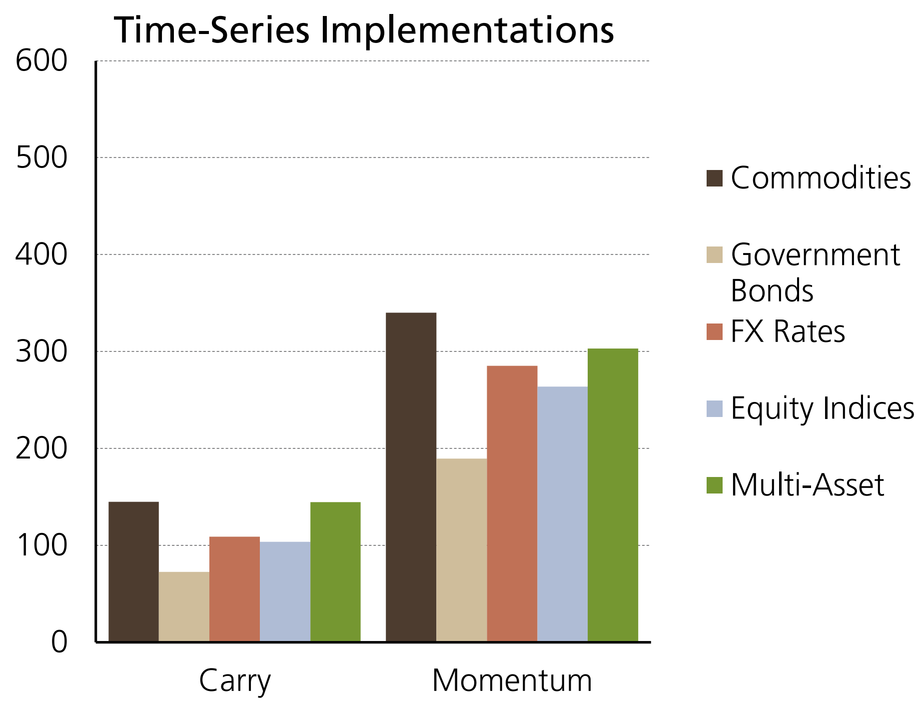
Source: UBS Quantitative Research
Note: For illustrative purposes only.

- **Volatility-targeting strongly impacts the performance of Momentum strategies in line with (among others) Barroso and Santa-Clara (2015).**

Appendix – Turnover [Jan. 1990 – Feb. 2017]

Annualised Turnover (%) for unlevered strategies (100% Gross Exposure)





Source: UBS Quantitative Research
Note: For illustrative purposes only.

Related Literature

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Neutral	FSR is between -6% and 6% of the MRA.	39%	27%
Sell	FSR is > 6% below the MRA.	15%	16%
Short-Term Rating	**Definition**	**Coverage[3]**	**IB Services[4]**
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

Source: UBS. Rating allocations are as of 31 December 2016.
1:Percentage of companies under coverage globally within the 12-month rating category.
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