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Global Research

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# Factor Investing: A synthesis of ideas Crowding, Timing and Allocating Between

## *UBS Risk Premia Conference 2017*


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# "I have so many names…"

**Smart beta**

**Alternative beta**

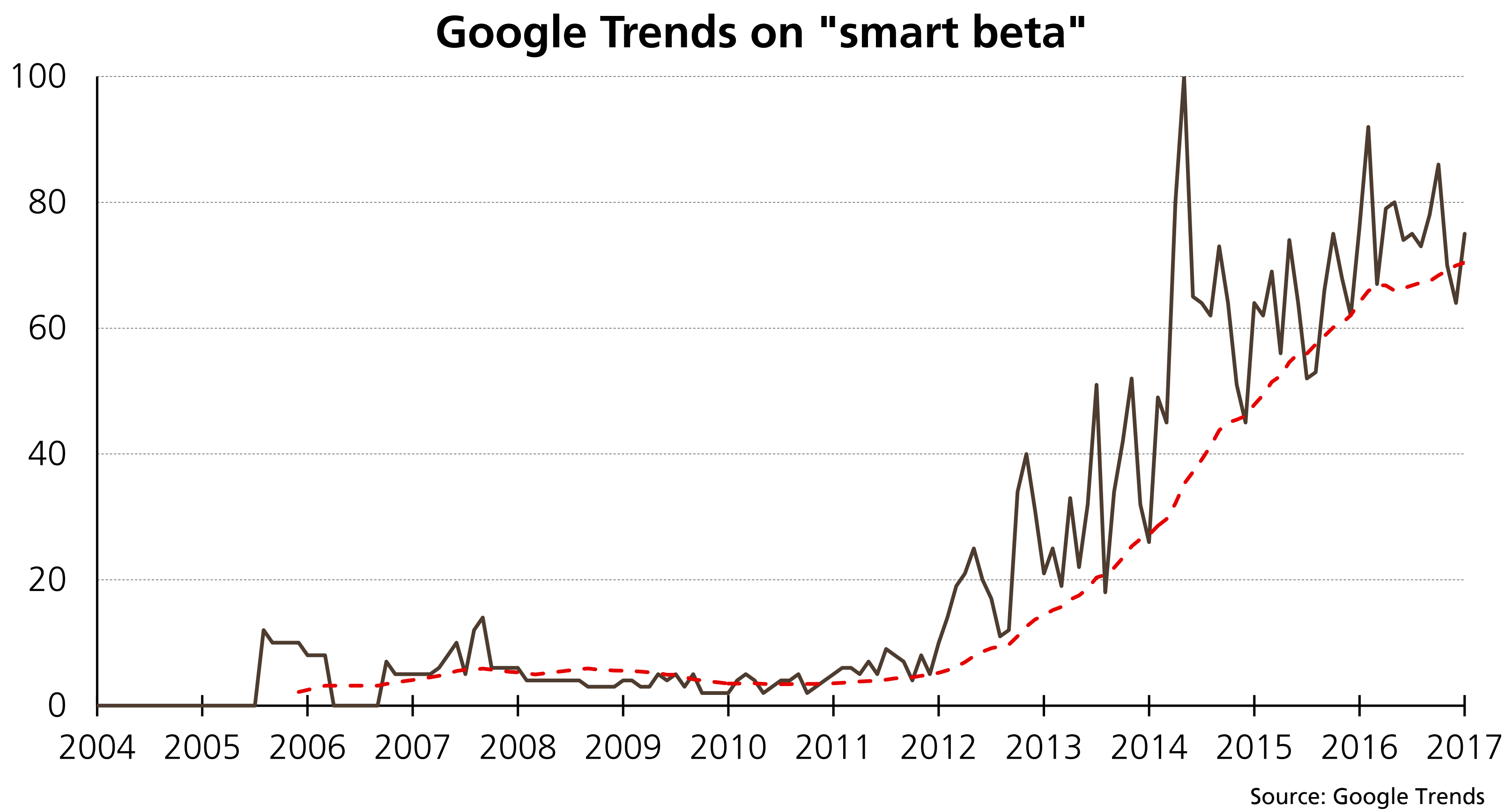
**Factor premia**

**Risk premia**

**Equity styles**

**Alternative premia**

# People talk about it.



# People invest in it.

BlackRock projects smart beta ETF assets will reach $1 trillion globally by 2020, and $2.4 trillion by 2025

BlackRock Press Release, May 12, 2016

— 72% of asset owners are using or actively evaluating smart beta
— 62% with existing smart beta allocations evaluating additional indexes
— Percentage using five or more smart beta indexes up 10 fold in 2 years

FTSE Russell 2016 Smart Beta Global Survey

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# And investors are worried about it.

**Smart beta strategies risk becoming crowded**

Benefit of active tilt to passive investing will be lost as more investors join in

The Financial Times, May 26, 2015

**Smart beta 'could go horribly wrong'**

Rob Arnott, one of the pioneers of the strategy, warns against its soaring popularity

The Financial Times, February 22, 2016

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# Framing the right questions

- How many equity factors are there?
- What is driving the premia? Is it risk or mispricing?
- What is the impact of crowding in the profitability of premia?
- Can the premia (just) go away?
- Is style timing/rotation possible?
- Timing or diversification?
- How to build a portfolio of factors

Section 1

# How many equity factors are there?

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# So, how many equity factors are there?

- 1960's: CAPM says 1 (the "market")
- 1993: Fama-French say 3 ("market" + Value and Size)
- 1997: Carhart says 4 (FF3 + MOM)
- 2016: Fama-French say 5 (but no MOM)
- 2015: Asness, Frazzini, Israel & Moskowitz say 6 (FF5 + MOM)

- Cochrane (2011) talks about a "*zoo of factors*"
- Harvey, Liu, Zhu (2015) identify >300 (definitions of) "factors"

# How many equity factors do we really need?

- PCA analysis:
  – "small" number of factors seem to matter

- Simple in-house exercise:
  – 3 least correlated factors: value, momentum, low-beta
  – 4 least correlated factors: value, momentum, low-vol, div. cover

Section 2

# What is driving the premia?

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# Is it risk or mispricing ("anomaly")?

| Factors | Rational (i.e. "Risk") | Mispricing / Limits-to-Arbitrage |
|---|---|---|
| Value / Reversals | Distress risk | • Growth extrapolation<br>• Delayed overreaction |
| Momentum / Trend | Skewness/tail risk | • Underreaction to public news<br>• Overreaction to private news<br>• Overconfidence<br>• Disposition effect<br>• High turnover/costs |
| Low-Risk / Quality | Skewness/tail risk | • Benchmarking<br>• Leverage aversion<br>• "Lottery tickets"<br>• Flight-to-quality/safety |
| Carry / Income | Funding liquidity risk<br>Tail/volatility risk | |
| Liquidity | Liquidity risk | • High costs/capacity barriers |

- The academic evidence is rich, yet inconclusive!

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Section 3

# What is the impact of crowding on factor premia?

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# The dynamics of premia differ

- Identify the mechanics of each premium.
- Risk premia behave genuinely differently to anomalies when capital flows in.
- To facilitate the discussion, let's use as examples:
  - Value as a Risk Premium
  - Momentum as an Anomaly

- *If capital flows in a value or a momentum strategy, then –ceteris paribus– what does this imply for each of them?*

# The impact of crowding

| | **Risk Premia** | **Anomalies** |
|---|---|---|
| *Type of Strategy* | Anchored / contrarian | Non-anchored / positive-feedback loop |
| *Impact of capital flow (all else being equal)* | Premium realises itself | Premium becomes (even) stronger |
| *Valuation spreads…* | Convergence | Divergence |
| *Crowing brings…* | Faster convergence → Search for new opportunities → More turnover | Stronger divergence → Concentration → More leverage |
| *Profitability implications* | ▪ Spreads progressively squeeze<br>▪ Premia harder (and more costly) to harvest | ▪ Profitability strengthens<br>▪ Risk of a crash increases (e.g. when funding liquidity becomes scarce) |

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# How to measure crowding?

- Analyst Recommendations (sell-side sentiment)

**Catalysts**

- Discretionary calls
- Systematic signals

- Institutional Ownership
- Shorting Demand

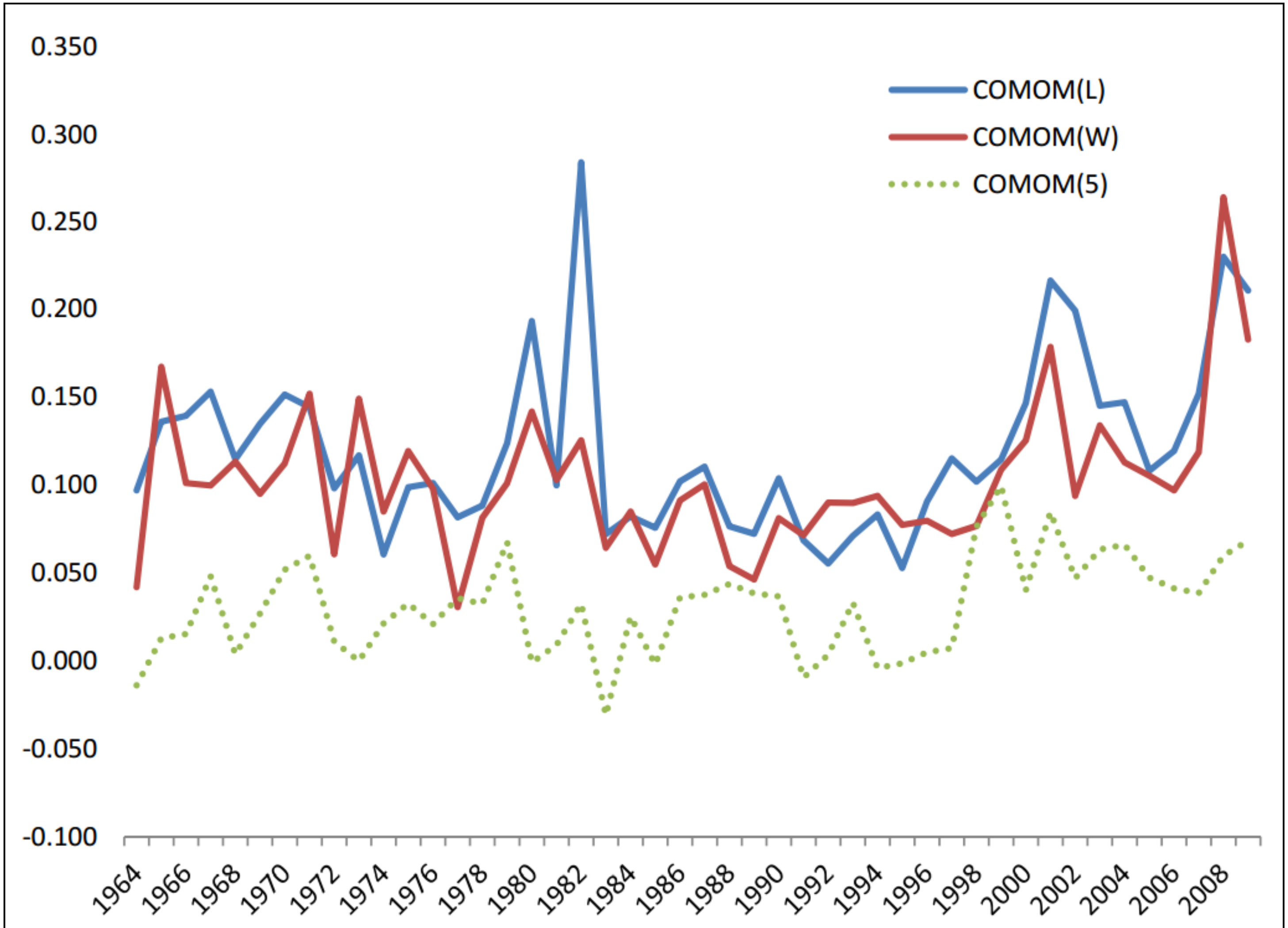
**Investment Process**

**Price moves**

- Peer-group pairwise correlations
- Valuation spreads

# Momentum activity

**Comomentum** (Lou and Polk, 2014): average pairwise excess (FF3) correlation across stocks in the same momentum decile during the portfolio ranking period.




Source: Lou and Polk (2014)

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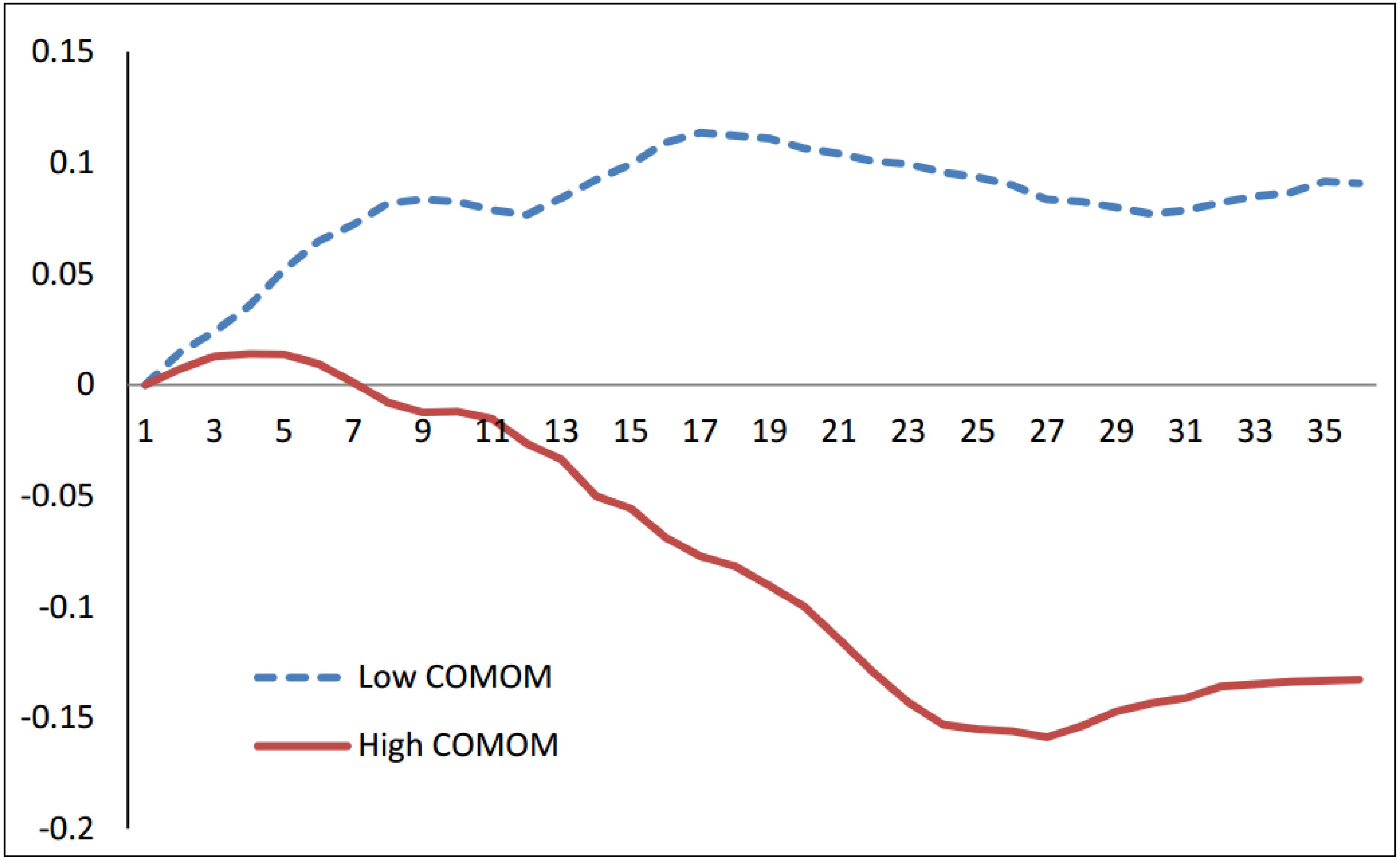
# Momentum activity

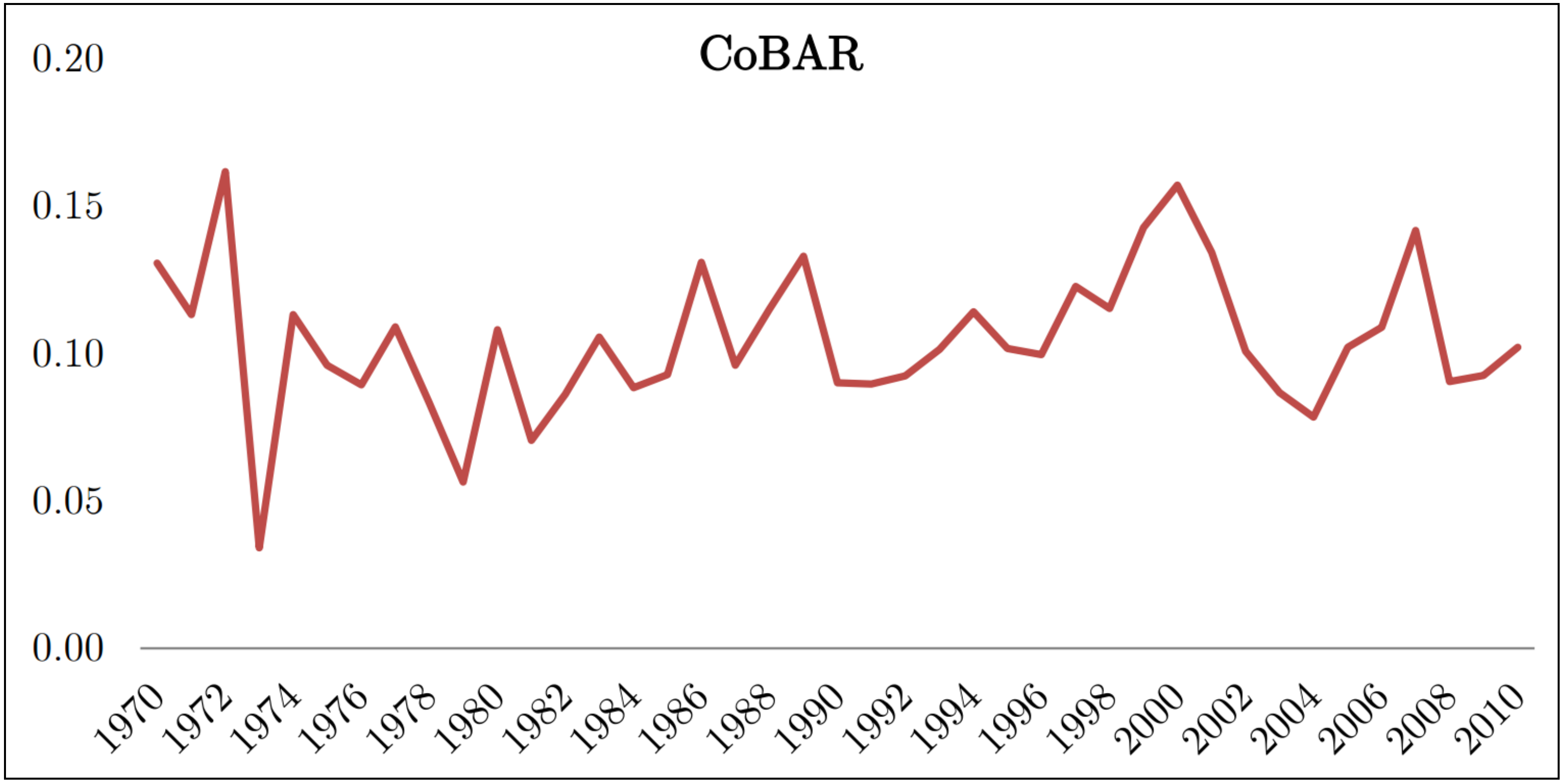
Momentum is much weaker and reverses strongly following periods of high momentum arbitrage activity.




Source: Lou and Polk (2014)

# Beta arbitrage activity

**CoBetaArbitrage** (Huang, Lou and Polk, 2016): average pairwise excess (FF3) correlation across stocks in the same beta decile during the portfolio ranking period.




Source: Huang, Lou and Polk (2016)

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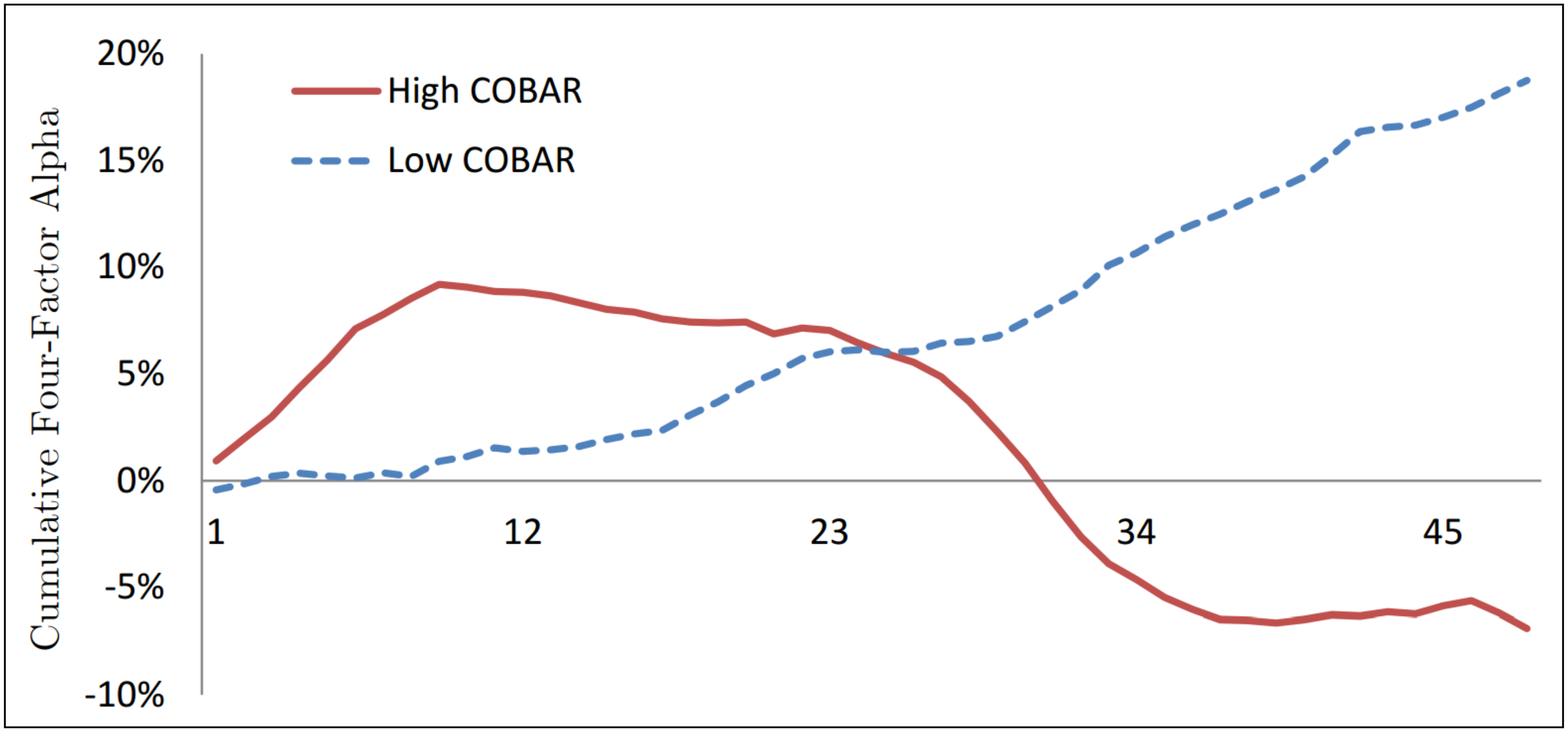
# Beta arbitrage activity

Betting-against-Beta outperforms strongly and then reverses strongly following periods of beta arbitrage activity.




Source: Huang, Lou and Polk (2016)

Section 4

# Can the premia (just) go away?

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# Can the premia go away?

**Well, YES, but only if…**

- …for Risk Premia:
  - the perception of "risk" changes
  - the risk preferences / tastes change
- …for Mispricing /"Anomalies":
  - human beings behave more "rationally" (in an economic sense)
  - enough capital becomes available to "take the other side"

So, it seems quite unlikely that premia can *just* disappear.

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Section 5

# Is style timing/rotation possible?

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# Is style timing/rotation possible?

- Style-timing is about the time-series:
  - One style
  - At the extreme: switch on and off
  - More realistic: increase/decrease exposure/leverage
- Style-rotation is (mainly) about the cross-section:
  - Two (or more) styles
  - At the extreme: switch from one (some) to other(s)
  - More realistic: overweight/underweight styles in a portfolio of styles

# Timing Risk Premia and Anomalies

- **Risk Premia**
  - The premium is compensation for bearing systematic risk.
  - Timing systematic risk means that this is no longer systematic…
  - Too hard to time genuine risk premia

- **Anomalies**
  - Anomalies can crash following periods of crowding (high COMOM, high COBAR), if/when funding liquidity becomes scarce.
  - Momentum profits are exposed to funding liquidity risk (Asness, Moskowitz and Pedersen, 2013).
  - BAB profits are exposed to funding liquidity risk (Frazzini and Pedersen, 2014).
  - Are there possibly any links between momentum and BAB?

# Timing (?) Anomalies

Fact:

*Both momentum and BAB underperform during strong market reversals and "junk rallies".*

Idea:

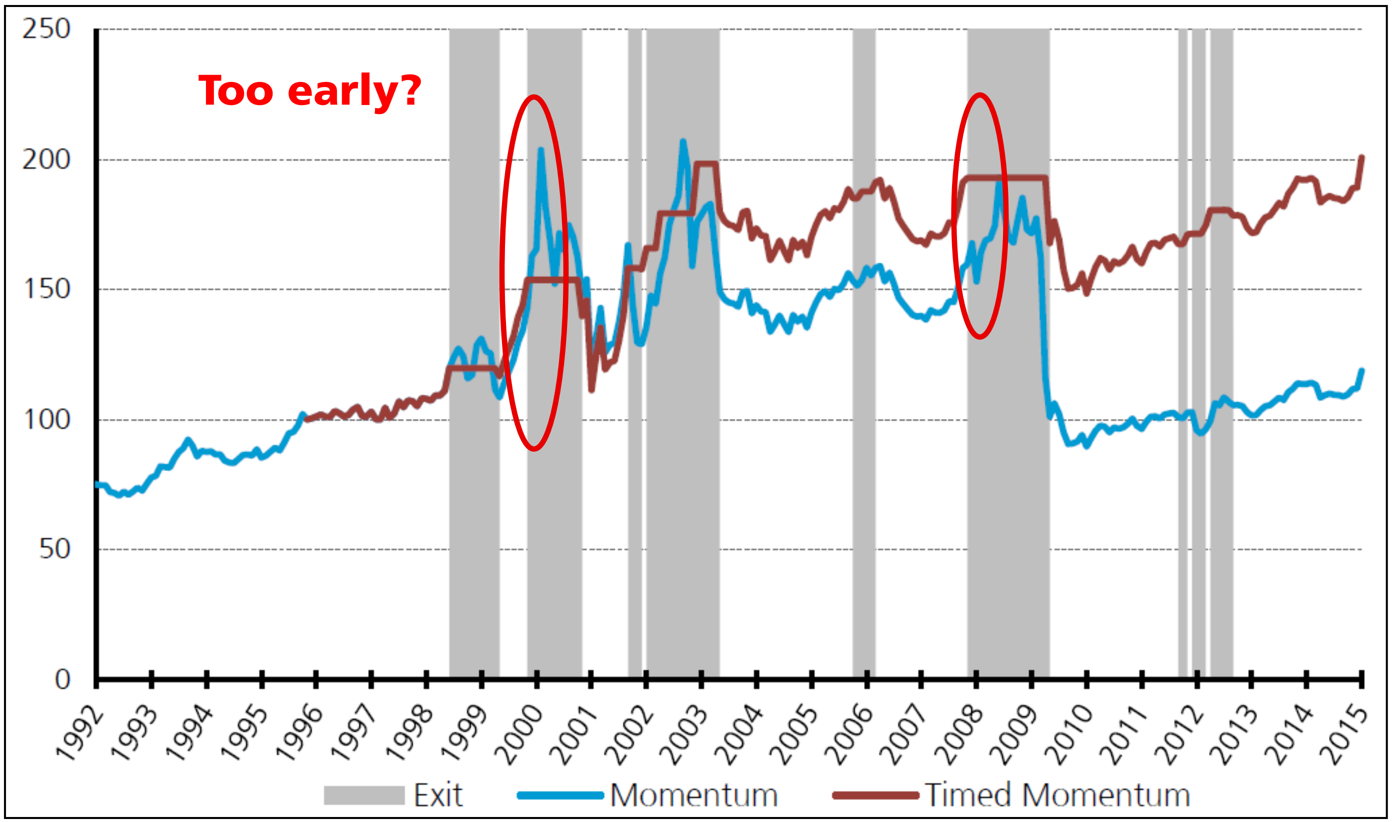
*Why not exit when crowding increases "too much" (assuming we have a good measure)?*

…good, but:

*Managers have rational incentive to stay invested (even when aware of crash risk) because of competition.*

# Momentum and reallocation of "Blind Capital"

- Momentum becomes crowded following periods of outperformance, as it attracts "blind capital" from return-chasing investors (Chabot, Chysels and Jagannathan, 2014).
- Use the level of momentum outperformance (vs. the market) to time the exit from the strategy.




Source: UBS Quantitative Research

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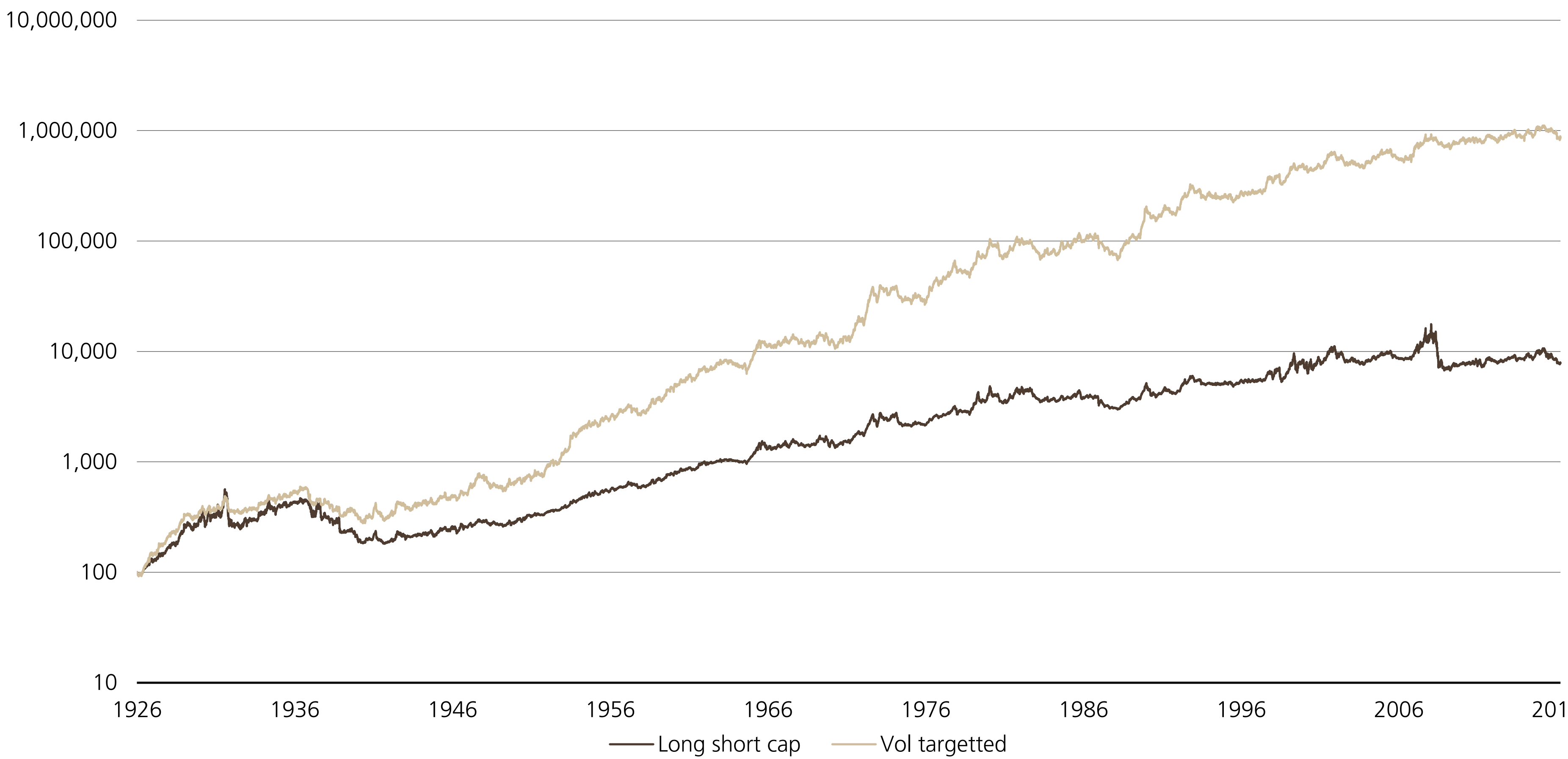
# Volatility targeting momentum

- Volatility targeting momentum is very effective – the return / risk goes from 0.40 to 0.75.




Source: UBS, Ken French Data Library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The momentum portfolio is a long / short portfolio based on the large cap "6 portfolios based on size and momentum". The volatility targeted portfolio has its gearing changed monthly to achieve a volatility equal to that of the base portfolio over the whole sample. The average gearing for the portfolio is 1.48.

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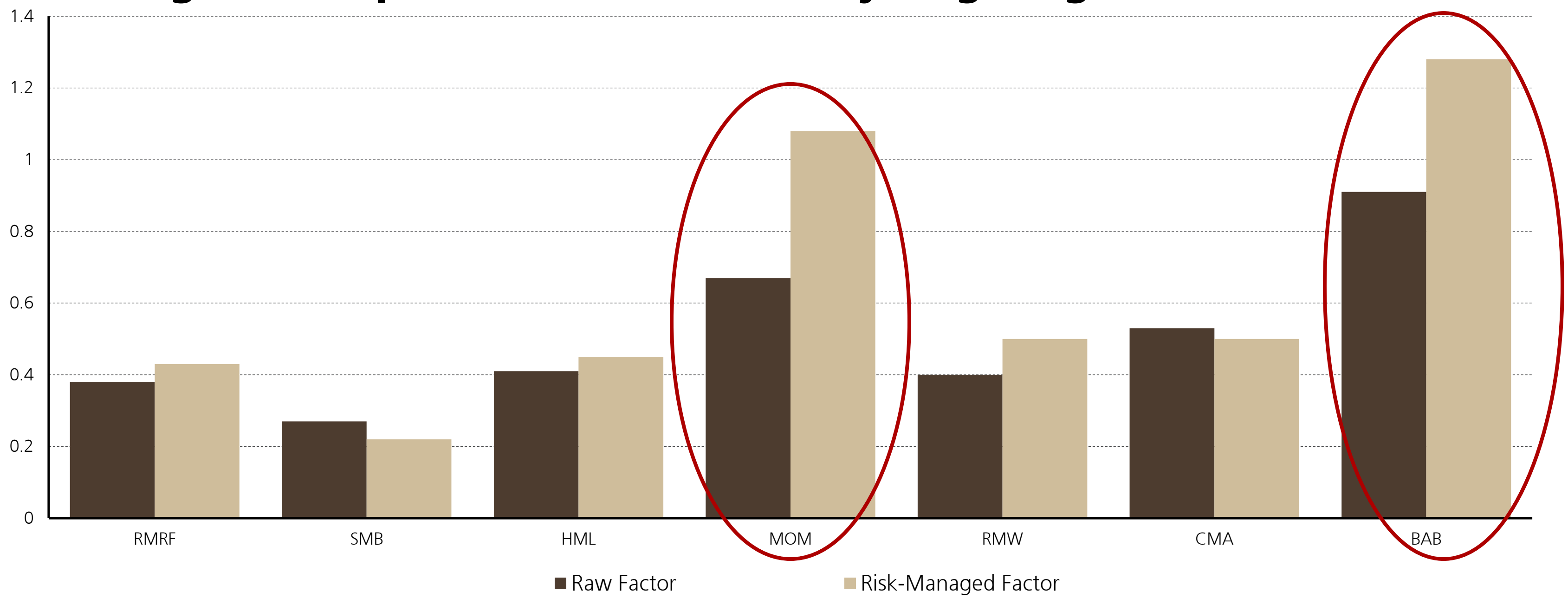
# Other factors

- What about other factors? We wrote on this in our January 2017 Academic Research Monitor where we summarised Barroso & Maio (2016) and Moreira & Muir (2016).
- Both papers look at a similar set of factors and report similar results. We note that the result for betting against beta extends to volatility as opposed to beta based portfolios.

**Change in Sharpe ratio due to volatility-targeting**




Source: "Managing the Risk of the 'Betting-Against-Beta' Anomaly: Does It Pay to Bet Against Beta?" by P. Barroso & P. Maio; the figure is constructed using data reported in Tables 1 and 3; reproduced with permission. The figure presents the Sharpe ratio of raw (buy and hold) long-short factors and of their risk-managed form using volatility-targeting. Sample period: January 1964 to December 2015.

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# Are momentum and BAB special?

Fact:

*Momentum and BAB are technical styles, and are independent to fundamental data; they only depend on price data.*

Observation:

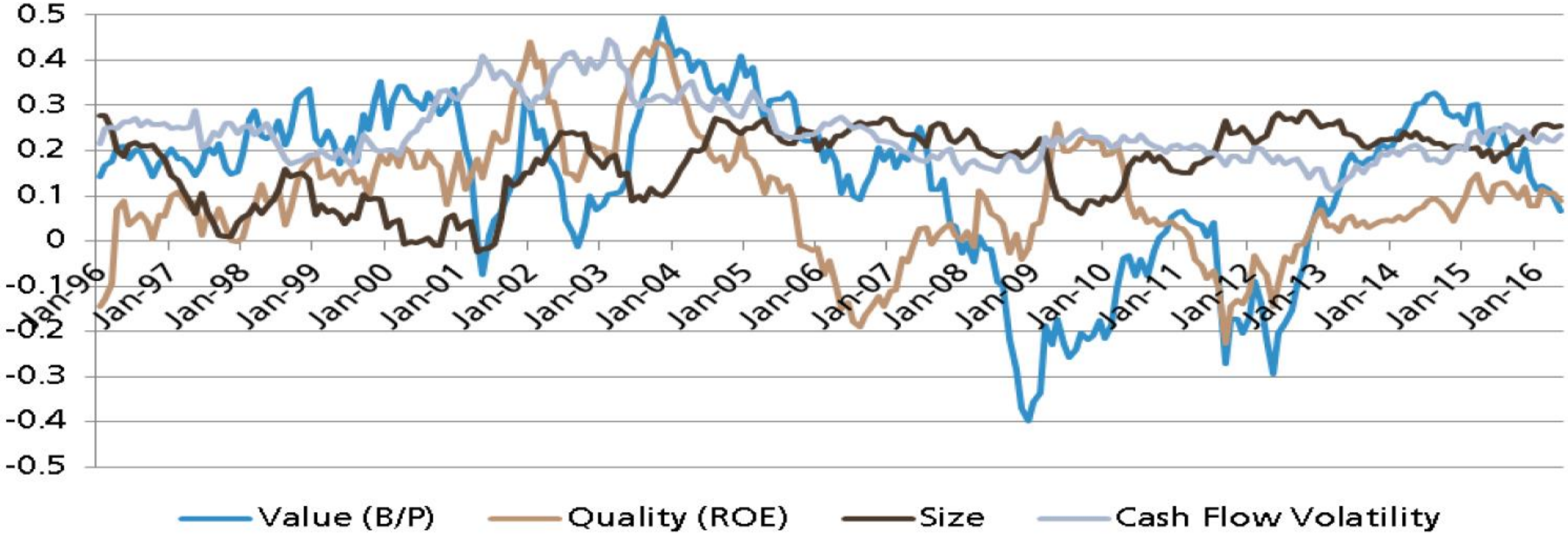
*Equity factors are not (especially on a conditional basis) orthogonal.*

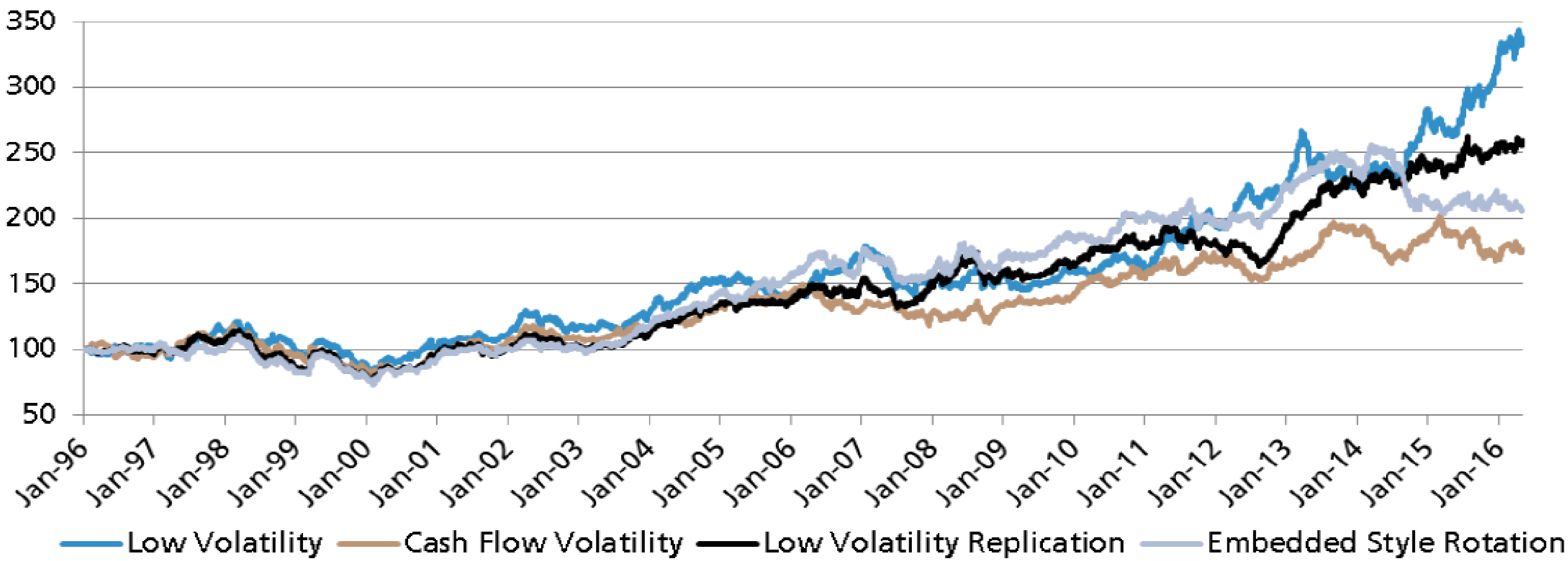
Testable hypothesis:

*Do the technical styles exhibit any systematic conditional tilts across fundamental styles (e.g. value, quality)?*

# Replicating Low-Risk (Betting-against-Beta)

…using dynamic shifts across value, quality, size and earnings variability.

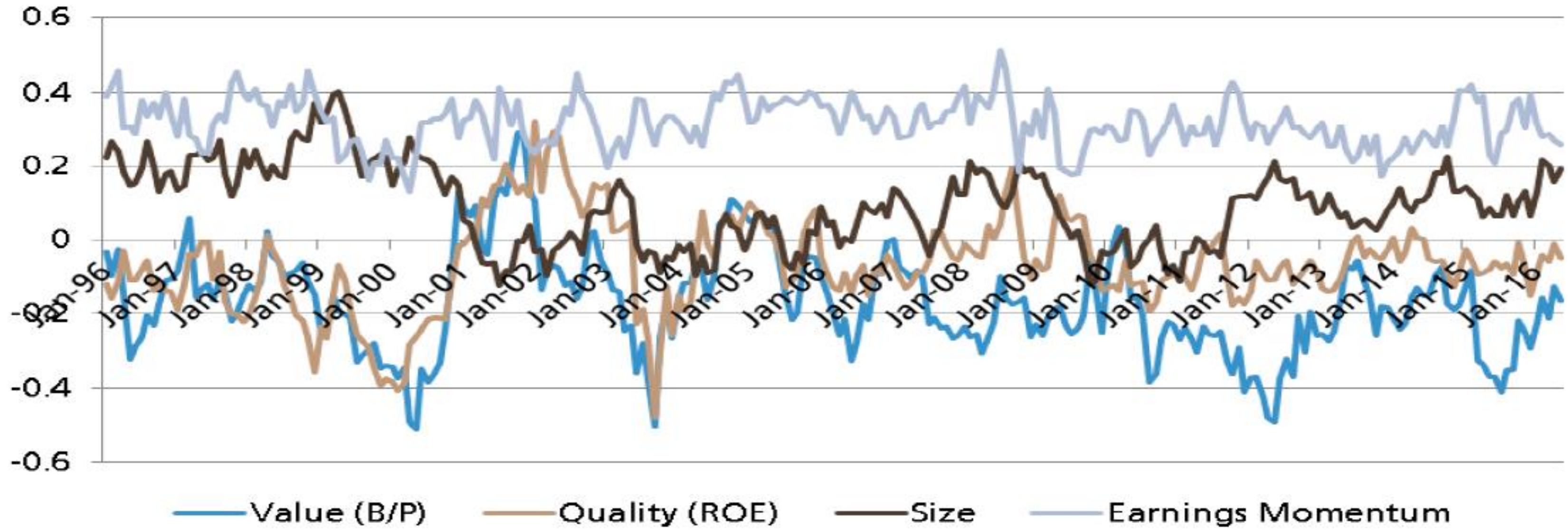


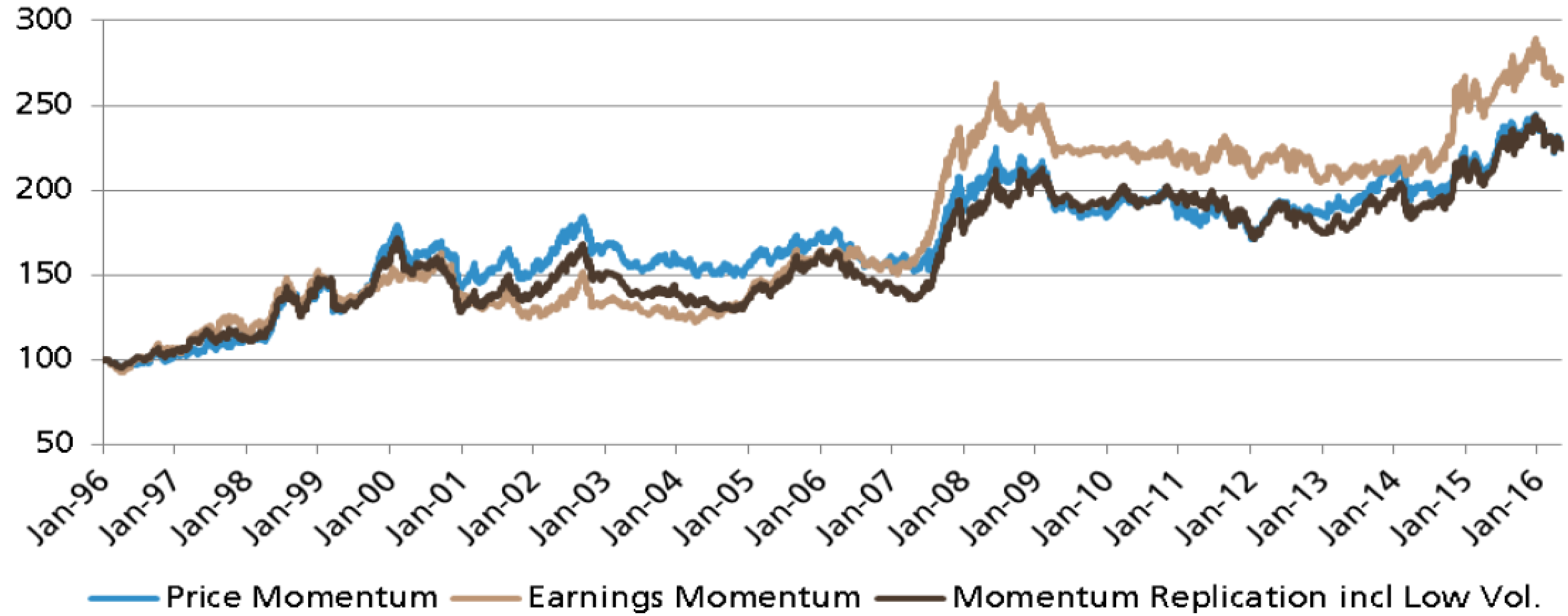




Source: UBS Quantitative Research

# Replicating Momentum

…using dynamic shifts across value, quality, size, earnings momentum and low-vol.

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Source: UBS Quantitative Research

# Timing versus Diversification

Finding:

*Technical styles (Momentum and Low-Risk) exhibit a genuine factor timing ability!*

"*Do you think you can time the factors?*"

*Take momentum and low-risk out of your pool of factors to "give yourself a chance".*

"*Is it enough to invest just in momentum and low-risk?*"
"*Are the fundamental factors redundant?*"

*No! "Timing" focuses on increasing future returns. A multi-factor allocation can reduce volatility (diversification)*

Section 6

# The value of diversification

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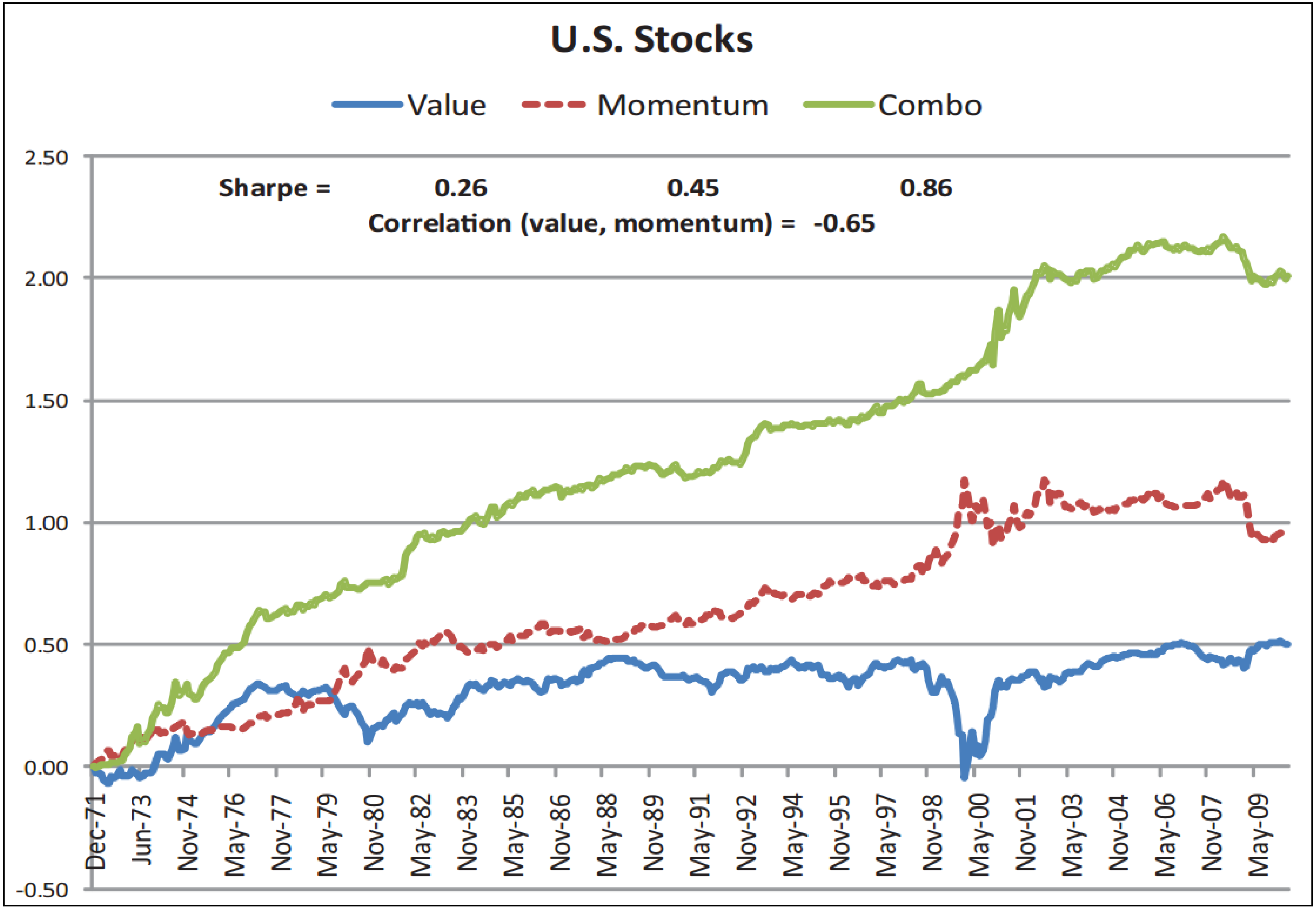
# A few lessons worth learning and remembering…

- Combine value with momentum
  – *Naturally negatively correlated: pick "cheap" winners*

- Combine value with quality
  – *Naturally negatively correlated: pick "cheap" and profitable*

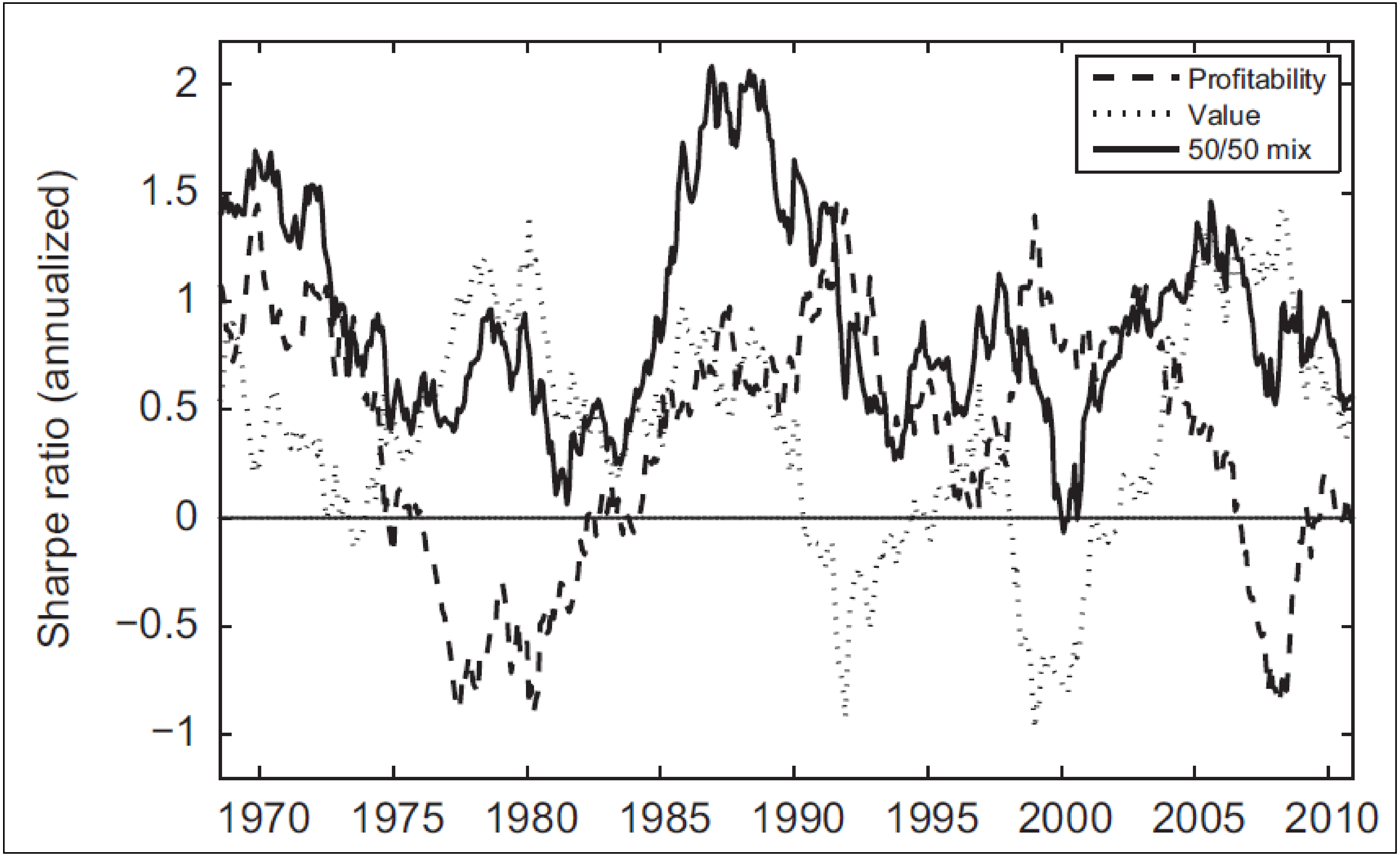
- "Clean" size from junk stocks
  – *Size is typically contaminated by junk (low-quality) names…*

# Combining Value and Momentum




Source: Asness, Moskowitz and Pedersen (2013)

# Combining Value and Quality




Source: Novy-Marx (2013)

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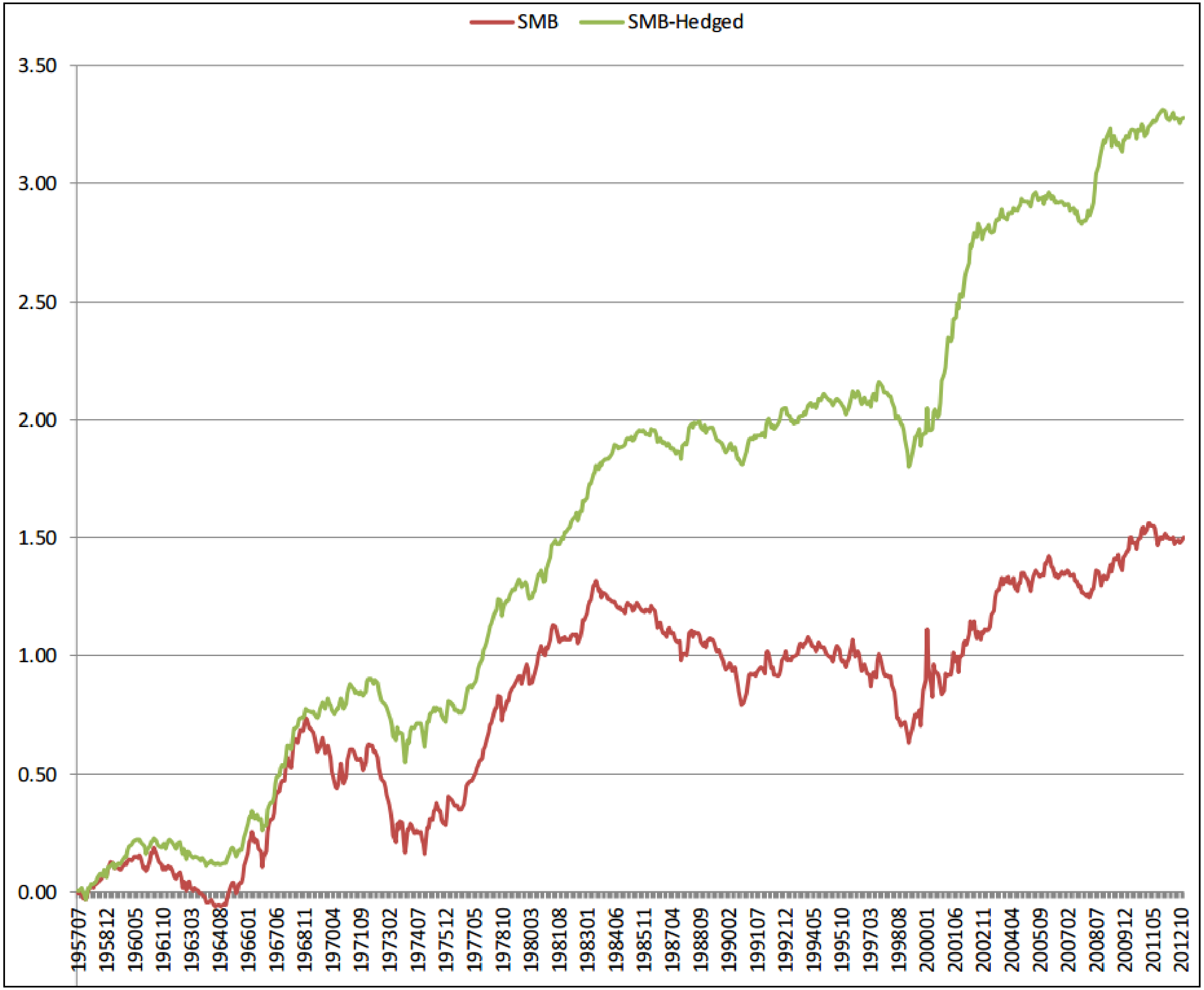
# Cleaning Size from Junk




Source: Asness, Frazzini, Israel, Moskowitz and Pedersen (2015)

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# Conclusions

- Identify what is driving the various premia. The various dynamics are largely different for genuine risk premia versus anomalies.

- Crowding can impact the profitability of equity premia; risk premia will become harder to harvest and anomalies will experience for frequent bubble-like behaviour, followed by pronounced crashes.

- Crowding cannot just make the premia vanish. Different utility function and correction of cognitive biases can. Quite unlikely to happen.

- Timing risk premia is fundamentally hard.

- Timing anomalies is theoretically possible, but market competition raises the bar. Volatility-targeting can greatly improve the performance of technical styles.

- Technical styles are one type of factor timing!

- Diversification matters!

Section 7

# Combining Smart Beta

# What weighting methods are available?

- No return forecasts
  - 1 / n
  - 1 / volatility
  - Risk parity
  - Maximum diversification
  - Maximum entropy
  - Minimum variance
- Tail / downside risk optimisation

- Note: we can use these methods both within the individual portfolios and between the portfolios.

- With return forecasts / judgement
  - Mean variance
  - Enhanced risk parity
- We can also consider a more active style rotation approach

# Equal weights and volatility parity

- Equal weighting is by far the simplest of approaches to combining our factor portfolios, and is quite hard to beat.
- As Kahneman says "More recent research went further: formulas that assign equal weights […] are often superior, because they are not affected by accidents of sampling."
- One simple extension of equal weighting is to equal weight between constant volatility versions of our portfolios (see *Understanding volatility targeting strategies, 2011*).

# Risk parity

- With risk parity, the portfolio weights are chosen so that the contributions to risk (or the risk budgets) from each asset are equal. There are no forecast returns taken into account; just the covariance matrix.
- We define the vector of weights of a portfolio as *w* and the covariance matrix of returns which we define as *V* then the total risk of a portfolio is defined as

$$\sigma = \sqrt{w'Vw}$$

- The marginal contribution to risk for an asset is defined as the marginal change in the risk for a marginal change in the weight of this asset.

$$MCR = \frac{\partial \sigma}{\partial w} = \frac{Vw}{\sqrt{w'Vw}}$$

- The weighted marginal contribution to risk is simply the weight multiplied by the *MCR*. These weighted MCRs are thought of as a risk budget as the sum across all assets equals the total risk of the portfolio.
- The risk parity solution is one where these weighted marginal contributions are equal for every asset in the portfolio. There is an alternative definition of risk parity which just weighting by 1 / volatility but we prefer the definition above.

# Maximum diversification

- The most-diversified ($MD$) portfolio (Choueifaty and Coignard, 2008) is defined as the allocation that maximises the Diversification Ratio ($DR$):

$$DR(\boldsymbol{w}) = \frac{\sum_{i=1}^{N} \sigma_i \cdot w_i}{\sigma_P(\boldsymbol{w})}$$

- i.e. it maximises the ratio of the weighted average portfolio volatility with the actual volatility.
- This portfolio is identical to the mean variance portfolio with $\mu_i = \sigma_i$ in the objective function.
- It has the advantage that it copes with identical assets, unlike risk parity.

# The identical asset problem

- Take the covariance matrix for four of our assets (here long / short) and add a fifth asset that is almost the same as the last factor.
- Then calculate the weights of each of our factor portfolios using various approaches.
- We note that for risk parity the total weight in "Size" when we have two assets is much larger than when only using one, unlike the other approaches.
- Although this is a valid criticism of risk parity the simple expedient of looking at the correlation matrix will help. Alternatively the factor risk parity approach will help.

| | EY | ROIC | Mom | Size | "Size 2" |
|---|---|---|---|---|---|
| EY | 5.13% | -0.648 | 0.419 | -0.206 | -0.206 |
| ROIC | | 5.39% | -0.476 | 0.151 | 0.151 |
| Mom | | | 8.51% | -0.073 | -0.073 |
| Size | | | | 5.85% | 0.990 |
| "Size 2" | | | | | 5.85% |

Source: UBS. Diagonal shows standard deviation; off diagonal shows the correlation

| | EY | ROIC | Mom | Size | "Size 2" | Total Size |
|---|---|---|---|---|---|---|
| Risk Par | 31.48% | 36.39% | 13.91% | 18.22% | 0.00% | 18.22% |
| Risk Par | 30.15% | 33.32% | 12.88% | 11.82% | 11.82% | 23.65% |
| Min Var | 38.69% | 40.34% | 8.07% | 12.90% | 0.00% | 12.90% |
| Min Var | 38.67% | 40.31% | 8.06% | 6.48% | 6.48% | 12.96% |
| Max Div | 35.08% | 40.25% | 11.57% | 13.10% | 0.00% | 13.10% |
| Max Div | 38.67% | 40.31% | 8.06% | 6.48% | 6.48% | 12.96% |

Source: UBS. For illustrative purposes only.

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# Maximum entropy

- A slight variation on the risk parity approach has been suggested by Lohre et al (2012) – which is to use maximum entropy, or equivalently maximise Meucci's (2009) measure of the effective number of bets.
- Carry out the factor rotation suggested above to obtain a diagonal $V_f$ where the diagonal elements are $f_i$ and the weights (exposures) in each factor are $\widetilde{w}_i$. Then the portfolio risk is simply

$$Portfolio\,Variance = \sum_{i=1}^{M} \widetilde{w}_i{}^2 f_i$$

- Then define the *diversification distribution* as

$$p_i = \frac{\widetilde{w}_i{}^2 f_i}{Portfolio\,Variance}$$

- Then Meucci defines the effective number of bets in the portfolio as

$$N_{Ent} = \exp\left(-\sum_{i=1}^{N} p_i ln p_i\right)$$

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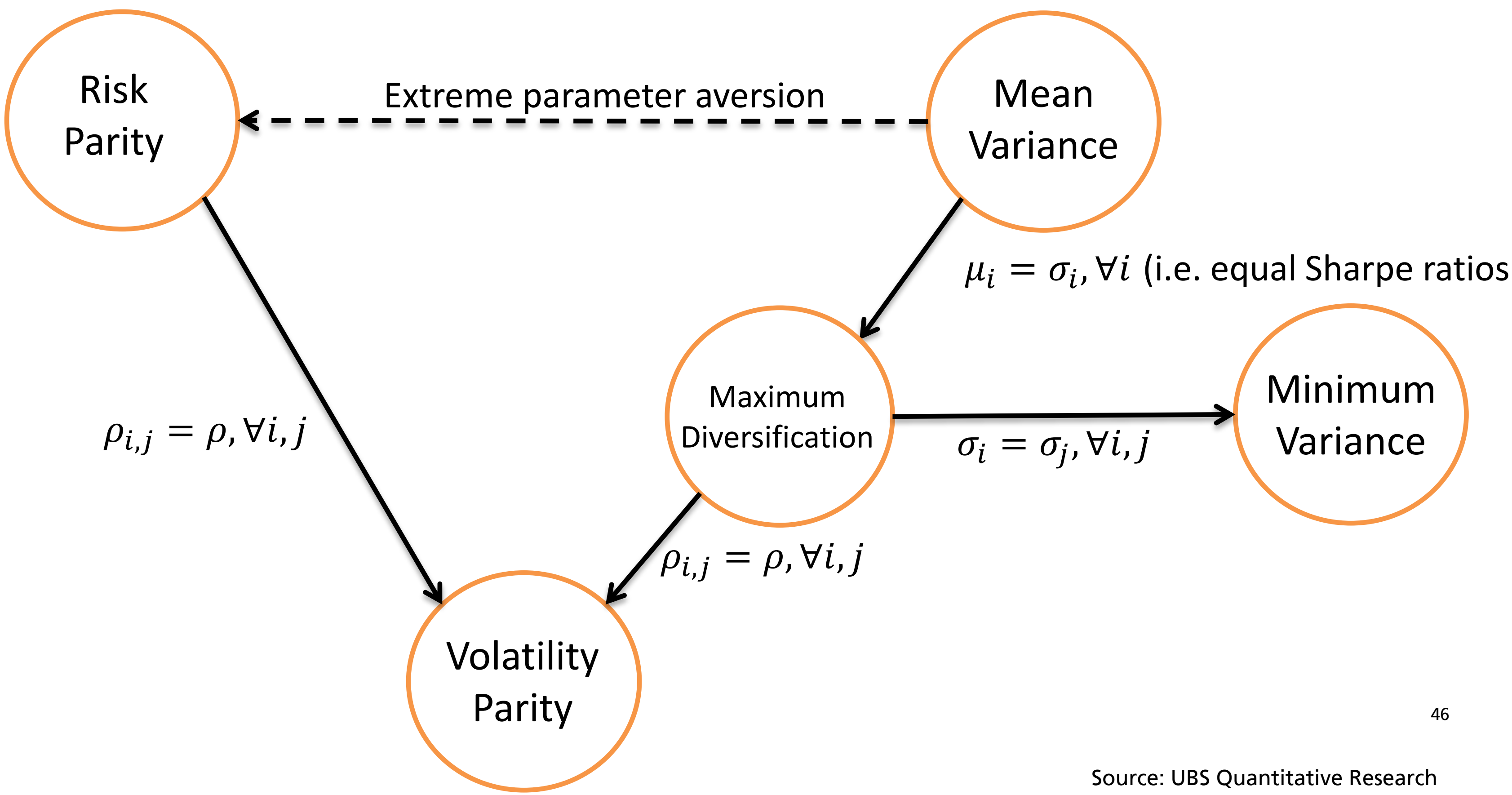
# Maximum entropy

- The minimum entropy portfolio maximises this measure which, in an unconstrained optimisation, is equivalent to obtaining risk parity between the factor portfolios. Lohre et al refer to this as *diversified risk parity.*
- An earlier suggestion for the use of entropy was by Bera and Park (2008) who used the same entropy measure except with $p_i$ = weight of asset *i*, which obviously ignores the correlation between assets entirely.
- As with risk parity one needs to consider which factors to reward. If you use PCA with long only portfolios (for example), how to deal with first (market) factor?
- Also which factor rotation should one use, as this leads to different resulting portfolios
- In a setting where bounds are not hit the entropy solution is identical to that obtained by running risk parity on the factors, hence we are not sure what is the justification for using the entropy measure.

# Comparing our weighting schemes

- The picture below shows the links between our weighting schemes, including also minimum variance. Maximum entropy doesn't quite fit in this picture

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Source: UBS Quantitative Research

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# Assumptions - summary

| Portfolio | Strategy definition | Optimality conditions | Capital / risk distribution | Risk characteristics |
|---|---|---|---|---|
| **Mean Variance** | Equalises $MRC_i$ | Identical excess returns | Highly concentrated<br>Highly sensitive to VCV<br>High turnover | Lowest risk<br>Lowest beta<br>High TE |
| **Maximum Diversification** | Equalises volatility-scaled $MRC_i$ | Identical Sharpe ratios | Highly concentrated<br>Highly sensitive to correlations<br>Moderately sensitive to vols<br>High turnover | Low / medium risk<br>Low beta<br>High TE |
| **Volatility Parity** | Equalises 1 / asset volatility | Identical Sharpe ratios<br>Identical correlations | Low / medium turnover<br>Only sensitive to diagonal of VCV | Medium risk<br>Beta below 1 |
| **Risk Parity** | Equalises $TRC_i$ | Identical Sharpe ratios<br>Unique correlation | Diversified in risk<br>Moderately sensitive to VCV<br>Medium turnover | Medium risk<br>Beta below but close to 1<br>Medium TE |
| **Equal Weight** | Equalises $w_i$ | Identical excess returns<br>Identical volatilities<br>Unique correlation | Diversified in capital<br>Insensitive to VCV<br>Low turnover | Medium to high total risk<br>Low / Medium specific risk<br>Beta above but close to 1<br>Low / medium TE |

Source: Based on Table 3 from "*Generalised Risk-Based Investing*" by Emmanuel Jurczenko, Thierry Michel and Jerome Teiletche; reproduced with permission. The table summarises the different risk-based strategies based on the choice of the parameters gamma and delta. $VCV$ denotes the covariance matrix, $MRC_i$ denotes the marginal risk contribution, $TRC_i$ denotes the total risk contribution and $w_i$ denotes $i$th asset's weight.

# Covariance matrices

- There is one final question to be answered, which is "Which covariance matrix should we use?"
- There are a number of options for this – below we consider two, one based on three years of weekly factor returns, another based on an EWMA on daily data.

## Weekly factor data

| | EY | ROIC | Mom | Size | Div Yield | Low vol |
|---|---|---|---|---|---|---|
| EY | 17.38% | 0.88 | 0.85 | 0.92 | 0.96 | 0.80 |
| ROIC | | 12.64% | 0.94 | 0.87 | 0.92 | 0.94 |
| Momentum | | | 13.36% | 0.84 | 0.89 | 0.90 |
| Size | | | | 16.06% | 0.87 | 0.74 |
| Div Yield | | | | | 13.44% | 0.90 |
| Low vol | | | | | | 10.35% |

Source: UBS. Calculated with 3 years of weekly factor returns on Wednesday. Data as at end September 2014. For illustrative purposes only

## EWMA daily data

| | EY | ROIC | Mom | Size | Div Yield | Low vol |
|---|---|---|---|---|---|---|
| EY | 11.06% | 0.89 | 0.97 | 0.80 | 0.99 | 0.92 |
| ROIC | | 8.48% | 0.92 | 0.81 | 0.91 | 0.95 |
| Momentum | | | 11.24% | 0.80 | 0.96 | 0.91 |
| Size | | | | 8.80% | 0.80 | 0.75 |
| Div Yield | | | | | 10.07% | 0.96 |
| Low vol | | | | | | 8.57% |

Source: UBS. Calculated using a daily EWMA with lambda = 0.95. For illustrative purposes only.

Section 7.A

# Combining Smart Beta

## Results: Long only

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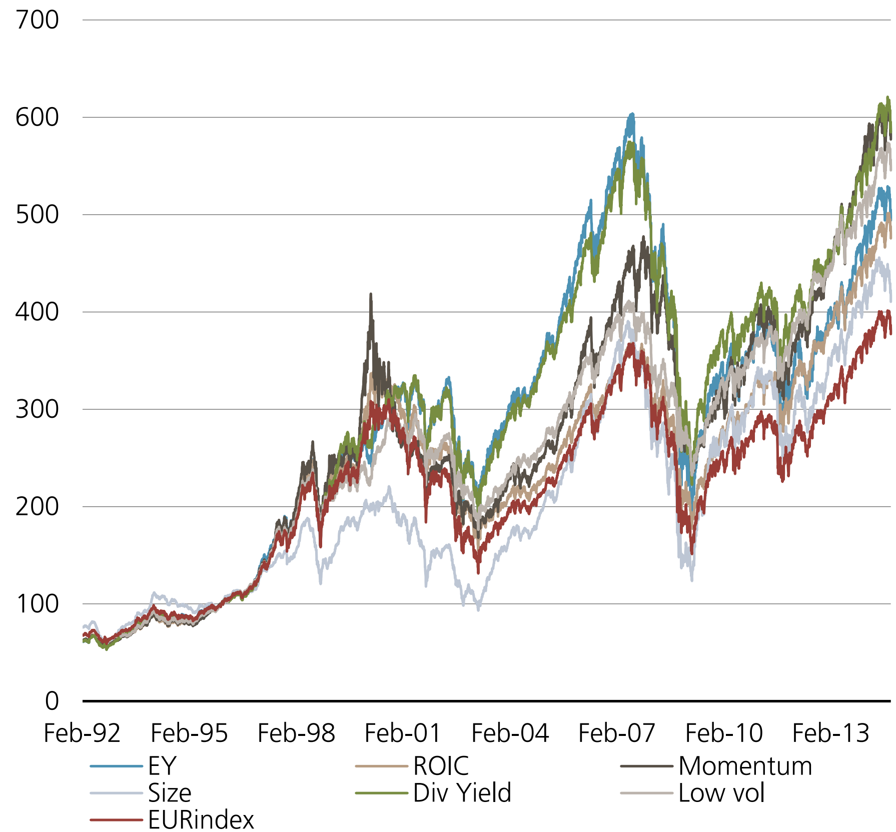
# Data

- In a long only framework we will use
  i) **Value**, price to earnings
  ii) **Quality**, ROIC
  iii) **Momentum**, price momentum from 12 months ago to 1 month ago, and
  iv) **Size**, small cap
  v) **Dividend Yield**, 12 month trailing dividend yield
  vi) **Low volatility**, daily volatility over the previous 12 months
- The US universe is the Russell 1000 stocks, the data starts in 1979 and all returns are in USD.
- The European universe is the Dow Jones Europe, the data starts in 1992 and returns are in Euros.
- Note: all the factor returns are calculated using index weights except for the low volatility in the US which is equal weighted.

# Data – Europe

## Dividend yield has the best IR in Europe; small cap the lowest

- The chart below shows the performance of our six European portfolios together with the index, total returns in EUR.




| | Earnings Yield | ROIC | 12m Mom | Size | Div Yield | Low vol | Index |
|---|---|---|---|---|---|---|---|
| Return | 8.57% | 8.35% | 9.44% | 7.54% | 9.51% | 9.12% | 7.07% |
| Std Dev | 21.06% | 18.36% | 19.09% | 16.11% | 18.98% | 14.56% | 19.69% |
| Sharpe (Rf=0%) | 0.41 | 0.45 | 0.49 | 0.47 | 0.50 | 0.63 | 0.36 |
| | | | | | | | |
| TE | 7.24% | 5.71% | 8.52% | 10.43% | 6.51% | 9.32% | |
| IR | 0.21 | 0.22 | 0.28 | 0.04 | 0.37 | 0.22 | |

Source: UBS. Risk and return in the table are from December 1995 to October 2014, calculated from daily returns.

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# Examples - Europe

- We now run a comparison of the different approaches for Europe and the US. We have two covariance calculations and 6 approaches to producing the portfolios.
- The tables below give the results for Europe.

**Weekly covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity |
|---|---|---|---|---|---|
| Return | 8.97% | 8.83% | 7.66% | 8.64% | 8.82% |
| Std Dev | 17.04% | 16.66% | 13.59% | 14.89% | 16.60% |
| Sharpe (Rf=0%) | 0.53 | 0.53 | 0.56 | 0.58 | 0.53 |
| | | | | | |
| TE | 5.24% | 5.52% | 9.38% | 7.16% | 5.56% |
| IR | 0.36 | 0.32 | 0.06 | 0.22 | 0.31 |

**Daily EWMA covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity |
|---|---|---|---|---|---|
| Return | 8.97% | 8.90% | 7.91% | 8.11% | 8.89% |
| Std Dev | 17.04% | 16.40% | 13.51% | 14.62% | 16.33% |
| Sharpe (Rf=0%) | 0.53 | 0.54 | 0.59 | 0.55 | 0.54 |
| | | | | | |
| TE | 5.24% | 5.80% | 9.92% | 7.70% | 5.85% |
| IR | 0.36 | 0.32 | 0.08 | 0.13 | 0.31 |

Source: UBS. For illustrative purposes only

- So in Europe we find that equal weighting is very hard to beat

# Examples - Europe

- The daily covariance matrix generates much more turnover than the weekly matrix (unsurprisingly).
- Equal weighting has the lowest turnover; and maximum diversification the most.

**Weekly covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity |
|---|---|---|---|---|---|
| Min. | 0.19% | 0.21% | 0.00% | 0.42% | 0.20% |
| 1st Qu. | 0.65% | 0.78% | 0.00% | 2.30% | 0.81% |
| Median | 0.99% | 1.22% | 0.22% | 4.38% | 1.26% |
| Mean | 1.27% | 2.31% | 4.40% | 9.01% | 2.35% |
| 3rd Qu. | 1.50% | 2.26% | 3.26% | 8.30% | 2.33% |
| Max. | 6.12% | 55.55% | 163.30% | 126.10% | 65.06% |

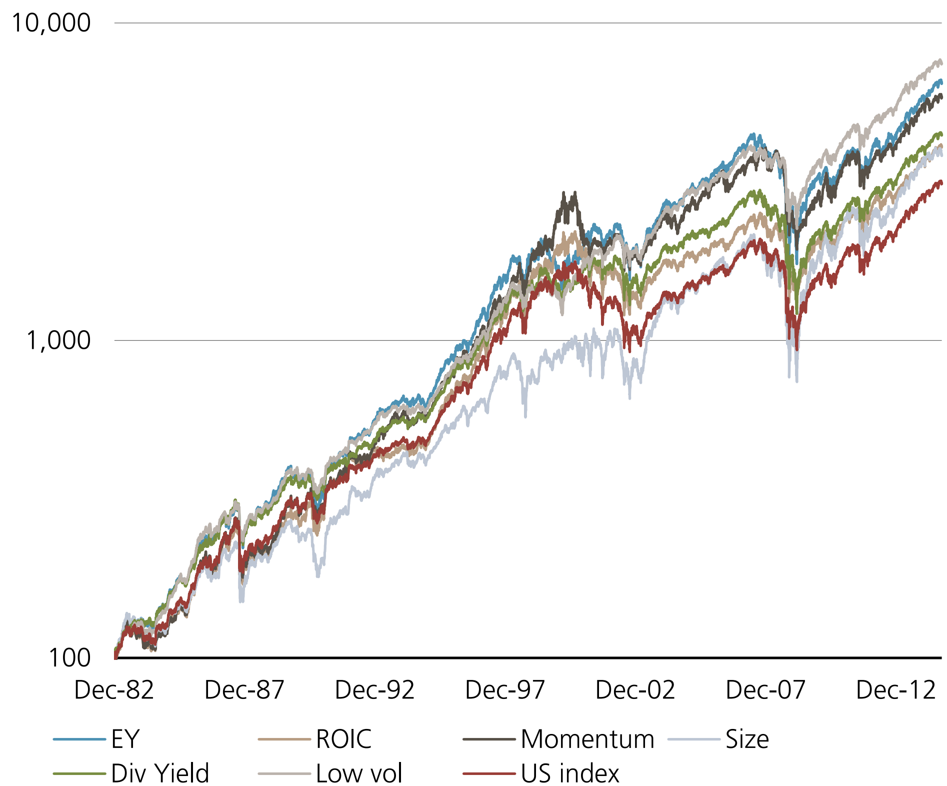
**Daily EWMA covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity |
|---|---|---|---|---|---|
| Min. | 0.19% | 0.89% | 0.00% | 0.43% | 0.92% |
| 1st Qu. | 0.65% | 3.48% | 0.00% | 15.96% | 3.68% |
| Median | 0.99% | 5.10% | 19.52% | 29.24% | 5.13% |
| Mean | 1.27% | 5.68% | 33.12% | 35.38% | 6.08% |
| 3rd Qu. | 1.50% | 6.95% | 52.05% | 49.91% | 7.66% |
| Max. | 6.12% | 22.76% | 200.00% | 138.80% | 25.73% |

Source: UBS.  For illustrative purposes only

# Data – US

- The chart below shows the performance of our six US styles.




| | Earnings Yield | ROIC | 12m mom | Size | Div Yield | Low vol | Index |
|---|---|---|---|---|---|---|---|
| Return | 13.51% | 11.95% | 13.17% | 11.74% | 12.23% | 13.75% | 11.03% |
| Std Dev | 17.98% | 18.14% | 18.77% | 19.09% | 16.13% | 17.59% | 17.41% |
| Sharpe (Rf=0%) | 0.75 | 0.66 | 0.70 | 0.62 | 0.76 | 0.78 | 0.63 |
| | | | | | | | |
| TE | 5.88% | 3.45% | 6.18% | 8.58% | 6.13% | 5.60% | |
| IR | 0.42 | 0.27 | 0.35 | 0.08 | 0.19 | 0.49 | |

Source: UBS. Risk and return in the table are from Dec 1982 to Sep 2014, calculated from daily returns. For illustrative purposes only

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# Examples - US

- The tables below give the results for US from Dec 82

**Weekly covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 0.1291 | 0.1279 | 0.1181 | 0.1235 | 0.1277 | 0.1216 |
| Std Dev | 0.1714 | 0.1694 | 0.1573 | 0.1645 | 0.1693 | 0.1607 |
| Sharpe (Rf=0%) | 0.7529 | 0.7547 | 0.7505 | 0.7508 | 0.7543 | 0.757 |
| | | | | | | |
| TE | 0.0303 | 0.0308 | 0.056 | 0.0392 | 0.0307 | 0.0653 |
| IR | 0.6199 | 0.5719 | 0.139 | 0.3363 | 0.5663 | 0.1738 |

**Daily EWMA covariance matrix**

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 0.1291 | 0.1282 | 0.1187 | 0.1246 | 0.1279 | 0.1035 |
| Std Dev | 0.1714 | 0.1678 | 0.1452 | 0.1626 | 0.1676 | 0.1545 |
| Sharpe (Rf=0%) | 0.7529 | 0.7643 | 0.8172 | 0.7659 | 0.7633 | 0.6703 |
| | | | | | | |
| TE | 0.0303 | 0.0329 | 0.0641 | 0.0419 | 0.033 | 0.073 |
| IR | 0.6199 | 0.5446 | 0.1303 | 0.3408 | 0.5344 | -0.0925 |

Source: UBS. For illustrative purposes only

- The turnover results are similar to those for Europe

Section 7.B

# Combining Smart Beta

## Results: Long/Short

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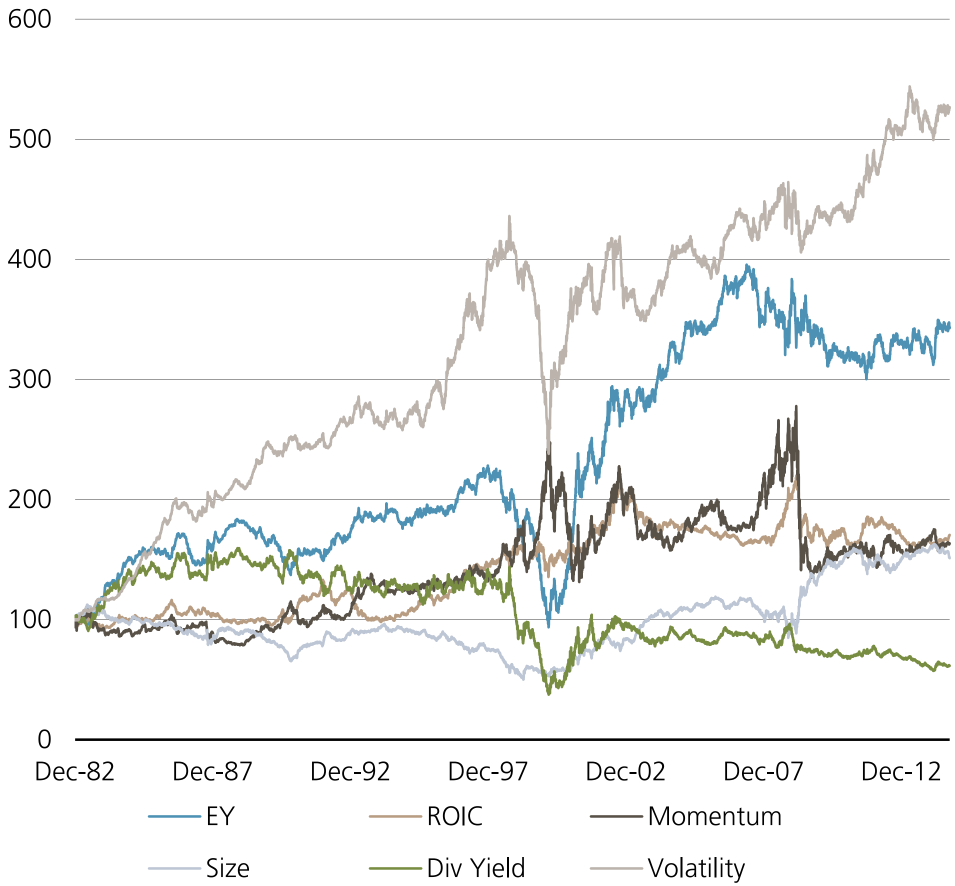
# Data

- In a long, short framework we will use
  - i) **Value**, price to earnings
  - ii) **Quality**, ROIC
  - iii) **Momentum**, price momentum from 12 months ago to 1 month ago, and
  - iv) **Size**, market-cap (small-cap minus large-cap)
  - v) **Dividend Yield**, 12 month trailing dividend yield
  - vi) **Low volatility**, daily volatility over the previous 12 months, with the long and short exposures adjusted to both have a beta of 1
- The US universe is the Russell 1000 stocks, the data starts in 1979 and all returns are in USD.

# Data – US

## Volatility is best overall, and momentum did badly more recently

- The chart below shows the performance of our six US styles.




| | EY | ROIC | Momentum | Size | Div Yield | Volatility |
|---|---|---|---|---|---|---|
| Return | 3.81% | 1.64% | 1.50% | 1.28% | -1.48% | 5.18% |
| Std Dev | 10.46% | 7.85% | 14.45% | 9.14% | 14.66% | 6.64% |
| Sharpe | 0.36 | 0.21 | 0.10 | 0.14 | -0.10 | 0.78 |

Source: UBS. Risk and return in the table are from Jan 1983 to September 2014, calculated from daily returns. For illustrative purposes only

- Given the historically poor performance of dividend yield we ran two tests, one with and one without dividend yield

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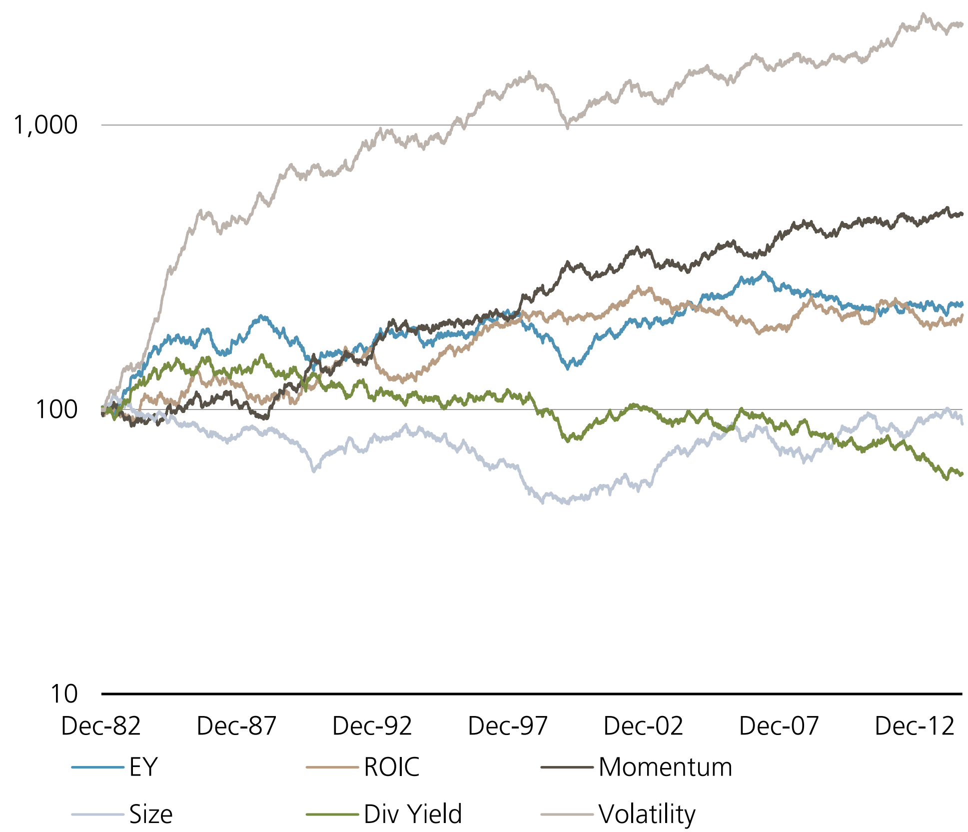
# Constant volatility – US

## Volatility targeting helps momentum and volatility

- The chart below shows the performance of a constant volatility version our six US styles, targeting 8% vol.




| | EY | ROIC | 12m mom | Size | Div Yield | Vol |
|---|---|---|---|---|---|---|
| Return | 2.61% | 2.37% | 4.93% | -0.35% | -1.58% | 9.96% |
| Std Dev | 7.75% | 7.77% | 7.74% | 7.76% | 7.76% | 7.73% |
| Sharpe | 0.34 | 0.30 | 0.64 | -0.05 | -0.20 | 1.29 |
| Untargetted SR | 0.36 | 0.21 | 0.10 | 0.14 | -0.10 | 0.78 |

Source: UBS. Risk and return in the table are from Dec 1982 to September 2014, calculated from daily returns. For illustrative purposes only.

# Examples - US

- The tables below give the results for US from Dec 82 and Dec 95

### Weekly covariance matrix

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 2.60% | 2.81% | 2.53% | 2.25% | 2.66% | 2.58% |
| Std Dev | 4.53% | 3.68% | 2.90% | 3.09% | 3.08% | 3.63% |
| Sharpe | 0.57 | 0.76 | 0.87 | 0.73 | 0.87 | 0.71 |

Source: UBS. First table shows results with Dividend Yield, the second without

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 3.21% | 3.29% | 3.20% | 3.17% | 3.29% | 2.42% |
| Std Dev | 3.74% | 3.34% | 3.03% | 3.21% | 3.14% | 3.83% |
| Sharpe | 0.86 | 0.98 | 1.05 | 0.99 | 1.05 | 0.63 |

### Daily EWMA covariance matrix

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 2.60% | 2.84% | 2.39% | 2.07% | 2.63% | 2.87% |
| Std Dev | 4.53% | 3.55% | 2.45% | 2.52% | 2.56% | 3.11% |
| Sharpe | 0.57 | 0.80 | 0.97 | 0.82 | 1.03 | 0.92 |

Source: UBS. First table shows results with Dividend Yield, the second without

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Return | 3.21% | 3.39% | 3.02% | 2.92% | 3.24% | 3.72% |
| Std Dev | 3.74% | 3.24% | 2.65% | 2.68% | 2.68% | 3.27% |
| Sharpe | 0.86 | 1.05 | 1.14 | 1.09 | 1.21 | 1.14 |

For illustrative purposes only

# Examples - US

- The results for the US (here showing for the ex dividend yield results) are similar to those for the long only case – equal weighting is the lowest; the max entropy the highest.

## Weekly covariance matrix

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Min. | 0.35% | 0.25% | 0.18% | 0.59% | 0.42% | 0.77% |
| 1st Qu. | 1.10% | 1.35% | 2.16% | 2.28% | 1.60% | 4.04% |
| Median | 1.58% | 1.90% | 3.46% | 3.52% | 2.36% | 7.81% |
| Mean | 2.03% | 2.40% | 4.35% | 4.48% | 2.94% | 18.80% |
| 3rd Qu. | 2.40% | 3.02% | 5.59% | 5.60% | 3.45% | 22.06% |
| Max. | 13.03% | 10.53% | 19.18% | 20.70% | 12.28% | 112.70% |

## Daily EWMA covariance matrix

| | Eq Wgt | Vol Parity | Min Var | Max Div | Risk Parity | Max Entropy |
|---|---|---|---|---|---|---|
| Min. | 0.35% | 1.64% | 1.51% | 3.48% | 3.38% | 5.71% |
| 1st Qu. | 1.10% | 7.58% | 17.62% | 16.79% | 9.92% | 38.59% |
| Median | 1.58% | 10.24% | 24.54% | 23.99% | 13.72% | 52.21% |
| Mean | 2.03% | 11.27% | 26.59% | 25.46% | 14.18% | 58.70% |
| 3rd Qu. | 2.40% | 14.14% | 33.47% | 31.87% | 17.29% | 75.75% |
| Max. | 13.03% | 35.42% | 92.93% | 95.80% | 38.94% | 184.20% |

Source: UBS. For illustrative purposes only

# Conclusions

- Equal weighting after volatility targeting momentum is hard to beat.
- This will be true if
  - The volatilities of the assets are similar, and
  - The correlation between the assets are relatively consistent
- In a cross asset universe, which we will address next, the first of these assumptions isn't true, so we have to use volatility parity as a starting point.
- It is hard to differentiate between risk parity, volatility parity and maximum diversification. As we have discussed in other presentations, volatility parity is theoretically inferior to the other two approaches, but empirically the bias from the momentum effect overweighs everything else.
- The turnover from maximum entropy and minimum variance are high.

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Section 8

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